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Association between Physical Fitness and Cardiovascular Risk in Young University Students: Systematic Review

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REVIEW ARTICLE

ABSTRACT

The aim of this systematic review was to analyse the association of physical fitness with risk factors for cardiovascular diseases in university students. Studies were collected from the following database: Medline, using the keywords: "Physical fitness" and "cardiovascular risk", associated with keywords: "Students" and "university". It was included epidemiological observational articles published between 2007 and 2017 written in English language. It was selected 4 quantitative cross-sectional studies, according to specific eligibility criteria, preferential Reporting Items for Systematic Reviews and Meta-Analyses protocol (PRISMA). The data extraction was done independently by different authors, including assessment of bias risk and classification of evidence rating. The results shown that university students have a sedentary behavior and low aerobic fitness, with high index of dyslipidaemia, central obesity, high blood pressure, therefore confirming many risk factors for cardiovascular diseases.
Keywords: Physical fitness; Cardiovascular risk; Students; University.

INTRODUCTION

Physical inactivity leads to a reduction in physical fitness while tends to increases body fat, thus, contributing to arterial hypertension and hypercholesterolemia (Crepaldi et al., 2016; da Cruz, Oselame, de Almeida Dutra, Oselame, & Neves, 2017; da Silva Gasparotto et al., 2013; Mariano, Ferreira, Amaral, & Oliveira, 2017). Both conditions are main risk factors for Cardiovascular diseases (CVD).

The main cause for the instalment of hypertension in young university students is the change in lifestyle after their entrance in college, since not only their tend to become sedentary, as previously explained, but in addition, there is also changes in their eating habits, and thus, altering their metabolism, as well their body composition (Fachineto & de Sá, 2008; Guedes, 2013; Rodrigues, 2012).

Regarding the abdominal fat, which has a direct relationship with visceral fat, a risk factor for CVD, it has been reported that obesity have a high prevalence in university population (Lubango, 2008; Maia, Veras, & de Souza Filho, 2010). This data is alarming since the WHO (World Health Organization) stated that CVD will be the first cause of death in the world in the next years. These CVDs are included in the group of chronic non-communicable diseases (CND) which are affecting patients due to physical inactivity (WHO, 2015)

The CVD has been responsible for 30% of deaths in Brazil. Each five patients that are in critical conditions in Brazilian hospitals, at least one have a CVD (Barim, Carvalhaes, McLellan, Corrente, & Castanheira, 2016; Ribeiro et al., 2016; Vigitel, 2017). The high prevalence of this problem places Brazil among the 10 countries with the highest rate of death for CVD (WHO, 2015, 2016).

The risk factors for CVD are divided in two main categories: Modifiable risk factors

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(environmental and behaviour), such as: smoking, high serum cholesterol, hypertension, physical inactivity and secondary: diabetes, obesity, stress, contraceptive pills and abdominal obesity; and non-modifiable risk factors (genetic and biologic), such as: heredity, sex, ageing (Correia, Cavalcante & Santos, 2010). In the present study, several of these variables, will be analysed (Hypertension, physical inactivity, abdominal fat, sex and age).

Studies showed (Brandão, Pimentel, Silva, & Cardoso, 2008; Moreira et al., 2011; Simão, Nahas, & Oliveira, 2012) that hypertension is associated with incidence of CVD, which not only represents a public health problem, but are also the main cause of death in adult population around the world.

This systematic review aims to analyse the association of physical fitness with risk factors of CVD in university students.

METHOD

This systematic review was conducted according to guidelines for reports of Systematic Reviews and Meta-Analyses: PRISMA (Galvão, Pansani & Harrad, 2015). In the present study, it was included studies that assayed the association of physical fitness with risk factors for CVD in young university students.

Eligibility criteria and selection of studies.

Regarding the selection criteria of the studies, only the following were considered: 1) Cross-sectional studies; 2) Studies that aimed to investigate the association between physical fitness and risk factors for CVD; 3) Studies which participants' age ranged between 18 and 30 years; 4) Studies published in peer reviewed journals in English language; 5) Studies published in journals from January 2007 to December 2017; 6) Studies which evaluated sedentary levels and physical fitness of participants through physical tests, questionnaires and biomarkers.

