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Research Article

Effect of Sedentary Lifestyle on the Physical Efficiency Index in Schoolchildren with Obesity

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Received: August 16, 2022; **Published:** August 30, 2022

Abstract

Background: It is necessary to systematize the use of instruments to measure physical capacity in children to have determinations of the physical impact of the sedentary lifestyle in order to implement measures that stop the damage and prevent them from reaching adulthood with decreased physical capacity.

Objectives: The objective of this study was to measure cardio-respiratory fitness and cardio-respiratory endurance, as well as its association with a sedentary lifestyle in children aged 8 to 12 years with obesity.

Methodology: Prospective cross-sectional study from July 2019 to February 2020 in the Department of Pediatrics of General Hospital of León, Guanajuato, México.

Results: Nineteen boys and 13 girls with an age of 10.6 ± 1.5 years, body mass index 26.2 ± 3.4 and waist/height index 0.6 ± 0.05 cm were reviewed. Sixty-nine percent were classified as sedentary. The median physical efficiency index was 68 (interquartile range 63 - 74). The cardio-respiratory fitness index was excellent in 15 (47%), very good in 6 (19%), good in 8 (25%), sufficient in 1 (3%) and poor in 2 (6%). There was a negative correlation between age and the physical efficiency index in the sedentary group (R2 0.2, Pearson's correlation coefficient -0.45 [95% CI -0.03 to -0.72], p = 0.037).

Conclusion: One in 10 children with obesity has impaired cardio-respiratory fitness. The sedentary lifestyle is correlated with a deterioration in the physical efficiency index in older schoolchildren with obesity.

Keywords: *Fitness; Children; Obesity; Sedentary Lifestyle*

Abbreviations

BMI: Body Mass Index; CDC: Centers for Disease Control and Prevention; HR: Heart Rate; KPR: Kasch Pulse Recovery; PAQ-C: Physical Activity Questionnaire for Children; PEI: Physical Efficiency Index

Introduction

Given the accelerated increase in the prevalence of obesity in children, there is a need to have determinations of the physical impact of this condition in order to implement measures that stop the damage and prevent them from reaching adulthood with decreased physical capacity.

Many authors agree on the importance of improving habits in childhood in order for them to become healthy adults [1]. The availability of subjects to lead healthy lifestyles has also been evaluated through models such as the Prochaska transtheoretical of change [2-10].

One of the main therapeutic strategies in the management of childhood obesity is physical activity. A fundamental point in therapeutic attachment is the objective evaluation of physical capacity and its modifications throughout the process. By measuring the physical capacity of the child, the result of the interventions can be quantified and feedback to the patient and his family can be given.

Various instruments have been proposed to measure physical ability in children. Jankowski M., *et al*. in Poland studied 7164 children aged 6 to 12 years to build percentiles of normal post-exercise heart rate using the step test and established 6 categories: excellent, very good, good, sufficient, poor and very poor [11].

Lee HT., *et al*. in Korea carried out an evaluation of the cardio-respiratory efficiency in schoolchildren using the Harvard step test and the physical efficiency index (PEI) in normal children and those with overweight and obesity, finding a lower PEI in children with obesity (55.2 ± 4.2) compared with eutrophic children (57.5 ± 5.5) ($p < 0.005$) [12].

In addition to measuring physical capacity, instruments have also been constructed to assess sedentary lifestyle in children. One of the most used worldwide is the Physical Activity Questionnaire for Children (PAQ-C) that is applied to children between 8 and 14 years old and has already been translated into Spanish by Benitez-Porres J and collaborators in 2016, who established a cut-off point of < 2.73 points to consider that a child is sedentary [13].

Objective of the Study

The objective of this study was to measure the level of physical capacity in children with obesity and to compare the results according to their level of sedentary lifestyle.

Materials and Methods

Study design

Prospective cross-sectional study conducted from July 2019 to February 2020 in the pediatrics department of General Hospital of León, Guanajuato, México. The main objective was to measure physical capacity through cardio-respiratory fitness and cardio-respiratory endurance, as well as its association with the PAQ-C score in children aged 8 to 12 years with obesity.

Children of both sexes, 8 to 12 years of age, with body mass index > 95th percentile according to graphs from the Centers for Disease Control and Prevention (CDC) and waist/height index > 0.5 were included. Children who had been ill during the 7 days prior to the study, who did not give consent to participate, whose parents or guardians did not give their consent to participate, with contraindications to physical activity or with neurodevelopmental delay were not included.

To calculate the sample size, it was considered that at least 25% of children had an adequate level of physical activity, with a variability of 15% and a confidence level of 95%, a sample size of 32 subjects was calculated. Non-probability sampling, of consecutive cases, for convenience.

