



Health Profile, Cardiovascular Risk Prevention and Physical Exercise in Adolescents

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Abstract

The objective of this paper was to ascertain health profile and cardiovascular risk prevention by means of the personal and family background and an electrocardiogram of adolescents in order to improve the indications for doing physical exercise in schools. A descriptive, observational study was performed with a cohort of pupils from state and private schools. *Sample*: 1391 adolescents (667 boys and 724 girls). *Methodology*: descriptive, observational study. Structured questionnaire about the family and personal background of physical exercise and risk factors and the performance of an electrocardiogram. *Results*. Physical exercise of between two and five hours a week was performed by 45% of the boys and 47% of the girls and for more than five hours by 39.7% and 23%, respectively. *Symptoms*: isolated palpitations (23.7% boys and 39.1% girls), dizziness and/or transient loss of consciousness without consequences (7.3% and 13.8%, respectively), some type of controlled cardiac pathology (4.2% boys and 2.1% girls). In the electrocardiograms, 59 presented unspecific repolarisation alterations and nine an incomplete right bundle branch block, with heart disease being ruled out in all of them. *Risk factors detected*: arterial hypertension (2.3%), hypercholesterolaemia (7.3%), diabetes (2.3%), pre-obese (7.6% boys and 6.5% girls), obesity (2.2% and 1.5%, respectively) and smokers of more than six cigarettes a day (1.2% boys and 2.2% girls). *Conclusion*. The information from the pupils about their personal and family background and cardiovascular history, the electrocardiogram and their level of physical activity makes it possible to carry out a health education programme that will help to improve eating habits, perform physical activity and eliminate bad and unhealthy habits.

Keywords: adolescence, cardiovascular risk, electrocardiogram, physical exercise, primary prevention

Introduction

Young people who live in cities or in rural communities have gradually shifted towards a sedentary lifestyle, mainly due to greater travel facilities and the advent of new technologies and games that reinforce a largely physically inactive life. This is one of the arguments that have been used to promote out-of-school sport, since the hours spent on physical exercise in the educational syllabus are regarded as insufficient. The lack of physical exercise combined with unsuitable eating habits are relevant factors that impact the health of adolescents and adults alike.

The promotion of sports and physical activity (PA) in schools is geared towards improving health through changes in lifestyle, ensuring it is performed in suitable conditions and drawing on the pupils' basic health information. The modification of eating habits and health education with a view to avoiding overweight, smoking and drinking alcohol are other aspects that should be addressed in order to be the starting point for their future lifestyle model as adults and outside the school setting (Villalbí et al., 2012; Lobos & Brotons, 2011; Rendo-Urteaga et al., 2015).

One solid argument for doing sports and avoiding unjustified exclusions from them is having access to information about pupils with any kind of cardiovascular problem. Nevertheless, what matters most is the possibility of designing programmes tailored to individual conditions in order to improve physical qualities and enhance risk prevention.

A decrease in hours of sedentary lifestyle and an increase in moderate-to-intense PA is associated with a reduction in cardiovascular risk factors and metabolic alterations, loss of fat mass percentage, increased insulin sensitivity, reduction in plasma lipids and better physical exercise tolerance (Ekelund et al., 2012; Väistö et al., 2018). Similarly, schoolchildren's cognitive function is known to increase if they are physically active at break times, which is another way of reducing sedentary time (Rendo-Urteaga et al., 2015).

The coexistence of several risk factors begins at an early age and is associated with the onset of arteriosclerosis. These factors are more evident in older adolescents. Obesity associated with cardiometabolic syndrome induces diabetes, hypertension and silent cardiovascular disease (Tanrikulu et al., 2016; Newman et al., 1986; Berenson, 2009). It is crucial that these factors, all of which can be modified, are targeted by early prevention actions through changing diet, doing physical exercise and conducting health education programmes, particularly in the more socially underprivileged groups (Bibiloni et al., 2012; Ortega et al., 2018).

Adolescents begin to drink alcohol and smoke in this stage. Nevertheless, this tendency is tapering off, largely thanks to prevention campaigns and the laws enacted (Villalbí et al., 2012; Sánchez-Quejia et al., 2015), albeit recent data point to a fresh rise in consumption and changes in their habits. Alcohol and smoking are related to many diseases, especially ones involving cardiovascular risk factors and diseases, and hence preventing drinking alcohol and smoking at early ages is of paramount importance.

Objective. To ascertain health profile and cardiovascular risk prevention by means of the personal and family background and an electrocardiogram (ECG) of adolescents in order to improve the indications for appropriate performance of physical exercise in schools.

