Influence of overweight and childhood obesity on physical fitness according to socioeconomic level

Influencia del sobrepeso y la obesidad infantil en la condición física según el nivel socioeconómico

Authors

Myriam Guerra-Balic [1]
Josep Cabedo-Sanromà [1]
Francesca Sánchez-Martínez [2]
Gemma Serral-Cano [2]
Josep Sánchez-Malagón[1]
Carles Ariz-Cardenal [2]

[1] University Ramon Llull (Spain)
[2] Agència de Salut Pública de Barcelona (Spain)

Corresponding author:
Josep Cabedo-Sanromà
josepcs@blanquerna.url.edu

How to cite in APA

Guerra-Balic, M., Cabedo-Sanroma, J., Sánchez-Martínez, F., Serral-Cano, G., Sánchez-Malagón, J., & Ariza-Cardenal, C. (2025). Influence of overweight and childhood obesity on physical fitness according to socioeconomic level. *Retos*, *70*, 696–707. https://doi.org/10.47197/retos.v70.110830

Abstract

Introduction: Overweight and childhood obesity has increased its prevalence.
Objective: The main purpose of this study was to analyze whether overweight and childhood obesity related to socioeconomic levels determined physical fitness.
Methods: The sample included 3,279 children (1,634 boys and 1,645 girls) between the ages of 8 and 9y, divided into two groups according to the gross disposable family income: advantaged group (n=1,829) and disadvantaged group (n=1,450). The anthropometric data obtained were weight and height to obtain the Body Mass Index (WHO z-scores). With regard to physical fitness, agility, cardiorespiratory condition and muscle strength were recorded.
Results: The field tests showed significantly higher performance in the advantaged group compared to the disadvantaged group: ball throw 422.6 ± 102.9 cm vs 391.9 ± 106.7 cm, vertical jump 22.8 ± 7.7 cm vs 21.4 ± 6.1 cm, long jump 131.9 ± 24.1 cm vs 122.2 ± 23.1 cm zig-zag race 12.0 ± 5.1 sec vs 12.7 ± 5.2 sec., 20-meter speed 4.6 ± 0.6 sec vs 4.8 ± 0.7 sec. and 20-meter shuttle run test 12.3 ± 3.9 paliers vs 11.6 ± 3.6 paliers. Significant differences were also found in the BMI of the advantaged group 17.3 ± 2.4 compared to the disadvantaged group 18.0 ± 3.2.
Conclusions: Children with a lower socioeconomic level showed a higher level of overweight and obesity, which contributed to lower physical fitness performance.

Keywords

Obesity; overweight; physical activity; physical fitness; socioeconomic level.

Resumen

Introducción: La prevalencia de sobrepeso y obesidad infantil ha aumentado.
Objetivo: El objetivo principal de este estudio fue analizar si el sobrepeso y la obesidad infantil relacionados con el nivel socioeconómico determinaban la condición física.
Metodología: La muestra incluyó a 3.279 niños (1.634 niños y 1.645 niñas) entre los 8 y 9 años, divididos en dos grupos según el ingreso familiar disponible bruto: grupo favorecido (n=1.829) y grupo desfavorecido (n=1.450). Se obtuvieron datos antropométricos de peso y altura para calcular el Índice de Masa Corporal (puntuaciones z de la OMS). Por lo que se refiere a la condición física, se registraron la agilidad, la condición cardiorrespiratoria y la fuerza muscular.
Resultados: Las pruebas de campo mostraron un rendimiento significativamente mayor en el grupo favorecido en comparación con el grupo desfavorecido: lanzamiento de balón 422,6 ± 102,9 cm vs 391,9 ± 106,7 cm, salto vertical 22,8 ± 7,7 cm vs 21,4 ± 6,1 cm, salto de longitud 131,9 ± 24,1 cm vs 122,2 ± 23,1 cm, carrera de zig-zag 12,0 ± 5,1 seg vs 12,7 ± 5,2 seg, velocidad en 20 metros 4,6 ± 0,6 seg vs 4,8 ± 0,7 seg y prueba de carrera de 20 metros 12,3 ± 3,9 niveles vs 11,6 ± 3,6 niveles. También se encontraron diferencias significativas en el IMC del grupo favorecido 17,3 ± 2,4 en comparación con el grupo desfavorecido 18,0 ± 3,2.
Conclusiones: Los niños con un nivel socioeconómico más bajo mostraron un mayor nivel de sobrepeso y obesidad, lo que contribuyó a un menor rendimiento en la aptitud física.

Palabras clave

Actividad física; condición física; nivel socioeconómico; obesidad; sobrepeso.

Introduction

Concept of childhood obesity and overweight

Overweight and obesity in childhood have become a major public health problem, as their prevalence has risen in recent decades. According to the 2020-21 Health Survey of Catalonia (Enquesta de Salut de Catalunya, or ESCA), 23.5% of children aged from birth to 14 are overweight and 13.3% are obese. Regarding sex, overweight and obesity do not affect boys and girls equally. While 25.7% of boys and 21.2% of girls are overweight, 15.0% of boys and 11.4% of girls are obese.

Overweight and obesity are characterized by being overweight compared to height and contribute to many metabolic disorders (Kyle et al., 2016).

Body Mass Index (BMI) is not a diagnostic measure but a tool to detect and prevent possible problems associated with these conditions. It consists of the relation between weight and height (BMI=weight(kg)/height^2 (m^2). The value of this index varies according to each child's sex and age, and it indicates the presence of overweight when it is ≥85th percentile, and obesity when it is ≥95th percentile among children the same age and sex based on the growth tables adapted to each country (Sobradillo et al., 2011).

