



ASSOCIATION BETWEEN CHILDHOOD OBESITY AND CARDIORESPIRATORY FITNESS: A SYSTEMATIC REVIEW

Associação entre a obesidade infantil e a capacidade cardiorrespiratória: revisão sistemática

Asociación entre la obesidad infantil y la capacidad cardiorrespiratoria: revisión sistemática

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ABSTRACT

Objective: To investigate the scientific evidence regarding the association between childhood obesity and cardiorespiratory fitness. **Methods:** A review was conducted on the literature arising from the search of articles published in the last five years in the databases SciELO and CAPES Journal Portal (Portal de Periódicos da CAPES). The descriptors used were cardiorespiratory fitness, overweight/obesity and children/adolescents/students. The study included full articles published in periodicals in English, Portuguese and Spanish, with publication year from 2010 to 2015, which aimed to predict the cardiorespiratory fitness with use of exercise testing in childhood obesity. **Results:** A total of 97 articles were surveyed but, after consideration and submission to the inclusion and exclusion criteria, five articles remained, two of them published in Portuguese, two in Spanish and one in English. Of the five articles analyzed, four studies reported that the cardiorespiratory fitness was affected by the body adiposity indexes. **Conclusion:** An inverse association was observed between the body mass index and the cardiorespiratory fitness, and the overweight students showed lower levels of cardiorespiratory fitness.

Descriptors: Obesity; Physical Fitness; Children; Adolescents.

RESUMO

Objetivo: Verificar as evidências científicas a respeito da associação entre obesidade infantil e aptidão cardiorrespiratória. **Métodos:** Realizou-se uma revisão de literatura advinda da busca de artigos, publicados nos últimos cinco anos, nas bases de dados SciELO e Portal de Periódicos da CAPES. Os descritores utilizados foram aptidão física, sobrepeso/obesidade e crianças/adolescentes/escolares. Incluíram-se no estudo artigos completos publicados em periódicos, nos idiomas inglês, português e espanhol, com ano de publicação no período de 2010 a 2015, e que tinham como objetivo a predição da aptidão cardiorrespiratória com testes de exercício na obesidade infantil. **Resultados:** Ao todo foram 97 artigos pesquisados, mas, após análise e submissão aos critérios de inclusão e exclusão, restaram cinco artigos, sendo dois em língua portuguesa, dois em espanhol e um em inglês. Dos cinco artigos analisados, quatro estudos relataram que a capacidade cardiorrespiratória foi afetada pelos índices de adiposidade corporal. **Conclusão:** Foi evidenciada associação inversa entre o índice de massa corporal e o condicionamento cardiorrespiratório, em que os escolares com excesso de peso apresentaram menores índices de aptidão cardiorrespiratória.

Descritores: Obesidade; Aptidão física; Crianças; Adolescentes.



RESUMEN

Objetivo: Verificar las evidencias científicas sobre la asociación entre la obesidad infantil y la aptitud cardiorrespiratoria. **Métodos:** Se realizó una revisión de la literatura a través de la búsqueda de artículos publicados en los últimos cinco años en la base de datos SciELO y en el Portal de Periódicos Capes. Los descriptores utilizados fueron “aptitud física”, “sobrepeso/obesidad” y “niños/adolescentes/escolares”. Se incluyeron en el estudio los artículos completos publicados en periódicos; en los idiomas inglés, portugués y español; con año de publicación entre el período de 2010 y 2015 y que tenían en su objetivo la predicción de la aptitud cardiorrespiratoria a través de pruebas de ejercicios para la obesidad infantil. **Resultados:** De los 97 artículos investigados se han quedado cinco artículos después del análisis y sumisión a los criterios de inclusión y exclusión siendo dos publicados en el idioma portugués, dos en español y uno en inglés. Cuatro de los cinco artículos analizados relataron que la capacidad cardiorrespiratoria ha sido influenciada por los índices de adiposidad corporal. **Conclusión:** Se evidenció la asociación inversa entre el índice de masa corporal y el acondicionamiento cardiorrespiratorio siendo los escolares con exceso de peso los que presentaron índices de aptitud cardiorrespiratoria más bajos.