Methodology

Descriptive, observational cross-sectional study

The study sample was comprised of pupils from Spanish second- and fourth-year compulsory secondary education (CSE) and second-year bachillerato (post-16 pre-Uni stage) attending the high schools Angeleta Ferrer i Sensat in Sant Cugat del Vallès, Banús in Cerdanyola del Vallès, Castellet in Sant Vicenç de Castellet, Montserrat Roig in Sant Andreu de la Barca, Poeta Maragall in Barcelona, INS Terrassa de Terrassa y Santa Teresa de Barcelona; they are private, state-subsidised private or state schools in the countries of el Baix Llobregat, el Vallès Occidental and el Bagès and the city of Barcelona in Catalonia.

The sample was determined randomly among the schools at which the teaching staff agreed to participate in the study between 2017 and 2018. The sample size was chosen with the same criteria used in the FRESC (*Factores de riesgo en estudiantes de secundaria de Barcelona*) [Risk Factors in Secondary Education Students of Barcelona] survey for adolescents of the Agencia de Salud Pública de Barcelona [Public Health Agency of Barcelona] (ASPB), i.e., with a precision of 3%, 5% α error, an estimated proportion of 50% ($p = q = .5$) and a non-response of 20%. With these parameters, the sample size calculated was 1391 adolescents, 667 boys and 724 girls.

A structured and specific questionnaire about cardiovascular risk factors based on the health questionnaire of Catalonia (BMI, hypercholesterolaemia, hypertension, smoking and alcohol) was produced. In addition, a specific survey on exercise was conducted (adapted from the International Physical Activity Questionnaire [IPAC]

Serra-Grima et al., 2008; Craig et al., 2003) which gathered information on the type of exercise done by the pupils and their parents and its intensity together with the presentation of any symptoms related to physical exercise such as palpitations, sensation of dizziness or loss of consciousness. Information was also collected on the family history of cardiovascular risk factors (arterial hypertension, hypercholesterolaemia and diabetes) or heart disease, as well as the type of food intake, smoking and drinking alcohol.

The study was presented to the school councils and was approved at each school. A letter was sent to the families explaining the purpose of the research to secure their informed consent, stating that participation was voluntary. It was signed by all the families.

Once informed consent had been obtained, the pupils were given instructions on how to complete the questionnaire and did so in school hours under the supervision of their PE teacher. Following completion of the survey, they underwent an electrocardiogram in a room prepared for this purpose in the school.

A specific database was created for data collection and analysis and a pilot test was carried out before the study. The data collected were validated and quality control was conducted before the statistical analysis. A uni- and bivariate descriptive analysis of the data was performed. The distribution of normality was evaluated in all the variables by means of the Kolmogorov-Smirnov test. The categorical variables were compared by means of contingency tables using the chi-squared test. Student's t-test was used to compare quantitative and categorical variables. In all cases, the level of significance required was $p < .05$ ($\alpha = .05$). The SPSS S.26 statistical program was used.

Results

The characteristics of the pupils who participated in the study are displayed in Table 1.

No significant differences were observed between boys and girls in by-year distribution.

Table 1
Sample size, sex and age.

	Sex		Age	
	Quantity	Percentage	Mean	SD
Girls, 12-27 years	724	52 %	15.6	1.59
Boys, 13-20 years	667	48 %	15.55	1.48
Total	1391	100 %		

Table 2
Year of study.

Year	Age	n	%
2nd High School	17-18 years	197	14.20 %
4th CSE	15-16 years	668	48 %
2nd CSE	13-14 years	526	37.80 %
Total		1391	100 %

PA performed by the pupils and their parents

Time spent in PE classes was excluded from the pupils' PA tally. The boys performed significantly ($p < .001$) more licensed (federation) competitions than the girls, who in turn engaged in more in-school and out-of-school competition. The number of licensed pupils diminished significantly as of the age of 17 years ($p < .001$) (Tables 3 and 4).

Table 3
Physical exercise of pupils through competition outside PE classes.

	Boys	Girls
None	137 (20.5 %)	289 (39.9 %)
Out-of-school competition	145 (21.7 %)	173 (23.9 %)
In-school competition	83 (12.4 %)	131 (18.1 %)
Licensed	286 (42.9 %)	121 (16.7 %)
International	16 (2.4 %)	10 (1.4 %)
Total	667 (100 %)	724 (100 %)

Table 4
Hours of physical exercise a week by pupils outside PE lessons.