The causes of overweight and obesity are multi-factors, with different complex components. Aggarwal and Jain (2018) state that the etiology of childhood obesity can be divided into two groups: exogenous and endogenous. Exogenous obesity is brought about by a chronic imbalance between energy intake and expenditure, whereas endogenous obesity is caused by a variety of genetic, syndromic, and endocrine causes. These authors state that BMI measurement should be a part of all health-related checks of children, both when there is an exogenous and an endogenous cause of obesity. Nevertheless, it is imperative to look for clinical features as well.

Other causes considered by different authors are socioeconomic disadvantages, membership in an immigrant group or being part of a single-parent family (Moens et al., 2009). Factors such as genetics, lifestyles associated with eating habits, level of physical activity, screen activities related to an increase in sedentary behavior (Vilchis-Gil et al., 2015) and fewer hours of sleep (Miller at al., 2015) should also be considered.

Story et al. (2008) say that environmental and policy interventions may be among the most effective strategies for creating population-wide improvements in eating. These authors suggest an ecological model of multiple influences in choosing food, as they believe that eating behavior when choosing food is highly complex and results from the interplay of multiple influences, and that it includes cognition, behaviors, and biological and demographic factors across different contexts.

The environment includes the social environments (family, friends, peers, and others in the community), physical environments (home, work sites, schools, restaurants, and supermarkets) and macro-level environments, which play a more distal and indirect role (food marketing, social norms, food production and distribution systems, agriculture policies, and economic price structures) (Story et al., 2008).

Physical fitness and its evaluation in children, field tests

The American College of Sports Medicine (ACSM) defines physical fitness (PF) as the ability to perform everyday activities in a vigorous, intense way. According to the ACSM, PF related to health corresponds to aerobic capacity, muscle strength, muscle endurance, balance, flexibility, and good overall body composition (Riebe et al., 2018). In children, it is also worthwhile to consider other components like coordination, speed and agility (Marques et al., 2021).

Having low PF levels can be related to vulnerability and lower academic results. Furthermore, there is a clear relationship between the PF level and health (Marques et al., 2021). Moreover, Andrade Lara et al. (2024) studied a group of primary school children, applying three Fitness field tests (sprint 25m, test 20m shuttle run test (palier) and horizontal jump) and evaluated the association of them with the BMI. They found that the field tests performance depends on the BMI.

We should note that in the current social situation, the increase in the number of hours spent on screens (mobile phones, TV, computers, tablets, video games, etc.) is particularly alarming in children and is further increasing sedentarism (Fang et al., 2019). Moreover, the NEREU project developed a 9-month intervention with physical activity in 86 children aged 10.65 ± 2y and showed a decrease of BMI and sedentary behavior (Serra-Payá et al., 2014).

There are several laboratory and field tests to evaluate PF, with protocols that have specifically been validated for pediatric ages. In a systematic review, Marques et al. (2021) identified 24 batteries of tests administered to children, but not all of them include an evaluation of all the health-related components of PF. The HELENA study determined the reliability of different field tests that evaluate the components of PF, including the handgrip (KgW), the 20m shuttle run test (20MST, in number of paliers), the sit & reach (cm) and the standing long jump (cm) (Ortega et al., 2008). Another battery commonly applied to children older than 10y is the EUROFIT battery (Galvez, 2010), but certain adaptations are needed when they are younger. Moreover, the HELENA study also relates the physical activity and fitness level with the social characteristics of adolescents (Moreno et al., 2014).

Concept of advantaged and disadvantaged level

A previous study developed in Mexico (Chaves Erives et al., 2024) showed that there is a direct relationship between the socio-economic level of children (10.69+ /- 2.7y) and the risk of obesity. They compared three city zones and concluded that the central one, which presents the highest social-economic level, is where the highest number of obese children are.

As mentioned above, one of the main social factors related to overweight and obesity is membership at a disadvantaged socioeconomic level. The indicator of socioeconomic level is based on the classifications of income levels, educational level, and occupational category. Groups with a disadvantaged socioeconomic level tend to adopt somewhat unhealthy behaviors, such as diet, inactivity, or sedentary behavior, and less sleep (Serral-Cano et al., 2019), all of which means that they run a higher risk of being overweight and obese.

Eutret & Bekelman (2024) stated that there are existing gaps in the literature related with the effects of socio-economic conditions on obesity. These authors propose to identify other factors which can provide opportunities for improving this problem. That is why adding physical activity in order to increase the fitness levels of children and adolescents would be a good tool, which would be also related individually to the socioeconomic levels.

The present study is part of the Prevention of Childhood Obesity in Barcelona Project (Projecte Prevenció de l'Obesitat Infantil a Barcelona, or POIBA Project), whose overarching goal is to design and evaluate the effectiveness of a multicomponent (classroom, physical activity and family) and a multilevel (individual, family and school) treatment. Some of the specific goals of the POIBA are to design a preventive treatment that improves attitudes and skills related to diet, to increase the practice of physical activity, to lower the amount of screen time and to increase the number of hours of sleep to prevent overweight and obesity in children between the ages 8-12y (Sánchez-Martínez et al., 2016).

The goal in this study is to analyze whether obesity and overweight related to socioeconomic level determine physical fitness, in this way convening one of the gaps proposed by Eutrat & Bekelman (2024).

Method

Design and Participants

To conduct this study, an observational cross-sectional analytic study design was used bearing in mind BMI (calculated according to age and sex) as the dependent variable, categorizing the values obtained into normal weight, overweight and obesity; and socioeconomic level and PF as the independent variables (Hernández Sampieri et al., 2014).