Descriptores: Obesidad; Aptitud física; Niño; Adolescente.

INTRODUCTION

Obesity is regarded as a multifactor disease with high prevalence among children and adolescents⁽¹⁾. A 10 to 20% increase in the rate of childhood and adolescent obesity has been registered in the last decade, and this is already recognized as a public health problem that affects societies in several parts of the world, being currently characterized as an epidemic^(2,3). A number of diseases may be associated with obesity in children and adolescents, such as systemic arterial hypertension (SAH), diabetes mellitus type II (DM), coronary heart disease, metabolic syndrome⁽⁴⁾, dyslipidemias, atherosclerosis, obstructive sleep apnea, and hypoventilation⁽⁵⁾, and all these pathophysiological conditions have an impact on the life quality and expectancy of this population⁽⁶⁾.

The origin of obesity is complex, as it is influenced by genetic, environmental, biological, behavioral, psychological and social factors⁽⁷⁾. The socioeconomic status and education level of parents, poor eating habits, physical inactivity and few hours of sleep are related to a greater likelihood of children and adolescents being obese⁽⁴⁾. There is current evidence demonstrating that children of obese parents are at a higher risk of becoming obese due to genes and shared environments, ie, it increases the risk of a child becoming an obese adult regardless of the fat status in childhood⁽⁸⁾, since childhood obesity is directly associated with obesity in adulthood⁽⁹⁾.

Good nutrition combined with the practice of physical activities makes all the difference in the weight of the child, the adolescent and the adult as well. However, data demonstrates that many children and adolescents consume few fruits and vegetables, and do not manage to practice the recommended 60 minutes of moderate to intense physical activity each day⁽¹⁰⁾, consuming foods rich in sugar, fat and salt, nutrient-poor foods, engaging in sedentary, screen-based activities for much longer than the recommended maximum of 120 minutes per day. A study in the physical activity segment bore out significant improvements in the weight of children who adopted reductions in the time of physical inactivity in front of the computer screen and an increase in physical activities⁽¹¹⁾.

On the other hand, the practice of physical activities has been recommended as a means of preventing various diseases, besides registering beneficial changes in relation to body composition, lipid profile, cardiorespiratory endurance and decrease in obesity⁽¹²⁾. In this sense, whether the children and adolescents are performing physical activities is a fact of concern, considering that the level of physical activity is a determining factor of the cardiorespiratory fitness⁽¹³⁾.

For survival, humans depend on oxygen and, when performing a physical work, they need to increase the air flow into the lungs, intensify blood circulation, and activate specific metabolic pathways in the skeletal muscles, resulting in increased oxygen uptake and utilization. Exercises involving large muscle groups produce responses in the respiratory, cardiovascular and muscular systems, and such responses increase up to a limit defined as the maximum oxygen consumption (VO_{2max}) or aerobic condition of the individual⁽¹⁴⁾.

The cardiorespiratory fitness can be evaluated either by the ventilatory anaerobic threshold (VAT) or by the absolute or relative VO_{2max} ⁽¹⁵⁾. VO_{2max} is considered an important predictor of associated morbidities and one of the best indicators of cardiorespiratory fitness^(16,17). In addition to diagnosing the level of cardiorespiratory fitness, the VO_{2max} evaluation is also used to monitor and prescribe aerobic training for athletes and sedentary individuals⁽¹⁸⁾.

In this context, the present study aims to verify the scientific evidence regarding the association between childhood obesity and cardiorespiratory fitness.

METHODS

The present study is a systematic review of scientific studies that have addressed the relationship between the cardiorespiratory fitness and the BMI (body mass index) of schoolchildren. The databases consulted were Scientific Electronic Library Online (SciELO) and CAPES Journal Portal. The following descriptors were used in the search for the articles: cardiorespiratory fitness, overweight/obesity, child, adolescent and students; with the search selecting articles published from January 2010 to August 2015.