	Boys	Girls
None	35 (5.2 %)	56 (7.7 %)
Less than 2	65 (9.7 %)	61 (22.2 %)
Between 2 and 5	305 (45 %)	340 (47 %)
More than 5	262 (39.3 %)	167 (23.1 %)
Totales	667 (100 %)	724 (100 %)

The boys did a significantly greater number of hours of sport ($p < .001$).

The 15-to-16-year-old age group did most physical exercise.

The parents' physical activity was rated in terms of time spent, type of sport and whether it was competitive or not (Table 5).

Table 5

Physical exercise performed by the pupils' parents.

	2nd CSE	4th CSE	2nd Bachillerato
Regularly	18.4 %	12.3 %	10.2 %
Sporadically	35.9 %	36.5 %	22.3 %
Did no exercise	45.6 %	51.2 %	67.5 %

11% of the parents engaged in some type of competitive sport; 6.8% of fathers and 2.1% of mothers, with both competing in 2.5% of the cases.

When the hours spent by the pupils were cross-tabulated with the variable pertaining to the parents' participation in competitive sport, a statistically significant relationship was found ($p < .001$) inasmuch as the pupils who did most hours of exercise were the children of parents who engaged most in competitive sport.

Exercise-related symptoms in the study pupils.

Isolated palpitations: 283 (39.1%) girls and 158 (23.7%) boys reported having presented episodes on some occasion. Forty-seven (47) (6.5%) girls and 30 (4.5%) boys saw a doctor for this reason.

Dizziness and/or loss of consciousness. One hundred and twenty-five (125) (17.3%) girls and 52 (7.8%) boys presented some episodes of dizziness, although none of them actually lost consciousness. Of the participants that presented a sensation of dizziness, 100 (13.8%) were girls and 49 (7.3%) boys and had to stop exercising with no major consequences.

Family cardiac disease. Father with cardiac problems: 12.8%. Mother with cardiac problems: 8.6%. Siblings with cardiac problems: 2%

Cardiac disease in the pupils: Seven hundred and eight (708) (97.8%) girls and 639 (95.8%) boys had no type of known pathology. Sixteen (16) (2.2%) girls and 28 (4.2%) boys stated that they had some type of heart condition that had been reported to the school PE teacher.

ECG. One thousand (1,000) 12-lead records were taken with a portable device. The entire sample was not included for technical reasons. Unspecific repolarisation

and/or early repolarisation disorders were recorded in 59 cases. The characteristics of these disorders are frequent and did not require any further examination to rule out the existence of organic heart disease. In three cases, repolarisation alterations were recorded in the right precordial leads (V1-V3) of the type of repolarisation that occurs in children and normally persists until the age of 7 years, although there are exceptions.

Incomplete right bundle branch block was recorded in nine cases, and a prolonged PR interval in two cases, which reverted to normal with a mild increase in heart rate.

Cardiovascular risk factors. 2.3% reported arterial hypertension, 7.3% hypercholesterolaemia and 2.3% diabetes.

Smoking. 90.1% of the girls and 93.4% of the boys had never smoked. Of the remaining percentage, more girls than boys ($p < .05$) were found to smoke and smoking increased in the group of pupils aged 17 years and above ($p < .001$).

Table 6

Number of cigarettes a day reported by the pupils.

No. of cigarettes	Boys	Girls
1-2	16 (2.4 %)	1 (0.1 %)
4-5	9 (1.3 %)	17 (2.3 %)
5-10	6 (0.9 %)	14 (1.9 %)
15	2 (3 %)	2 (0.3 %)
Occasional	1 (0.1 %)	4 (0.6 %)
Total:	667 (100 %)	724 (100 %)

Obesity. BMI was below 18 in 296 (21.3%) of the cases and above 30 in 26 (1.9%). A total of 97 of the 1254 pupils were above 25. BMI was above 30 in 26 (1.9%) of the cases, meaning overweight/obesity. No significant differences were observed between boys and girls.

Table 7

Distribution of BMI in the pupils.

BMI	Boys	Girls
<18 insufficient weight	146 (21.9 %)	150 (20.7 %)
18-25 normal weight	455 (68.2 %)	516 (71.3 %)
25-29 pre-obesity	51 (7.6 %)	47 (6.5 %)
>30 obesity	15 (2.2 %)	11 (1.5 %)
Total	677 (100 %)	724 (100 %)

Drinking alcohol. Most of the pupils drank occasionally and at weekends, more specifically 20.8% of the boys and 24.3% of the girls. 75.9% of the boys and 70.3% of the girls were non-drinkers. Although the ratio was not significant, there was a clear trend towards greater alcohol consumption among the girls ($p < .07$), as has also been observed in recent studies. This trend was additionally reflected in drunkenness among the drinkers, with 15.1% of the boys and 22.2% of the girls having been drunk in the previous few days. As the pupils become older, alcohol consumption increased significantly ($p < .001$), and 58.9% of the *bachillerato* pupils drank alcohol.