A total of 4,139 students (4th grade) from 104 schools in 10 districts in the city of Barcelona were recruited. The schools were chosen randomly following a criterion of representativeness in the city in terms of their ownership (public, semi-private/private), and conducting a sample of the schools located in disadvantaged neighborhoods to obtain a sample in which 50% of the schoolchildren went to schools located in disadvantaged neighborhoods. The random assignment was conducted in the form of conglomerates, taking the classroom as the sample unit. Ultimately, 3,279 school children participated in the study, with a non-response rate of 20.8%. The reason 860 children did not participate was that their families did not sign the informed consent for their children to participate or because of the student's absence in the classroom when the data were collected. Finally, of the total participants, 1,634 were boys and 1,645 were girls between the ages of 8 (1,803) and 9 (1,476) years. The sample was also stratified according to the school ownership (1,545 public and 1,734 semi-public/private), and socioeconomic status (SES) (1,829 advantaged and 1,450 disadvantaged) (see Table 1). Data were obtained during April-June 2012. These data were collected throughout the school year, not all at the same time.

The Clinical Ethics Committee of the Parc de Salut Mar evaluated and approved this project (reference number 2009/3470/l). During the study, the national and international guidelines (professional codes of ethics, the 1964 Helsinki Declaration and the subsequent versions of it until the most current one from 2008) were followed. The parents provided their signed consent for their children to participate in the project. All the information was collected using data-protection and -storage procedures. The children's participation was voluntary, and they were assumed to agree to participate unless they stated otherwise. Nevertheless, considering that children also had the right to accept or not to voluntarily participate, they were asked orally if they wanted to participate in the study. If they did not, their decision was respected, and they were not forced to participate.

Instruments and Procedure

Through the personnel at the Public Health Agency of Barcelona (Agència de Salut Pública de Barcelona, or ASPB), with the prior written consent of the families, the following measurements were taken in school classrooms: height, weight, waist, and hip circumference, among others.

The SES was measured according to disposable family income (DFI) in 2009, which is an ecological indicator that measures the average purchasing power of families in each neighborhood. It shows the resources available for consumption or saving and is the macroeconomic indicator that best measures the average level of material wellbeing of the population. A favorable SES corresponds to a value ≥85, while an unfavorable one is <85 (Sánchez-Martínez et al., 2018; Ajuntament de Barcelona, 2021).

The BMI was calculated, and the guidelines of the World Health Organization (WHO) were followed to evaluate the degree of overweight and obesity (WHO, 2011). Height was measured to the nearest 0.1cm using a stadiometer. Weight was measured to the nearest 0.1kg on a digital balance scale with the subject wearing light weight clothing and no shoes.

To evaluate PF, certain tests were administered that are part of the European battery of EUROFIT tests, which allow for evaluation after the age of 10y (Gálvez, 2010). This battery has been accepted by the European Council to measure the PF at schools and is based on the principle of Sport for All. Given that the target population of this study was under the age of 10, within the framework of the POIBA project, an adaptation of the tests for children between the ages of 8 and 12 was designed with expert advice (Carrere et al., 2015). The final battery used consisted of a total of 6 tests which are classified according to the dimension of physical fitness they explore. To measure cardiorespiratory fitness (aerobic capacity) the test used was the 20 MRT. With regard to muscle strength (capacity to work against resistance), the vertical jump and the long jump which assess the explosive strength of the lower limbs, and a medicine ball throw was used to measure the strength of the arms, trunk and legs. Finally, for speed/agility (the ability to move the body, or part of it, as quickly as possible), the tests chosen were the 20m race for displacement speed and the zig-zag race with a ball to assess perceptual-motor coordination with an object. Three of these tests were added to replace others that the EUROFIT battery originally included. They were the 20 MRT, the vertical jump and the zig-zag race with a ball. We should note that several physical education teachers at each school were in charge of administering the battery to the participants in the study, following the PF exploration guide in school-aged children developed for this purpose. These PE teachers were trained previously to the beginning of the study.

The Family Affluence Scale (FAS) questionnaire (Hobza et al., 2017; Hollingshead, 1975) was administered to determine the SES. The FAS is an indicator of socioeconomic status. It was first developed in Scotland 25 years ago (Currie et al., 2008). This scale was included in a general POIBA questionnaire which was designed to obtain information about children's situations. It was a self-responded questionnaire answered by parents or legal tutors (Serral Cano et al., 2019).

Data analysis

During the fieldwork, the data collected were entered into the Microsoft Office Excel 2017 program in a personal computer. A database for each of the variables recorded was devised. Later, all the information was transferred to the Statistical Package for the Social Sciences (SPSS) 25.0 (IBM SPSS Statistics, Chicago, IL, USA) to statistically analyze the data obtained.

The dependent variable and the independent variables were analyzed via descriptive statistics using the repeated measures or frequency test, the arithmetic mean for central tendency, and standard deviation for dispersion.

The normality of the distributions in the continuous variables was checked using the Kolmogorov-Smirnov test, finding a p>.05, a hypothesis which was not rejected. For this reason, we checked the existence of differences among the advantaged and disadvantaged groups by means of the parametric Student T-test for independent samples in the physical fitness tests and BMI. Finally, we used a one-factor ANOVA applying Tukey's post-hoc test to compare the groups with normal weight, overweight and obesity according to socioeconomic level.

Results

The descriptives of the participants in the study are shown in Table 1.

Table 1. Variables description of sample by gender, type of school and socioeconomic status

Variables		n (%)
Sex	Boys	1,634 (49.8)
	Girls	1,645 (50.2)
Age (y)	8	1,803 (54.9)
	9	1,476 (45.1)
School ownership	Public	1,545 (47.1)
	Semi-private / Private	1,734 (52.9)
SES	Advantaged	1,829 (55.8)
	Disadvantaged	1,450 (44.2)
Total sample		3,279 (100)

Note. SES: Socioeconomic status

Table 2 shows the descriptive statistics and percentages of the assessment of obesity following the WHO's criteria in relation to socioeconomic level. The data show that 48% of the total sample presented overweight (24.6%) or obesity (13.4%). In both cases, the group with a disadvantaged socioeconomic level showed worse results, with 1.9% more overweight and 7.9% more obesity compared to the group with a higher family income.