Ethics

Approval was obtained by the ethics committee of the León General Hospital to carry out this study, with the registration number SSGTO00301 of the Guanajuato Ministry of Health. In order to be included in the study, a written informed consent letter was signed by parents and assent by the children.

Measurements

Measurement of physical activity level [13]: The instrument physical activity questionnaire for children (PAQ-C) version validated in Spanish was used to classify the children as active if the score was > 2.73 and as sedentary if it was lower than this level.

Kasch pulse recovery test (KPR test) [11]: The KPR Test consisted of climbing a 0.2m step with anti-skid base at a rate of 24 cycles of steps up and down per minute using a metronome set at 96 beats per minute. A cycle was defined as: right foot up, left foot up, right foot down, left foot down. The heart rate (HR) was recorded with fingertip pulse oximeter model C101A3 iMDK. Throughout the test, HR was monitored continuously during 3 minutes of exercise and during 1 minute of recovery (seated position). The test was discontinued if the exercise HR exceeded 180 beats per minute for more to 15 seconds, it was considered as very poor cardiorespiratory fitness.

Measurement of cardio-respiratory fitness [11]: Post-exercise respiratory rate was evaluated with the KPR Test for children under 12 years of age, classified into 6 categories.

Cardio-respiratory fitness	Heart rate post exercise (beats per minute)			
	Boys (6 - 9 years)	Boys (10 - 12 years)	Girls (6 - 9 years)	Girls (10 - 12 years)
Excellent	< 95	< 93	< 100	< 102
Very good	95 - 106	93 - 105	100 - 113	102 - 116
Good	107 - 115	106 - 116	114 - 123	117 - 128
Sufficient	116 - 126	117 - 128	124 - 134	129 - 141
Poor	127 - 142	129 - 147	135 - 152	142 - 157
Very poor	> 142	> 147	> 152	> 157

Measurement of the physical efficiency index [12]: The physical efficiency index (PEI) was measured with the step test using the formula PEI = D/(2xP) x 100.

D: Duration of exercise (seconds).

P: Heart rates first phase (60 - 90 seconds) + second phase (120 - 150 seconds) + third phase (180 - 210 seconds).

Statistical analysis

Descriptive statistics with mean and standard deviation were applied to measure the numerical variables that had a normal distribution and the median and interquartile range were used for the variables that did not have a normal distribution. The normality of the distribution was evaluated with the kurtosis test. Percentages were used for the nominal variables.

Inferential statistics were applied to evaluate the association between the cardio-respiratory fitness, the PEI and the level of sedentary lifestyle using Fisher's exact test for the nominal variables and the Student's t test for the numerical variables. Pearson's correlation was made between the variables age and score of the physical efficiency index. A p value less than 0.05 was considered significant.

The statistical package NCSS 2004 was used.

Results

Thirty-two patients were reviewed, 19 boys (60%) and 13 girls (40%), with a mean age of 10.6 ± 1.5 years. The average body mass index (BMI) was 26.2 ± 3.4 and the waist/height index was 0.6 ± 0.05 cm.

The median PEI was 68 (interquartile range 63 - 74).

Cardio-respiratory fitness was excellent in 15 (47%), very good in 6 (19%), good in 8 (25%), sufficient in 1 (3%) and poor in 2 (6%). No cases were found in the very poor category.

According to the PAQ-C questionnaire, the average score was 2.5 ± 0.6 and 22 sedentary children were identified (69%).

Table 1 shows the characteristics of the patients grouped into active and sedentary according to the score obtained with the PAQ-C instrument.

Variable	Sedentarism		p
	No (n = 10)	Yes (n = 22)	
Demographic variables			
Age (years)	10 ± 1.5	10.9 ± 1.5	0.07*
Gender (girls / boys)	2/8	11/11	0.11**
Clinical variables			
Body mass index (BMI)	24.9 ± 2.8	26.7 ± 3.5	0.08*
Waist / height index	0.6 ± 0.05	0.6 ± 0.06	0.18*
Physical capacity variables			
Physical efficiency index (PEI)	71.2 ± 15.9	69.8 ± 9.4	0.37*
Cardio-respiratory fitness			0.7**
-Adequate (excellent, very good, good)	9	20	
-Inadequate (sufficient, poor, very poor)	1	2	
PAQ-C score	3.2 ± 0.3	2.2 ± 0.4	< 0.001*
*: Student's T test; **: Fisher's exact test			

Table 1: *Clinical characteristics of patients and sedentary lifestyle measured by the PAQ-C instrument.*

The average time for the application of the PAQ-C questionnaire was 11 ± 2 minutes. The time required for the application of the KPR Test was 8 ± 1 minute. There were no cases in which it was necessary to interrupt the step test.