Discussion

Physical exercise, diet and the absence of bad habits, particularly smoking which is the most common one, are basic cornerstones for the promotion and maintenance of health. There is a broad corpus of scientific evidence demonstrating that the coexistence of different risk factors begins in childhood (Newman et al, 1986; Berenson, 2009; Henriksson et al., 2017) and hence the importance of changing pupils' lifestyles, particularly with regard to physical exercise and eating habits. An increase in physical activity and a reduction in sedentary time are positively related to cardiometabolic risk and other major risk factors (Väistö et al., 2018; Sanjaolu et al., 2019; Rendo-Urteaga et al., 2015).

The prevalence of cardiovascular risk factors in Spain is equal to or greater than the mean of other European countries and is on the increase. This is one of the arguments for promoting prevention measures in school years so that pupils will continue to exercise once they have left high school (Lobos & Brotons, 2011).

Most state and private school dining facilities are supervised by nutritionists as the first link in the chain of health promotion measures. The second link, physical exercise, does not receive the attention it warrants. Two hours a week is totally insufficient, and teaching staff admit that they have to contend with limitations in implementing exercise programmes with the twofold function of being educational and improving health and physical qualities.

To make up for this drawback, out-of-school sports and activities intended to encourage pupils to engage regularly in physical activity were fostered. Further work is required in order to extend this base by including more girls and boys who due to a lack of motivation or physical limitations are not able to make the most of all the known benefits delivered by sport as a global, educational and recreational therapy.

Physical exercise is a planned, structured and repetitive activity which, besides helping to improve physical qualities, has gained fresh recognition in view of the evidence of its favourable effect on cognitive function and memorisation

and learning capacity in children and adolescents (Bueno, 2017; Mora, 2013; Manes, 2015).

The information on physical exercise that is performed by parents, since their example and motivation adolescents will benefit, which entails an education with a healthy lifestyle.

The quantification of physical exercise in energy expenditure to further health promotion has its limitations despite the contribution of questionnaires produced with this objective in mind. A questionnaire that was administered to former athletes who had retired from elite competition was used to evaluate activity in terms of hours a week along with the IPAC which is a reference point and has been validated.

Most of the study pupils did between two and five hours of exercise a week, below the recommendations of the American Academy of Pediatrics which considers that the age group between 6 and 17 years should do at least one hour a day of moderate activity, and if it is intense then it should be at least three days a week. 26.1% of American adolescents do no physical activity and 15.4% are sedentary (Lobelo et al, 2020). The lowest levels of physical exercise are in adolescents and groups with special needs. One relevant piece of data is that physical inactivity increases with age. In the pupils studied, 39.3% of the boys and 23.1% of the girls fulfilled the recommendations of allotting at least one hour a day to physical exercise.

Habits acquired during school years are not always maintained when pupils leave school. Nevertheless, inclusive physical exercise programmes which may be beneficial for pupils with more limited physical qualities or some type of doctor-supervised condition should be promoted to ensure adherence.

Exercise done in school and out-of-school sports does not usually involve very high physical demands and the rules that govern participation in team or individual sports make it possible in theory to regulate the effort made by adolescents. These rules foster inclusion, which is one of the priority objectives in sport.

Risk in sports is unusual, particularly if the training method is correct and proper preparation is ensured (Serra-Grima, 2015). Nevertheless, in order to ensure pupil safety and for PE teaching staff to be able to do their job properly, such staff should have extensive information about the pupils' family and personal background available. This was the case with the population analysed as shown in the questionnaire which was produced. Any background or history of cardiovascular diseases in first-generation members and whether or not they do physical exercise was ascertained. The pupils were asked if they had ever presented symptoms such as chest pain, palpitations, sensation of dizziness or loss of consciousness, and their answers, as well as the medical visit, did not yield any information that would lead to a recommendation for them to temporarily give up sport. 83.7% of the pupils had never had a sensation of dizziness

or loss of consciousness. Fifty-two (52) (7.8%) boys and 125 (13.8%) girls had to stop, although they recovered spontaneously and required no further measures.