Table 2. Percentage of obesity in relation to socioeconomic level (n=3,279)

	Socioeconomic level (SES)		
BMI (kg/m^2)	Advantaged group n (%)	Disadvantaged group n (%)	Total sample n (%)
Normal weight	1,214 (66.4)	820 (56.6)	2,034 (62.0)
Overweight	435 (23.8)	373 (25.7)	808 (24.6)
Obesity	180 (9.8)	257 (17.7)	437 (13.4)

Note. BMI: Body Mass Index

The different tests to assess PF and BMI between the two SES groups are shown in Table 3. There were significant differences in all the performance indicators on PF analyzed (p=.000) with the advantaged group attaining better results than the disadvantaged group. For example, the zig-zag test evaluates the coordination and running speed of the children (agility). If children are overweight or obese, it is supposed that this test will take more time to perform. So, as expected, children with advantaged SES run faster than those with disadvantaged SES, because they present more overweight/obese levels.

Table 3. Results of the Student T-test of BMI and the physical fitness tests between the two SES groups

Variables	Advantaged group Mean ± SD	Disadvantaged group Mean ± SD	*p*
Anthropometry			
BMI (kg/m²)	17.3 ± 2.4	18.0 ± 3.2	<.001
Field tests			
Ball throw (cm)	422.6 ± 102.9	391.9 ± 106.7	<.001
Vertical jump (cm)	22.8 ± 7.7	21.4 ± 6.1	<.001
Horizontal jump (cm)	131.9 ± 24	122.2 ± 23.1	<.001
Zig-zag race (sec.)	12.0 ± 5.1	12.7 ± 5.2	<.001
20m speed (sec.)	4.6 ± 0.6	4.8 ± 0.7	<.001
20 MSRT (paliers)	12.3 ± 3.9	11.6 ± 3.6	<.001

Note. BMI: Body Mass Index 20 MSRT: 20 m shuttle run test

The results shown in Table 4 further the analysis of the independent variable SES, this time according to BMI. Compared to the entire sample, only in children with overweight there were significant differences in performance on all the physical fitness tests ($p < .05$). This is not so with the normal-weight children, in which the advantaged group continued to attain the best results on the zig-zag race (11.9 ± 4.3 vs 12.4 ± 4.7 sec) and in the endurance test (12.8 ± 3.9 vs 12.5 ± 3.4 *paliers*), although these differences are not statistically significant. The palier is an indicator of the test measurement. It refers to the number of rounds that the participant has done. This circumstance of p>.05 also occurs in the obese population in leg strength tested through the vertical jump.

Table 4. Results of the analysis with the Student T-test comparing the two SES groups according to weight in relation to BMI and the physical fitness tests

	Normal weight			Overweight			Obese		
	Adv.Gr. Mean ± SD	Disadv.Gr Mean ± SD	*p*	Adv.Gr. Mean ± SD	Disadv.Gr. Mean ± SD	*p*	Adv.Gr. Mean ± SD	Disadv.Gr. Mean ± SD	*p*
BMI (kg/m²)	15.8 ± 1.2	15.7 ± 1.2)	.048	19.1 ± 0.8	19.2 ± 0.9	.019	22.3 ± 1.7	23.2 ± 2.5	<.001
Ball throw (cm)	412.8 ± 99.8	382.3 ± 99.5	<.001	433.9 ± 103.3	398.7 ± 113.5	<.001	456.8 ± 111.1	412.5 ± 114.7	<.001
Vertical jump (cm)	23.3 ± 7.5	22.3 ± 6.2	.003	22.2 ± 7.7	20.7 ± 5.8	.002	21.0 ± 8.2	19.7 ± 5.5	.068
Horizontal jump (cm)	135.3 ± 22.0	126.7 ± 23.4	<.001	127.6 ± 25.2	118.3 ± 21.5	<.001	121.0 ± 28.7	113.5 ± 20.9	<.001
Zig-zag race (sec.)	11.9 ± 4.3	12.4 ± 4.7	.053	11.8 ± 5.5	13.4 ± 6.5	<.001	12.6 ± 7.4	12.7 ± 4.7	.874
20m speed (sec.)	4.5 ± 0.6	4.7 ± 0.6	<.001	4.6 ± 0.6	4.8 ± 0.7	<.001	4.8 ± 0.7	5.0 ± 0.6	.020
20 MSRT (paliers)	12.8 ± 3.9	12.5 ± 3.4	.090	11.6 ± 3.6	10.9 ± 3.4	.004	10.4 ± 4.2	9.7 ± 3.5	.068

Note. BMI: Body Mass Index; 20 MSRT: 20 m shuttle run test

Tables 5 and 6 show the influence of normal weight, overweight and obesity on the performance of the different PF tests in the two SES populations separately. The obese children showed lower values compared to the other groups on all the variables recorded except the ball throw. Furthermore, significant differences were found between the normal weight group and the obese group, with a p=.000, except in the zig-zag race. In the lower limb strength test (horizontal jump), the speed test (20 m race) and the endurance test (20 MSRT), overweight and obesity, significance of a $p < .05$ was reached in all the comparisons between normal weight. This situation was the same in both the advantaged and the disadvantaged group. The disadvantaged SES performed lower on all the tests compared to the advantaged group.