Figure 1 shows the correlation between the PEI and age in the group of sedentary children (A) and in the group of active children (B), finding a significant negative correlation in the sedentary group, with values lower PEI in older subjects (R^2 0.2, Pearson correlation coefficient -0.45 [95% CI -0.03 to -0.72], p = 0.037). No correlation was found in the group of active children.

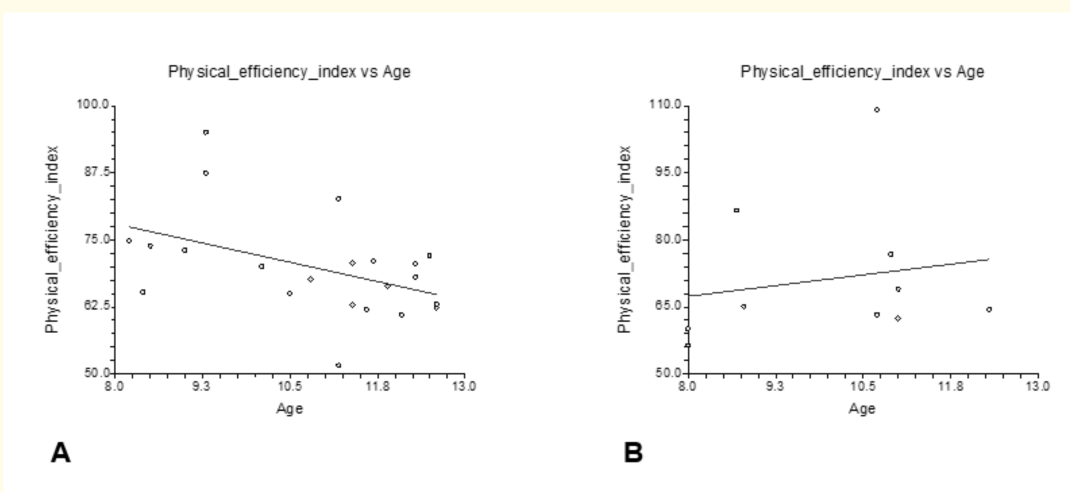

Figure 1: *A - Comparison of the physical efficiency index with age (years) in children with sedentary lifestyle, R-Squared 0.02, Pearson correlation coefficient -0.45 (CI 95% -0.03 to 0.72), p = 0.037. B - Comparison of the physical efficiency index with age (years) in children with active lifestyle, R-Squared 0.03, Pearson correlation coefficient 0.18 (CI 95% -0.48 to 0.7), p = 0.6.*

Discussion

The levels of cardio-respiratory fitness found in this study were higher than those reported in previous studies. Lee HT., *et al*. [12] found levels of 55.2 ± 4.2 in Korean children with obesity and our study showed 69.8 in sedentary children and 71.2 in active children. This difference can be explained because the instruments to measure heart rate were different in both studies, Lee HT., *et al*. used an instrument for sports use (sport watch) and we used an instrument for clinical use (pulse oximeter).

In both the active and sedentary groups, 10% of the children presented inadequate levels of cardio-respiratory fitness, which indicates that central adiposity is the determining factor to correct in order to stop cardiovascular deterioration. Soltero EG., *et al*. [14] suggest that children with more central adiposity have high levels of circulating endothelial cells, which may explain cardiovascular deterioration at an early age.

The most important finding of the study is that in children with a sedentary lifestyle the physical efficiency index shows lower values in the older age groups but in the group of children with an active lifestyle, the index of physical efficiency was found at similar adequate levels in all age groups. This suggests that physical activity has an effect that maintains fitness in children even if they are obese. Vaara JP., *et al*. [15] have studied this phenomenon in young adults, describing improvement in cardiorespiratory fitness by reducing sedentary time.

Both in the sedentary and active group, the cardio-respiratory fitness index prevailed at the appropriate levels. This indicates that despite having a BMI greater than the 95th percentile with central adiposity and sedentary lifestyle, the physical capacity of children remains at levels that allow starting physical activity programs according to their age group.

The weakness of the study is to have included patients from a single reference hospital, so it will be necessary to reproduce it in an open population.

This study has the strength of having used instruments previously validated by other authors [11,12] and translated into the native language of the study subjects [13].

The time required to apply the PAQ-C questionnaire and the KPR Test makes feasible to apply both in the first pediatric medical consultation and in the subsequent ones.

Conclusion

One in 10 children with obesity has impaired cardio-respiratory fitness.

The sedentary lifestyle is correlated with a deterioration in the physical efficiency index in older schoolchildren with obesity.

School-age children who are active maintain adequate levels of the physical efficiency index, regardless of obesity and age.

Acknowledgements

We would like to acknowledge the staff and fellows of the Department of Pediatrics of the Hospital General León.

Conflict of Interest

The authors have no relevant financial or non-financial interests to disclose.

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Volume 11 Issue 9 September 2022