PE teachers may not be able to identify the significance of effort-related symptoms that might not be normal. If pupils report symptoms such as palpitations, dizziness or loss of consciousness, the diagnosis must be made by a doctor. As shown in the table, only 4.4% and 6% of the pupils who reported palpitations actually went to see a doctor, and the episodes were regarded as benign in all cases. The sensation of palpitations reported by them cannot strictly speaking be interpreted as arrhythmia because they presented transiently at the beginning or at the end of exercising and fit more within the type of symptoms that may occur due to changes in pace or even in posture. There was no suspicion of actual arrhythmia in any case and generally speaking it is accompanied by other symptoms. Fifty-two (52) (7.8%) of the boys and 125 (17.3%) of the girls presented some type of episode, although none of them ever lost consciousness.

A total of 83.7% had never experienced a sensation of exercise-related dizziness or loss of consciousness. In the 49 (7.3%) boys and 100 (13.8%) girls who reported a sensation of dizziness, the episodes occurred after the effort made, a fairly common phenomenon when exercise is discontinued abruptly; none of them required medical care.

The inclusion of the ECG in the study is in line with the recommendations of the European Society of Cardiology (Corrado et al., 2005) for pre-participation screening to do sport. The drawback is the false positives that generate doubts, which may involve the performance of complementary examinations to be able to rule out the presence of structural heart disease. Of the 59 ECG in which alterations were recorded, most of them were non-specific repolarisation disorders, a relatively frequent finding in young people who do sports. In the pupils who presented other alterations such as incomplete right bundle branch block, the ECG was normal which meant the presence of structural heart disease could be ruled out. The two cases in which a prolonged PR interval was recorded reverted to normal with slight increases in heart rate, suggesting a functional alteration. In the absence of a family or personal background of exercise-related symptoms and an ECG with alterations of scant clinical value, the likelihood of risk is low. This enables PE teaching staff or coaches to do their job more safely and confidently.

Tackling obesity in both adults and adolescents is one of the objectives of community health programmes. Programmes for primary prevention, consisting of promoting physical exercise, and secondary prevention, involving education intended to maintain physical exercise and good eating habits in adult life, have been run (Sanyaolu et al., 2019). Promoting physical exercise and reducing sedentary lifestyles are factors for lessening cardiometabolic risk. 7.6% of the boys

and 6.5% of the girls in the pupils studied were overweight. A BMI greater than 30 is regarded as obesity, and 2% of the boys and 1.5% of the girls were above this figure (Table 7).

Studies conducted in adolescents to ascertain the prevalence of smoking in Spain indicate that it has diminished. There was a bracket ranging between 8.5% and 13.3% in boys and between 12.7% and 16.4% among girls. These results corresponded to the years between 1993 and 2008 (Villalbí et al., 2012). In the group of adolescents that were assessed, 93.4% of the boys and 90.1% of the girls were non-smokers, lower percentages which confirm the data obtained from the abovementioned study that pointed to a trend towards a reduction in smoking.

With regard to not drinking alcohol, also one of the mainstays of health, 75.9% of the boys and 70.3% of the girls stated that they do not drink. Those who do are occasional and weekend drinkers. However, it was found that the girls drank more and reported more episodes of drunkenness at the weekend. The results of a study conducted by Sánchez-Quejia et al. (2015) in three series point to a reduction in the consumption of wine and spirits between 2002 and 2010 and a rising trend in episodes of drunkenness, although some more recent data also indicate an increase in drinking. The questionnaire about alcohol consumption only asked the generic question without specifying the type of alcohol.

The study's objective was not to compare years or schools which is why the sample was selected globally, bearing in mind that not all pupils who complete 4th CSE go on to higher secondary education. Nevertheless, the sample size meant the results were representative of all the pupils in the research team's setting.

Conclusions

Promoting physical activity and education in order to embrace a healthy lifestyle should be initiated during school years and with a view to ensuring continuity in adulthood.

The overall information from the pupils about their personal and family background and level of physical activity performed makes it possible to take measures to embark upon a health education programme that will help with improving eating habits, performing physical activity and eliminating bad and unhealthy habits.

PE teachers or the people running out-of-school sports need to know whether pupils present effort-related symptoms, if they do whether such symptoms are significant and whether they have had a normal medical check-up by their paediatrician or GP. If in addition pupils have an ECG that rules out the existence of structural heart disease with a likelihood of risk, then PE teachers can do their job knowing that a serious cardiovascular event will only occur in exceptional circumstances.

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