Table 5. Results of the ANOVA of the BMI and the physical fitness tests comparing normal weight, overweight and obesity in the advantaged SES group

Variables	Normal weight Mean ± SD	Overweight Mean ± SD	Obesity Mean ± SD	*p*1	*p*2	*p*3
BMI (kg/m²)	15.8 ± 1.2	19.1 ± 0.8	22.3 ± 1.7	<.001	<.001	<.001
Ball throw (cm)	412.8 ± 99.8	433.9 ± 103.3	456.8 ± 111.1	.002	<.001	.040
Vertical jump (cm)	23.3 ± 7.5	22.2 ± 7.7	21.0 ± 8.2	.067	<.001	.182
Horizontal jump (cm)	135.3 ± 22.0	127.6 ± 25.2	121.0 ± 28.7	<.001	<.001	.007
Zig-zag race (sec.)	11.9 ± 4.3	11.8 ± 5.5	12.6 ± 7.4	.951	.267	.248
20m speed (sec.)	4.5 ± 0.6	4.6 ± 0.6	4.8 ± 0.7	.002	<.001	.001
20 MSRT (paliers)	12.8 ± 3.9	11.6 ± 3.6	10.4 ± 4.2	<.001	<.001	.003

Note. BMI: Body Mass Index; 20 MSRT: 20 m shuttle run test
*p*1: significant difference between normal weight and overweight; *p*2: significant difference between normal weight and obesity; *p*3: significant difference between overweight and obesity.

Table 6. Results of the ANOVA of the BMI and the physical fitness tests comparing normal weight, overweight and obesity in the disadvantaged SES group

Variables	Normal weight Mean ± SD	Overweight Mean ± SD	Obesity Mean ± SD	*p*1	*p*2	*p*3
BMI (kg/m^2)	15.7 ± 1.2	19.2 ± 0.9	23.2 ± 2.5	<.001	<.001	<.001
Ball throw (cm)	382.3 ± 99.5	398.7 ± 113.5	412.5 ± 114.7	.047	<.001	.270
Vertical jump (cm)	22.3 ± 6.2	20.7 ± 5.8	19.7 ± 5.5	<.001	<.001	.141
Horizontal jump (cm)	126.7 ± 23.4	118.3 ± 2 1.5	113.5 ± 20.9	<.001	<.001	.028
Zig-zag race (sec.)	12.4 ± 4.7	13.4 ± 6.5	12.7 ± 4.7	.006	.667	.235
20m speed (sec.)	4.7 ± 0.6	4.8 ± 0.7	5.0 ± 0.6	.001	<.001	.013
20 MSRT (paliers)	12.5 ± 3.4	10.9 ± 3.4	9.7 ± 3.5	<.001	<.001	<.001

Note. BMI: Body Mass Index; 20 MSRT: 20 m shuttle run test
*p*1: significant difference between normal weight and overweight; *p*2: significant difference between normal weight and obesity; *p*3: significant difference between overweight and obesity

Discussion

The POIBA project is based on a program for preventing childhood obesity in the city of Barcelona. This study analyzed the information of participants between the ages of 8 and 9y, describing their health-related PF evaluated through field tests, and its association with their SES.

Moens et al. (2009) explored the influence of multiple family factors that can condition the weight of children aged 6 to 14y, including the parents' stress and the characteristics of disadvantaged families. Other factors are the mother's BMI, the number of siblings, family structure, socioeconomic level, family situation, parental mental health, and parental stress. All these factors are moderate predictors of the children's weight, and therefore it is essential to seek other family mechanisms, as these authors believe that family characteristics have only been studied in a fragmentary way.

Our study focused on analyzing PF in relation to the SES of the school's neighborhood according to disposable family income (DFI). In Moens et al. (2009), the SES was calculated via the Hollingshead Index of Social Position (ISP) (Moens et al., 2009; Hollingshead, 1975). In any case, these authors concluded that family characteristics are not sufficient in themselves to explain the prevalence of overweight in children.

We should note that there are other methods to find the SES. For example, Shishehbor et al. (2018) studied the status of the neighborhood where one lives using ad-hoc scores and say that it is associated with an alteration in PF and cardiovascular disease, although unfortunately their study focused on adults. The same holds true of Talaei et al. (2013), who studied the relationship between SES and physical activity in an Iranian adult population. Other study found the information through family earnings, educational level, type of job and measures recommended by WHO regarding socioeconomic inequalities related to health and access to healthcare services in Central and Eastern Europe (Walters & Suhrcke, 2005). These authors focused on SES measured through indicators of material well-being (earnings, expenses, or self-declared financial status) or education. Most of them are not based on health inequalities in different socioeconomic groups like age, sex, or ethnicity. Meanwhile Wang & Geng (2019) studied it via the International Socio-Economic Index (ISEI) proposed by Ganzeboom, Graaf & Treiman (1992) in middle-aged adults (mean age 44.69 ± 13.36y) and reflect socioeconomic circumstances in relation to education, occupation and economic earnings. Regardless of how the SES was found in the different studies, the results are similar to ours.

This study shows that almost seven out of every ten children who participated and are of normal weight belonged to the advantaged socioeconomic group, while most of the children with overweight and obesity were in the disadvantaged group. These figures are like those reported by Moens et al. (2009) who studied the social status index and found that a group of children between the ages of 6 and 14y with a low social position presented more overweight than normal weight. Family characteristics accounted for only 26.5% of the variance in the BMI adjusted for children.

Regarding the field tests (Table 3), we can see that all the children with an advantaged SES obtained significantly better results (p<.05). These results are similar, albeit not at the level of significance, to those found by Esmaeilzadeh et al. (2013) in a study conducted with a sample of 766 participants aged 7-11y, which assessed BMI and cardiorespiratory capacity using the mile test. SES was calculated according to the parents' educational level and occupational status. Likewise, in the European HELENA-CSS (Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study) conducted with 3,259 adolescents, Jiménez-Pavón et al. (2010) evaluated PF according to socioeconomic level by applying the family affluence scale (FAS), just as in our study. Bearing in mind that the sample was older than ours, the participants with a high FAS showed a significantly higher level of PF than those with a low FAS on all the tests except speed-agility.

The same results were obtained with the younger sample than ours in the PREFIT study (fitness evaluation in preschool children) conducted by Merino-De Haro et al. (2019). The 2,638 participants in this study were children aged 3-5y whose PF and degree of obesity were evaluated, as well as whether the family's socioeconomic level affected performance on the physical tests using the PREFIT battery, and the BFI, too. This study showed that the children with a lower SES have a higher risk of obesity and lower PF from the earliest years of life. This battery included two of the tests applied in our study: strength (20 MRT) and speed/agility (4x10m).