It was excluded studies based on the following criteria: 1) Longitudinal studies; 2) Studies that included military participants; 3) pregnant women or in postmenopausal period or; 4) participants with comorbidities (obesity, cancer, Aids/HIV, degenerative disease, neurological conditions). The studies were imported to EndNote® software and the duplicated were excluded using the "duplicated" command.

The selection process of the studies was made in the following steps: At the first step, two independent reviewers searched potentially relevant studies. Both reviewers selected 247 articles. At the second step, two reviewers analysed abstracts of studies chosen at the first step. In case of disagreement regarding the inclusion of studies in the next step, these were removed through the mediation of a third reviewer. In the third and last step, studies selected on the previous steps were completely analysed by three independent reviewers, taking into consideration the previously mentioned eligibility criteria. In this step, divergences between reviewers regarding that inclusion of articles were solved through consensus between them.

Information sources

Systematic searches were made in April 2018, by three independent authors, using Medline database. The keywords used in searching for literature were among: "physical fitness" and "cardiovascular risk" associated with the following words: "students" and university". Manual searches were also performed which consisted in the use of a reference list in identified articles. Search in database were made during January 2010 to December 2017. Furthermore, search in database and on the reference list of studies were analysed to identify new studies that could be included in this article.

Study Selection

Three authors tracked the title and the abstract of all citations found in literature searched. Studies with potential relevance were searched by full text and eligibility criteria was applied. According to PRISMA recommendations, inclusion and exclusion criteria were based on relevant characteristics of the present study (young university student, risk factor for CVD, physical fitness). Articles were

included if: (1) was a cross-sectional study with young university students with 18 to 30 years; (2) aimed to assay the association between risk factors of CVD and physical fitness. The different steps of the research along with number of studies reviewed in each stage and the reasons for exclusion were showed in figure 1.

Data extraction and risk of bias in individual studies

The three reviewers involved in studies selection extracted the data independently. Characteristics from studies, including authors, country in each research was conducted, methodological design, students' profile, instruments to assay sedentary behaviour, instruments for psychological evaluation, indicators, results and conclusions were registered. In this stage, divergences regarding data were resolved through reviewers' consensus.

It is necessary a careful evaluation of bias risk in each observational study which explains the self-context to analyse the reliability of studies results. (Vandenbroucke, 2011). The risk of bias in were estimated using RTI item bank (Viswanathan, Berkman, Dryden & Hartling, 2013). However, the RTI item bank was adapted to attend the characteristics of studies included in the present review. Thus, the following items for bias assessment were considered: selection bias, confounding selection bias, confounding detection bias, friction bias, report of selective results, confounding and global evaluation. The assessment of these items was based on the following answers: "yes"; "no"; "partially"; "impossible to determine"; "not applicable".

A text box were included for each item to register the explanation regarding the evaluations for additional review(Viswanathan, Berkman, Dryden, & Hartling, 2013). Therefore, according to the answer of these items and the respective explanations, the studies were classified as (good, modest and poor) by adaptations of criteria suggested by (Balk et al., 2006). To minimize the risk of bias during the bias assessment of studies, two reviewers independently analysed the results by calculating the interjudge agreement using kappa coefficient (Cohen, 1960). Thereafter, reviewers compared their scores and in cases of divergence, a third reviewer was included to mediate an agreement.

Classification of evidence strength.

The goal of evidence strength is to provide clear judgment regarding the reliability of reviewers conclusions (Atkins, Fink & Slutsky, 2005). The classification of evidence strength of main results were conducted through strength classification of evidence systems (Berkman et al., 2013). This system allowed the distribution of results in five domains (limitations of the study, accuracy, consistence, bias report). Thereafter, the strength of the results were allocated in one of the four levels: High, moderate, low, insufficient(Berkman et al., 2013). Two reviewers individually analysed the strength of the study results and calculated and rate of interjudge agreement using kappa coefficient(Cohen, 1960). Then both reviewers compared scores and in cases of divergence, a third reviewer was in included to mediate the final agreement.