In order to select the articles, the reading of the abstracts of the retrieved publications was initially carried out, with the purpose of refining the sample through the inclusion and exclusion criteria. The eligibility criteria of the study were: articles published in full in periodicals; in English, Portuguese or Spanish language; year of publication within the specified period, from 2010 to 2015, and articles that aimed to predict cardiorespiratory fitness with use of exercise testing. The exclusion criteria were: incompatible cardiorespiratory fitness test; review articles, and articles conducted with other specific populations, such as adults, the elderly, and people with special needs.

The critical evaluation of the articles consisted in reading the study in full and, then, drawing up synoptic charts with the data collected regarding each research, namely: authors/date, sample, methodological aspects and main results on the cardiorespiratory variables and fat-free mass. In an auxiliary manner, the thematic content analysis technique was used by reading and re-reading the results of the studies, trying to identify relevant aspects that were repeated or highlighted.

RESULTS

The search identified 97 studies, of which 84 were excluded after applying the first step of the inclusion criteria, resulting in 13 articles that were analyzed in full. Of these, three were excluded for containing repeated data and retrospective study, and another five were excluded because they presented incompatible cardiorespiratory fitness test and BMI classification, resulting in five articles for review analysis. Figure 1 shows the flowchart of the strategy used for the selection of articles and shows the total of articles excluded.

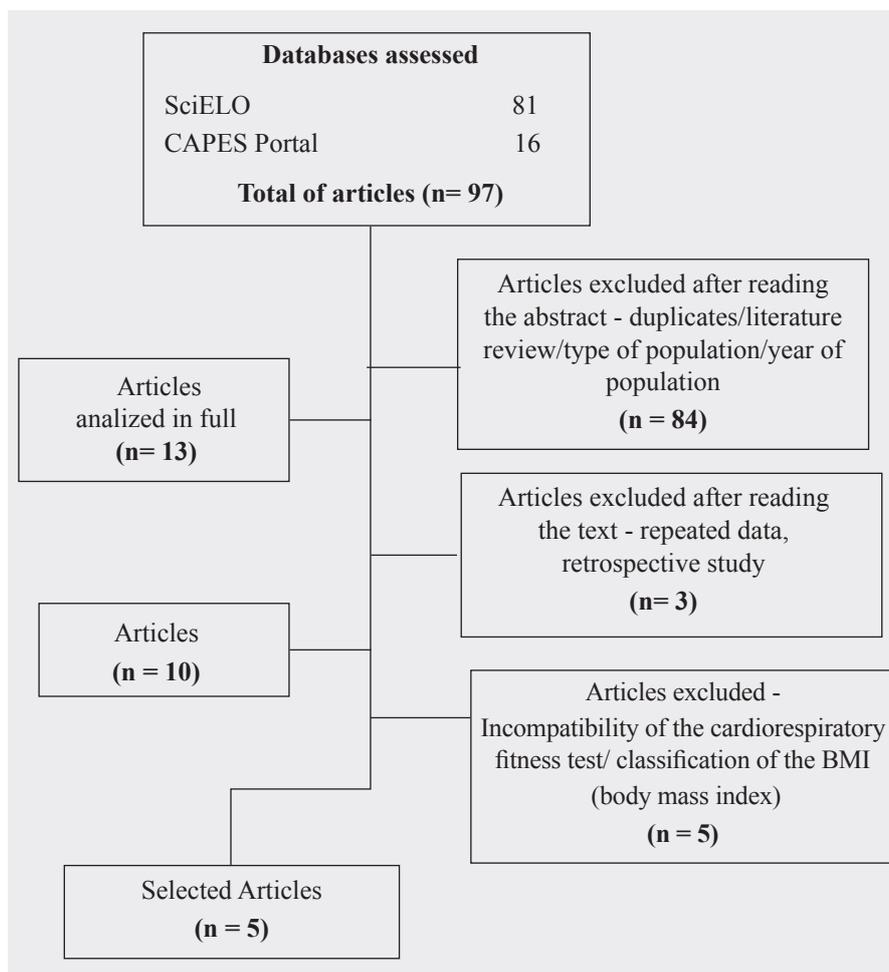


Figure 1- Flowchart of articles included in the study.

Of the articles selected, two were published in Portuguese, two articles in Spanish and one in English. Of the five articles analyzed in the final sample, two were published in 2012, one was published in 2013, and the other two articles, in 2014.