Furthermore, we should note that when we compare SES according to BMI in our study, we still find that SES conditions the performance on the tests evaluated in each of these circumstances (Table 4). Thus, performance is always better in the advantaged group, which reached statistical significance in the population with overweight. The results are closer in obese children, specifically in the leg strength, agility, and endurance tests, but statistical significance is not reached (p>.05). These results are quite like those of Carvalho et al. (2010), who concluded that higher BMI levels are associated with a decline in PF, regardless of age, in a sample of schoolchildren aged 7-15y. Most obese children and almost half of those with overweight were classified in the category of lower PF. The tests administered, just like in our study, were 20 MRT, ball throw and horizontal jump.

We should also add that when the two SES groups are analyzed separately (Tables 5 and 6), the participants with normal weight from the advantaged and disadvantaged group showed higher performance than the sample with overweight and obesity in all the physical fitness tests (p<.05) in the horizontal jump, 20m race, and endurance test. It is noteworthy that the upper-limb strength test, with the ball throw, is the only case in which the obese participants showed significantly better performance compared to their counterparts with overweight and normal weight (p<.05). However, the advantaged group still earned higher scores than the disadvantaged group (456.8 ± 111.1cm vs 412.5 ± 114.7cm). Specifically, having higher body weight, it helps send the ball further, given that overall weight may help throw it in a general strength test with technical execution involving the legs, trunk and arms. This is a similar circumstance to the other throwing tests (shot put and hammer) associated with track and field, where the endomorphic somatotype can lead to better athletic performance (Rodríguez et al., 2014).

Conclusions

This descriptive study has found that overweight and obesity in childhood and socioeconomic levels are variables that have a clear influence on performance in different tests to assess PF, including strength, speed, agility, and aerobic endurance, along with BMI.

Children from the disadvantaged socioeconomic group showed significantly lower PF performance than the group with a higher family income. This also occurred with BMI as an assessment of obesity. Thus, the data show that the children with a lower family income present a higher overweight and obesity rate, which leads to lower performance on PF assessments.

At the same time, data also indicate that regardless of the SES group to which they belonged, children with normal weight always showed a significantly higher level of performance than the obese group in all the variables measured except in the ball throw.

Results suggest that future studies track this population during their compulsory education, while intervention programs should be conducted to improve their lifestyles and health.

Limitations and Strengths

The first limitation is the design of the study, as it is a cross-sectional one, which does not allow us to determine part of the causality criteria of the association. Another limitation is that findings cannot be generalized to other countries or regions, as the sample only belongs to Catalonia. It is also interesting to point out that, for body composition, only BMI was obtained in our study, instead of measuring adiposity through four skinfolds as recommended. It was not possible to collect four skinfolds from a sample of more than 3,500 children. It also can be considered a limitation that the collection data period could have been shorter because at the ages studied some children could grow and change their physiological characteristics, and that might condition the results of the physical tests. A strength of this study is the large sample of children in the city of Barcelona. The information extracted from this study showing the importance of keeping children and adolescents fit is also important.

Acknowledgements

We would like to thank the Agència de Gestió d'Ajuts Universitaris i de Recerca de la Generalitat de Catalunya (AGAUR SGR 2009-1345) for they support which was non-financial.

The authors would also like to thank the schools for their collaboration, the staff of the Terrassa City Council Department of Community Health for their involvement in the pilot study and the nursing team of the Community Health Department of the Agència de Salut Pública de Barcelona, who established contacts with the schools and were involved in the anthropometric measurements. We also appreciate the participation of the other POIBA Project Evaluation Group members [Elia Díez, Inma González, Olga Juárez, María Isabel Pasarín, Cristina Rey, Dolors Roca, Natàlia Sagarra, Elisabet Suades, and Nutrients 2021, 13, 453 20 of 22 Sara Valmayor (Agència de Salut Pública de Barcelona, Spain); Conxa Castell, (Agència de Salut Pública de Catalunya, Spain); Núria Lozano (Institut Barcelona Esports, Spain); Marc Llinàs (CoSESll Català de l'Esport, Spain); Albert Moncada (Terrassa City Council, Spain); Lluís Rajmil (Institut Hospital del Mar d'Investigacions Mèdiques, IMIM, Spain); Yolanda Montero (Institut Municipal d'Educació de Barcelona, Spain); Eduard Ortega (ABS Nova Lloreda, Badalona, Spain)]. This paper is in partial fulfilment of the requirements for the PhD program of Francesca Sánchez-Martínez at the University Pompeu Fabra, Barcelona (Spain).

Financing

This study was partially funded by the Health Research Fund (PI09/02259), which is part of the Carlos III Health Institute (Ministry of Economy and Competitiveness, Spanish Government) and by the Agència de Salut Pública de Barcelona.

References

Aggarwal, B. & Jain, V. (2018). Obesity in Children: Definition, Etiology and Approach. Indian Journal of Pediatrics, 85: 463–71 https://doi.org/10.1007/s12098-017-2531-x

Ajuntament de Barcelona, Oficina Municipal de dades del Departament d'anàlisi. (2021) La Renda de les Llars de Barcelona, distribució per districtes, barris i seccions censals 2018. [cited 2022/03/07]; Available from: https://ajuntament.barcelona.cat/barcelonaeconomia/sites/default/files/LA%20RENDA%20DE%20LES%20LLARS_2018_juliol.pdf

Andrade Lara, K. E., Latorre Román, P. Ángel ., Párraga Montilla, J. A., Pincay-Lozada, J. L., Cabrera Linares, J. C., & Mayanquer Lara, A. A. . (2024). Asociación entre la condición física y el estado ponderal en escolares de Educación Primaria (Association between physical condition and weight status in primary school students). *Retos*, *51*, 888–894. https://doi.org/10.47197/retos.v51.100788