RESULTS

Initially, it was found 247 studies potentially relevant for this review. The different steps of research, the number of reviewed studies in each step and the reasons for exclusion are presented in figure 1. Only 4 articles were considered eligible to be included in this review. Therefore, 243 articles were excluded for different reasons: Samples using animals, age out of the established range, profession of the subject (military and athletes), and samples associated with comorbidities, among other reasons (Figure 1).

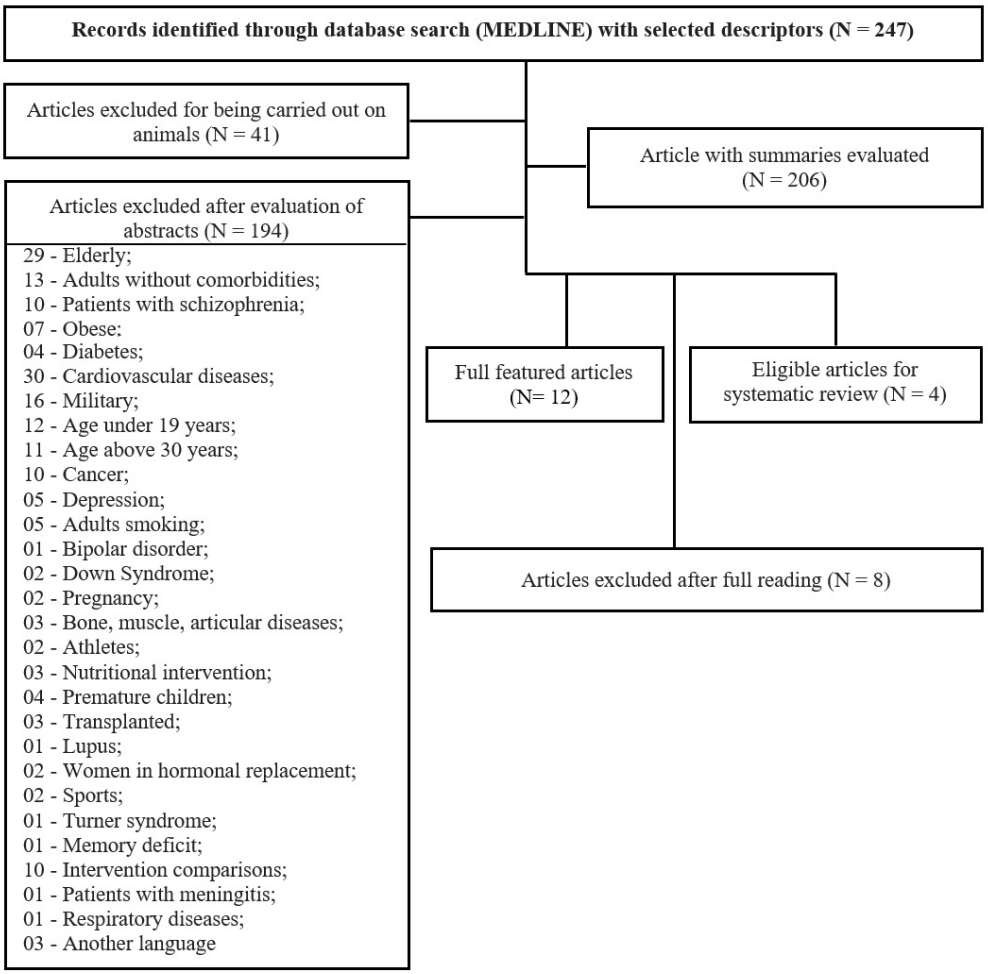

Figure 1. Records identified through database search.