Among the selected studies, four adopted the cross-sectional study methodology and one article was a descriptive study. The sample ranged from 193 to 795 students, totaling 1,927 individuals involved. Only one of the articles involved only female students, while the others involved female and male schoolchildren. The articles involved a sample of schoolchildren from 6th to 9th grade, with an age range of 6 to 16 years.

The different instruments were classified as direct and indirect, with questionnaires and/or forms regarded as indirect, and laboratory and field tests, anthropometric factors and clinical examinations regarded as direct. Three of the studies presented only direct instruments and two presented both indirect and direct instruments.

The articles included in this study are presented in Chart I, being possible to observe information about the authors, country where the research was carried out, sample, methodological aspects, main results on the cardiorespiratory variables and overweight. The results show that the low cardiorespiratory fitness is related to overweight/obesity, and students with high BMI presented lower values when compared to their eutrophic peers.

Chart I - Characteristics of the analyzed articles, described by author, country, sample, methodological aspects and main results.

Authors Country	Sample	Methodological aspects	Main results
Santana et al. ⁽¹³⁾ Brazil	417 students of both sexes between the ages of 10 and 13 years	Cross-sectional study	Overweight adversely affected the cardiorespiratory fitness of boys and girls.
Gómes-Campos et al. ⁽¹⁹⁾ Peru	795 children aged 6 to 11 years living at moderate altitude	Cross-sectional study	The low cardiorespiratory fitness is directly related to excess weight, presenting weak negative values.
Galavíz et al. ⁽²⁰⁾ Mexico	193 schoolchildren with an average age of 11 years	Cross-sectional study	In both sexes, higher cardiorespiratory fitness was observed in individuals with lower BMI, waist circumference and sum of skin folds.
Duque; Parra ⁽²¹⁾ Colombia	325 students aged from 10 to 12 years	Cross-sectional study	Cardiorespiratory fitness was not affected by the rates of body adiposity.
Capel et al. ⁽²²⁾ Brazil	197 girls aged from 10 to 16 years	Cross-sectional study	The highest values of BMI and body fat percentage presented lower values of VO_{2max} .

BMI = body mass index; VO_{2max} = maximum oxygen consumption.

DISCUSSION

In all the highlighted articles it was possible to evidence that obesity in children and adolescents negatively affected the cardiorespiratory fitness, being emphasized that they associate it to the reduction of cardiorespiratory fitness with indicators of overweight⁽²³⁾. Physical fitness, recognized as one of the most important health indicators, has the aerobic fitness among its several components, which shows an inverse relation with the indicators of body adiposity⁽²⁴⁾.

The increase in aerobic capacity is inversely associated with fat accumulation and other cardiovascular risk factors, since the improvement in the aerobic condition triggers a series of physiological stimuli that potentiate the uptake of oxygen and the use of fatty acids as an energy source, thus reducing body fat deposits and obesity⁽²⁵⁾.

Therefore, a study⁽²²⁾ evaluated 197 girls, aged between 10 and 16 years, students attending two public schools in the city of Atibaia, São Paulo, Brazil, with the objective of identifying and correlating body composition, BMI and age at menarche with aerobic capacity. The study observed that girls with higher values of fat percentage and BMI presented lower values of VO_{2max} . Menarche onset at earlier ages and the advancement of the chronological age are important factors in the reduction of aerobic capacity, evaluated by the indirect VO_{2max} . Moreover, the mean age at menarche was higher in girls with adequate BMI when compared to overweight and obese girls.

A study with adolescents⁽²⁶⁾ pointed out that the stage of maturation is a relevant factor and must be observed because there is an intimate relationship between VO_{2max} values and the pubertal phase. Thus, the evaluation of the maturation stage may be

more important than the chronological age, especially in obese individuals. Another research⁽²⁷⁾ revealed that adolescents with excess weight tend to mature earlier when compared to non-obese ones.