Eutret, K., & Bekelman, T. A. (2024). Socioeconomic Status and Obesity. Journal of the Endocrine Society, 8(11), bvae176. https://doi.org/10.1210/jendso/bvae176

Carvalho Dumith, S., Viana Ramires, V., Alves Souza, M., Souza Moraes, D., Godoy Petry, F., Soldera Oliveira, E., Viana Ramires, S. & Hallal, P.C. (2010). Overweight/obesity and physical fitness among children and adolescents. Journal of Physical Activity and Health, 7(5):641-8. https://doi.org/10.1123/jpah.7.5.641

Carrere, J., Sánchez, F., Ariza, C. & Serral, G. (2015). Guía d'exploració de la condició física en edat escolar. Barcelona: Agència de Salut Publica de Barcelona. Available: https://www.aspb.cat/wp-content/uploads/2019/11/ASPB_guia-exploracio-fisica-edat-escolar.pdf

Chávez Erives, A. I. ., Ortiz Rodríguez, C. J. ., Islas Guerra, S. A., Trevizo, A. M., López-Alonso, S. J., & Gastélum-Cuadras, G. (2024). Prevalencia de sobre peso y obesidad en escuelas primarias por zonas socioeconómicas de la ciudad de Chihuahua (Prevalence of overweight and obesity in elementary schools by socioeconomic zones in socioeconomic zones of the city of Chihuahua). *Retos, 51*, 778–781. https://doi.org/10.47197/retos.v51.99706

Currie, C., Molcho, M., Boyce, W., Holstein, B., Torsheim, T., & Richter, M. (2008). Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. Social Science & Medicine, 66(6):1429–1436. https://doi.org/10.1016/j.socscimed.2007.11.024

Esmaeilzadeh, S., Kalantari, H.A. & Babak Nakhostin-Roohi, B. (2013).Cardiorespiratory fitness, activity level, health-related anthropometric variables, sedentary behaviour and socioeconomic status in a sample of Iranian 7-11 years old boys. Biology of Sport, 30(1):67-71. https://doi.org/10.5604/20831862.1029825

Fang, K., Mu, M., Liu, K. & He, Y. (2019). Screen time and childhood overweight/obesity: a systematic review and meta-analysis. Child: Care, Health and Development, 45(5):744-53. http://doi.org/10.1111/cch.12701

Gálvez, A.J. (2010). Medición y evaluación de la condición física: Batería eurofit. Revista digital efdeportes, 14 (141) (https://efdeportes.com/efd141/bateria-de-test-eurofit.htm)

Hernández Sampieri, R, Fernandez Collado, C. & Baptista Lucio, P. (2014). Metodología de la investigación, 4th Ed. Madrid: Mc Graw Hill

Hobza, V., Hamrik, Z., Bucksch, J. & De Clercq, B. (2017). The Family Affluence Scale as an Indicator for Socioeconomic Status: Validation on Regional Income Differences in the Czech Republic. Internationa Journal of Environmental Research and Public Health, 14(12): 1540. https://doi.org/10.3390/ijerph14121540

Hollingshead, A.B. Four Factors Index of Social Status. Unpublished working paper. Department of Sociology. Yale University. 1975 [cited 2022/09/29]; Available from: https://www.academia.edu/9608051/1975_Hollingshead_SES_Four_factor_index_of_social_status

Jiménez Pavón, D., Ortega, F.P., Ruiz, J.R., España Romero, V., García Artero, E., Moliner Urdiales, D., Gómez Martínez, S., Vicente Rodríguez, G., Manios, Y., Béghin, L., Répasy, J., Sjöstrom, M., Moreno, L.A., González Gross, M. & Castillo, M.J.; HELENA Study Group. (2010). Socioeconomic status influences physical fitness in European adolescents independently of body fat and physical activity: the HELENA study. Nutrición Hospitalaria, 25(2):311-6.

Kyle, T.K., Dhurandhar, E.J. & Allison, D.B. (2016). Regarding obesity as a disease: evolving policiesand their implications. Endocrinology and Metabolism Clinics of North America, 45:511–520. https://doi.org/10.1016/j.ecl.2016.04.004

Marques, A., Henriques-Neto, D., Peralta, M., Martins, J., Gomes, F., Popovic, S., Masanovic, B., Demetriou, Y., Schlund, A. & Ihle, A. (2021). Field-Based Health-Related Physical Fitness Tests in Children and Adolescents: A Systematic Review. Frontiers in Pediatrics, 9:640028. http://doi.org/10.3389/fped.2021.640028

Merino-De Haro, I., Mora-Gonzalez, J., Cadenas-Sanchez, C., Borras, P.A., Benito, P.J., Chiva-Bartoll, O., Torrijos-Niño, C., Samaniego-Sánchez, C., Quesada-Granados, J.J., Sánchez-Delgado, A., Dorado-García, C., García-Martínez, J.M., Vicente-Rodríguez, G., Labayen, I. & Ortega, F.B., PREFIT project group. (2019). Higher socioeconomic status is related to healthier levels of fatness and fitness already at 3 to 5 years of age: The PREFIT project. Journal of Sports Sciences, 37(12):1327-37. https://doi.org/10.1080/02640414.2018.1558509

Miller, A. L., Lumeng, J. C. & LeBourgeois, M. K. (2015). Sleep patterns and obesity in childhood. Current opinion in endocrinology, diabetes, and obesity, 22(1): 41–47. https://doi.org/10.1097/MED.0000000000000125

Moreno, L. A., Gottrand, F., Huybrechts, I., Ruiz, J. J., González-Gross, M., DeHenauw, S., on behalf of the HELENA Study Group (2014). Nutrition and Lifestyle in European Adolescents: The HELENA

(Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. Advances in Nutrition, 5 (5): 615S-623S https://doi.org/10.3945/an.113.005678

Moens, E., Braet C., Bosmans, G. & Rosseel, Y. (2009). Unfavourable family characteristics and their associations with childhood obesity: A cross-sectional study. European Eating Disorders Review, 17:315-23. https://doi.org/10.1002/erv.940

Ortega, F.B., Artero, E.G., Ruiz, J.R., Vicente-Rodriguez, G., Bergman, P., Hagstromer, M., et al. (2008). Reliability of health-related physical fitness tests in European adolescents. The HELENA Study. International Journal of Obesity, 32:S49–S57. http://doi.org/10.1038/ijo.2008.183

Riebe, D., Ehrman, J.K., Liguori, G. et al. (2018) American College of Sports Medicine. ACSM´s guidelines for exercise testing and prescription. 10th ed. Philadelphia: Wolter Kluwer.