The first excluded article (*Cardiorespiratory Fitness, Sedentary Time, and Cardiovascular Risk Factor Clustering*), analysed whether a high cardiorespiratory capacity is associated with reduced deleterious consequences for health which in turn is correlated with sedentary behaviour through a cross-sectional study with 12.274 men and 14.209 women without known cardiovascular disease, with minimum age of 20 years but without age limit. This resulted in exclusion of the study.

The second excluded article (*Physical exercise and cardiac autonomic activity in healthy adult men*) verified the effect of exercise in autonomic cardiac control in adult men. In addition, it was assayed the level of daily physical activity, however, it was conducted in non-university students and the methodology adopted was comparative longitudinal.

The third non-eligible article (*Blood Pressure and Circulatory Relationships with Physical Activity Level in Young Normotensive Individuals: IPAQ Validity and Reliability Considerations*) aimed to evaluate the relation between IPAQ and blood pressure, blood flow and vascular resistance in normotensive patients with university age. Although, vascular occlusion was included in methodology, which in turn led to the exclusion from this review.

The fourth article (*Muscular fitness and cardiometabolic risk factors among Colombian young adults)* aimed to determine the relation between muscle fitness with risks markers for cardiometabolic in 172 men with age ranging with 18 to 24 years through a descriptive cross-sectional study. The study was published in Spanish and the sample was not composed by university students, factors that led this study to be excluded.

The fifth article (*Associations of Leisure Time, Commuting, and Occupational Physical Activity with Physical Fitness and Cardiovascular Risk Factors in*

Young Men) correlated different domains of physical activity and risk factors for cardiovascular disease in militaries. This fact invalidated the study to be included in the final review.

The sixth article excluded (*Cardiometabolic and behavioural risk factors in young overweight women identified with simple anthropometric measures)* investigated markers for cardiometabolic risk in young women with 18 to 30 years to verify whether waist circumference measures and body mass index were associated similarly to cardiometabolic risks. Due to the overweight seen in the subjects, the article was excluded after final review.

The seventh article (*Associations of Maximal Strength and Muscular Endurance with Cardiovascular Risk Factors)* was also excluded due to military sample. This study aimed to verify whether the muscle or cardiorespiratory fitness are significantly associated with scores of risk factors for cardiovascular diseases, independently.

The general characteristics from the reviewed studies are shown in table 1 and 2. Data presented in table 1 on the following order: author, number of participants, sex, age, city, country and year of publication. The number of participants ranged from 35 to 2168. Mean age found was 24 years with minimum age as 18 years old and the maximum age as 30 years old. Publication period was from 2013 to 2017, in four different continents: African, European, American and Oceania.

Table 1
Characteristics of studies included in this review.

Author	Sample	Age	City/Country
Prioreschi, Brage, Westgate, Norris, and Micklesfield (2017)	409 / 218 Men and 191 women	19–20	Soweto / África
Fernström, Fernberg, Eliason, and Hurtig-Wennlöf (2017)	834 / 257 Men and 577 women	18–25,9	Uppsala /Sweden
Martínez-Torres et al. (2017)	890 / 427 Men and 463 women	18-30	Bogotá/Colombia
Liberato, Maple-Brown, Bressan, and Hills (2013)	35 – Men	18-25	Darwin / Australia

Source: Prepared by the authors, 2018.

Table 2
Description of objectives, anthropometric variables, physical tests, metabolic tests and main outcomes from included articles

Author	Objectives	Anthropometry	Physical Tests	Metabolic Tests	Main results
(Prioreschi et al., 2017)	Describe and verify the association between levels of PhF, PhA and BMI	- BMI	- Submaximal step test - Electrocardiogram - Accelerometer		Moderate and vigorous PhA are associated with PhF; Women have higher risk of CrF reductions
(Fernström et al., 2017)	Evaluate and analyse the association between the tunica intima of carotid with factors related to lifestyle and CVD	- BMI - Bioelectrical impedance	- Stationary bicycle test -Ultrasonography	- Fasting blood glucose	High aerobic fitness is associated with low risk for CVD in young adults and high prevalence of young adults with high LDL and insulin resistance.
(Martínez-Torres et al., 2017)	Evaluate the association of MS with CVD risk	-RWH - Bioelectrical impedance		- Fasting blood glucose - Cholesterol - LDL-c - HDL-c	Risk factors for MS included: Male, with more than 23 years, with obesity or overweight with a non-healthy proportion between waist and height.
(Liberato et al., 2013)	Investigate the association between BC, HB and risks for CVD	- BMI - WC - HC - DEXA	- Blood pressure assessment - Energy expenditure (METs)	-Fasting blood glucose - Cholesterol - LDL-c - HDL-c - Triglycerides	Elevated risk factors for CVD in healthy men.