A study carried out in Recife, Pernambuco, Brazil⁽²⁷⁾ with 417 schoolchildren between 10 and 13 years of age, aiming to analyze the association between the nutritional status and health-related physical fitness components, found that overweight students presented lower level of physical fitness when compared to normal-weight and low-weight students. The higher the BMI, the greater the body adiposity and fat-free mass. Furthermore, overweight students presented lower VO_{2max} , when compared to their peers with normal or low weight. When age adjustment was applied, the results evidenced positive correlations between the BMI and body adiposity (%), and negative correlations between the BMI and VO_{2max} , in both genders.

Lower VO_{2max} values in obese individuals, which could limit the maximal oxygen consumption, occur due to two hypotheses: firstly, that there would be a central limitation, that is, it depends on the maximum cardiac output and the oxygen content in the arterial blood; and secondly, that the limitation would be peripheral, expressed by the arteriovenous oxygen difference and the tissue metabolism⁽²⁸⁾.

A cross-sectional study conducted in the city of Guadalajara, Mexico⁽²⁰⁾, evaluated 193 schoolchildren, with a mean age of 11 years, aiming to evaluate the independent relationship between physical activity and cardiorespiratory fitness with obesity measures. The results suggest that cardiorespiratory fitness is a stronger correlate and predictor of general and abdominal obesity than is physical activity.

When analyzing the responses of VO_{2max} relative to body mass, it stands out that overweight adolescents present lower values when compared to normal weight groups, which can be explained by the fact that overweight adolescents present increased body mass, by the low cardiorespiratory fitness that is characteristic of the obesity status, or by both situations⁽²⁹⁾.

Within this context, the fact that the obese individual presents higher or similar absolute VO_{2max} values compared to the non-obese individuals indicates a preserved functional capacity, since the Fick equation (which relates the oxygen pumped by the heart and the oxygen collected by the tissues) reveals that the heart seems to provide an adequate supply of oxygen to the muscle tissue⁽³⁰⁾; however, when expressed relative to body weight, the obese, for having a higher body mass, present lower values than non-obese individuals⁽³¹⁻³³⁾.

A study⁽¹⁹⁾ conducted with 795 children in the city of Arequipa, Peru, aimed to identify the cardiorespiratory fitness of schoolchildren living in moderate altitude. The results showed that schoolchildren of both sexes have low levels of cardiorespiratory fitness, as well as the schoolchildren who are overweight and obese, which corroborates another study previously described in the literature⁽³⁴⁾, which indicates that altitude can negatively affect the aerobic capacity.

A survey⁽²¹⁾ comprising 389 schoolchildren from Manizales, Colombia, aged between 10 and 12 years, aimed at establishing the association between the screen time (time spent watching TV and using the computer) and overweight and the lack of physical conditioning, did not indicate anthropometric differences related to the longer time of exposure to the screen. Girls had significantly lower values of VO_{2max} than boys, and the fat content did not affect the maximal cardiorespiratory fitness⁽²¹⁾.

The time spent in sedentary behavior has been associated with negative health outcomes, such as body composition, biomarkers of cardiovascular and metabolic diseases, and a lower level of cardiorespiratory fitness⁽³⁵⁾, being evidenced that the regular practice of physical activity promotes an improvement in the individual's cardiorespiratory fitness, reducing several risk factors for the development of chronic-degenerative diseases and contributing to the improvement of quality of life⁽³⁶⁾.

A study conducted in Chile showed that, in both sexes, good levels of cardiorespiratory fitness were associated with higher scores on language tests. However, on the average academic performance, after adjusting screen time, this association became non-significant. Likewise, no relation was observed after analyzing children whose screen time is longer (≥ 2 hours/day). These findings seem to suggest that parents and regulators should minimize the negative effects of screen time on children's lives to maximize the beneficial effect of healthy habits on the academic achievement⁽³⁷⁾.

CONCLUSION

By analyzing the studies comprised in this review, it was possible to verify an inverse association between BMI and cardiorespiratory fitness, in which overweight schoolchildren presented lower levels of cardiorespiratory fitness. There are many factors that lead to the prevalence of obesity, including sedentary lifestyle and inadequate diet, since physical inactivity contributes directly to a reduction in the cardiorespiratory fitness. Therefore, the importance of actions to be developed at the school setting in order to stimulate healthy habits among children and adolescents is emphasized, since the school becomes an important ally in health promotion and disease prevention.

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