Rodríguez, X., Castillo, O., Tejo, J. & Rozowski, J. (2014). Somatotype of high performance athletes of Santiago, Chile. Revista chilena de nutrición, 41 (1): 102-18. http://dx.doi.org/10.4067/S0717-75182014000100004

Sánchez-Martínez, F., Torres Capcha, P., Serral Cano, G., Valmayor Safont, S., Castell Abat, C. & Ariza Cardenal, C. Grupo de Evaluación del Proyecto POIBA. (2016). Factores asociados al sobrepeso y la obesidad en escolares de 8 a 9 años de Barcelona. Revista Española de Salud Pública,90: e1-e11

Sánchez-Martínez, F., Juárez, O., Serral, G., Valmayor, S., Puigpinós, R., Pasarín, M.I., Díez, E. & Ariza, C. (2018). Evaluation Group of the POIBA Project. A childhood obesity prevention programme in Barcelona (POIBA Project): Study protocol of the intervention. Journal of Public Health Research, 7:1129 https://doi.org/10.4081/jphr.2018.1129

Serra-Paya, N., Ensenyat Solé, A. & Blanco Nespereira, A. (2014). Multi-Disciplinary an Uncompetitive Intervention in Public Health for the Treatment of Sedentary and Overweight or Obese Children: Nereu Programme. APUNT's d'Educació Física, 117:7-http://dx.doi.org/10.5672/apunts.2014-0983.cat.(2014/3).117.01

Serral-Cano, G., Bru Ciges, R., Sánchez-Martínez, F. & Ariza Cardenal, C. Grupo de Evaluación del Proyecto POIBA. (2019). Sobrepeso y obesidad infantil según variables socioeconómicas en escolares de tercero de primaria de la ciudad de Barcelona. Nutrición Hospitalaria, 36(5):1043-48 https://dx.doi.org/10.20960/nh.02205

Shishehbor, M.H, Gordon-Larsen, P., Kiefe, C.I. & Litaker, D. (2018) Association of Neighborhood Socioeconomic Status with Physical Fitness in Healthy Young Adults: The Coronary Artery Risk Development in Young Adults (CARDIA) Study. American Heart Journal, 55: 699-705. http://dx.doi.org/10.1016/j.ahj.2007.07.055

Sobradillo, B., Aguirre, A., Aresti, U., Bilbao, A., Fernández Ramos, A., Lizárraga, A., Lorenzo, H., Madariaga, L., Rica, I., Ruiz, I., Sánchez, E., Santamaria, C., Serrano, J.M., Zabala, A., Zurimendi, B. & Hernández, M. (2011). Curvas de Crecimiento (longitudinal y transversal). Fundación Faustino Orbegozo Eizaguirre. [cited 2022/09/29]; Available from: https://www.aepap.org/sites/default/files/documento/archivos-adjuntos/f_orbegozo_04.pdf

Story, M., Kaphingst, K.M., Robinson-O'Brien, R. & Glanz, K. (2008). Creating healthy food and eating environments: Policy and environmental approaches. Annual Review of Public Health, 29:253–72. https://doi.org/10.1007/s12098-017-2531-x

Talaei, M., Rabiei, K., Talaei, Z., Amiri, N., Zolfaghari, B., Kabiri, P., & Sarrafzadegan, N. (2013). Physical activity, sex, and socioeconomic status: A population based study. ARYA Atherosclerosis, 9(1): 51-60.

Vilchis-Gil, J., Galván-Portillo, M., Klünder-Klünder, M., Cruz, M. & Flores-Huerta, S. (2015). Food habits, physical activities and sedentary lifestyles of eutrophic and obese school children: a case-control study. BMC public health, 15: 124. https://doi.org/10.1186/s12889-015-1491-1

Walters, S. & Suhrcke, M. (2005). Socioeconomic inequalities in health and health care access in central and eastern Europe and the CIS: a review of the recent literature. WHO/EURO:2005-4079-43838-61724. [cited 2022/09/29]; Available from: https://apps.who.int/iris/handle/10665/350352

Wang, J. & Geng, L. (2019). Effects of Socioeconomic Status on Physical and Psychological Health: Lifestyle as a Mediator. International Journal of Environmental Research in Public Health, 16(2):281. https://doi.org/10.3390/ijerph16020281

World Health Organization (WHO). (2011). Body mass index-for-age (BMI-for-age) (who.int)). [cited 2022/08/15]; Available from: https://www.who.int/toolkits/child-growth-standards/standards/body-mass-index-for-age-bmi-for-age

Authors' and translators' details:

Myriam Guerra-Balic	miriamelisagb@blanquerna.url.edu	Autor/a
Josep Cabedo Sanroma	josepcs@blanquerna.url.edu	Autor/a
Francesca Sánchez-Martínez	fsanchez@aspb.cat	Autor/a
Gemma Serral-Cano	gserral@aspb.cat	Autor/a
Josep Sánchez-Malagón	josesm0@blanquerna.url.edu	Autor/a
Carles Ariza-Cardenal	cariza@aspb.cat	Autor/a