Source: Prepared by the authors, 2018. PhF – Physical Fitness, CrF – Cardiovascular fitness, PhA – Physical activity, BMI– Body Mass Index, WC – Waist Circumference, HC – Hip circumference, CVD – Cardiovascular disease, MS– Metabolic Syndrome, ST – Sedentary time, BC – Body composition, HB – Healthy behaviour, DEXA - Dual-energy X-ray absorptiometry.

Table 2 describes the following information: Objectives, anthropometry, physical tests, metabolic tests and main results. The outcome investigated was the risk for CVD associated with different variables. Furthermore, the main goal was to associate physical fitness, cardiovascular fitness, levels of physical activity body composition, and metabolic variables. Three out of four chosen articles applied assayed fasting blood sugar. Other applied tests were: cholesterol, LDL –c, HDL – c and triglycerides.

All articles used anthropometric test BMI. A considerable number of men presented normal index, around 40% of the sample was considered with overweight, and obesity despite they self-consider healthy.

Regarding the studies that assayed VO2max, the majority of the sample showed high and normal levels. All articles found association of at least one the following variables with CVD: Sedentary behaviour, low intensity exercise associated with overweight and obesity, excessive adipose tissue and low physical fitness, bad eating habits, low levels of VO2max, reduced strength and low aerobic fitness; male with more than 23 years and overweight or obese and bad RCE associated with metabolic syndrome; sedentary behaviour associated to CC, fasting hyperglycaemia, high cholesterol and triglycerides levels. One of the articles provides evidence that high levels of physical fitness abolished adverse effects associated with high ST.

DISCUSSION

This systematic review, by analysing 2168 subjects, being 937 man and 1231 woman, suggests that physical exercise significantly improves PhF, CrF and reduces CVD biomarkers related to lipoproteins, glucose intolerance, insulin resistance and anthropometric makers. Furthermore, we identified important variables, which modify the effects of exercise in cardiovascular health of young adults, including age, sex, intensity of exercise and present health condition.

Physical fitness is an important factor to improve health and to reduce stress considering that physical activity promotes physiological and psychological benefits (Deuster & Silverman, 2013). Studies regarding young university students are scarce in literature, urging the need for a large intervention in this population.

A previous study points that health perception is related to physical activity in two samples of adults in 1990 and in 2015. However, multivariate models and mutually adjusted suggests that the most important variables for perceived physical health could have change from VO2máx and chronicle degenerative diseases in 1990, to age, BMI, and educational level in 2015(Olsson et al., 2018). These findings demonstrate the relevance and the comprehension of multicausality to understand the concept of physical fitness in health perception, and consequently, cardiovascular risk in adults. Similar reports were not found for young university students.

Metabolic markers are health predictors in young university students. In addition, it is also indicators for better cardiovascular fitness. Previous studies states that physical fitness, but not muscle strength, are risk factors for premature death in young adults with amyotrophic lateral sclerosis (ALS) (Longinetti et al., 2017; Mattsson, Lönnstedt, Nygren, & Askmark, 2012). This indicates that a common factor is subjacent to physical fitness as for risk of ALS.

These results suggest that aerobic conditioning is correlated with a better cognitive control and to the development of a more proactive behaviour during tasks performed by teenagers

In this review, it was shown that higher levels of triglycerides, LDL-c, fasting blood glucose, and total cholesterol were correlated with reduced physical fitness. However, CVD markers such as adipokines, and inflammatory biomarkers have not been analysed in this study. The relevance of this question regards the fact that cardiorespiratory fitness and adiposity influence the risk of CVD mediated through inflammatory processes(Sun et al., 2014). Intervention programs that aims to improve physical fitness, reduce child obesity and keep

physical condition and weight in later life, could lead to reductions in inflammation process in adults. Physical fitness lowers the risk of cardiovascular events, reducing inflammation(Church et al., 2002; Nauman, Stensvold, Coombes, & Wisløff, 2016; Williams, Milne, Hancox, & Poulton, 2005). A meta-analysis study from(Lin et al., 2015) showed that exercise significantly improved cardiorespiratory fitness and cardiometabolic biomarkers. Effects of physical exercise were modified by age, sex and health condition. The results of this study have significant implications for planning interventions for physical exercise in young university students(Lin et al., 2015).

Three analysed studies involving both sex show data of differences between men and women regarding the risk of CVD. This results corroborates with other studies in literature that points a greater risk for men due to lifestyle and overweight while woman have an increased risk to adopt a sedentary behaviour(Martínez-Torres et al., 2017; Prioreschi et al., 2017). Moreover, both are associated with levels of physical activity, IMC and insulin resistance. Secchi (Secchi, García, España-Romero, & Castro-Piñero, 2014) reports that male children and teenagers shows higher levels of physical fitness. These differences increase with age, though. Approximately one in three participants shows poor aerobic fitness indicating risk of a future CVD. Prioreschi et al. (2017) evaluated 409 young black south African (with age of 19 and 20 years) and stated that overweight and obesity are more prevalent in women rather than men (35% vs 8%, $p<0,001$). However, men demonstrated higher values for VO2max compared to women(Prioreschi et al., 2017). In addition, elevated levels of sedentary behaviour in this population might be a factor that contributes to prevalence of overweight and obesity in this population

The analysis of studies that composed this review shows significant clinical implications for this specific population. Corroborating with previous studies(Brandão, Cardoso, & Pimentel, 2010; Brandão et al., 2008; Crepaldi et al., 2016; Correia, Cavalcante, & Santos, 2010; da Cruz et al., 2017), moderate and vigorous physical exercise are related to beneficial effects in physical fitness, cardiorespiratory fitness and cardiometabolic health. It was observed that differences in risk for CVD between the exercise and control group are significantly modified by lifestyle, BMI and intervention duration(Panda & Krishna, 2014; Racette et al., 2014; Ramírez-Vélez, Meneses-Echavez, González-Ruíz, & Correa, 2014; Sánchez-López et al., 2013; Vaara et al., 2014). These findings suggest that exercise interventions could produce similar effects for cardiovascular health in these populations independently of these factors. Furthermore, the efficiency of physical conditioning might be different depending on age, sex and health condition.

Although the studies aim to evaluate the association between physical fitness with risk for CVD in young university students, the heterogeneity among the studied population (geographic, age and number of subjects), the methodology of intervention and the analysed variables, which turns difficult to compared the results at the same time that raise relevant questions regarding the association of physical fitness with CVD in young university students. Another limitation is the reduced number of works with the theme

Since the association of physical fitness and risk factors for CVD are significant, other indicators should be analysed to make studies with this population more robust. Evaluate and compare stress, sleep quality, metabolic and inflammatory variables could be a strategy to find more evidences regarding physical fitness and CVD. Increase projects complexity should be considered in the future. Therefore, would be pertinent find other investigations though experimental designs, with both sexes, allowing to clarify the casual relation between CVD and physical activity.

CONCLUSION

Results showed that young university students are presenting sedentary behaviour along with low aerobic fitness, with high rate of dyslipidaemia, central obesity, high blood pressure, factors that predicts CVD. Although there is a significant number of evidences

presented this review, they are not consistent due to the small number of publications with the studied population in the last 10 years that compare the relation between sedentary behaviour of young university students and analysed indicators. Therefore, more studies are needed.

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