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Original article

Are former elite athletes more protected against metabolic syndrome?

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ABSTRACT

Background and purpose: Scientific literature offers no epidemiological data regarding prevalence and protective factors for the metabolic syndrome (MetSyn) among former athletes. The aim of this cross-sectional study was to investigate whether former athletes are better protected against MetSyn and if this hypothetical protection is dependent on sex, career, or later lifestyle.
Methods: We assessed demographic, behavioral, physical, and biochemical characteristics in a population of 491 subjects of both sexes.
Results: After adjustment for potential confounding factors, we found no significant differences in the likelihood of MetSyn among former elite, non-elite, and non-athletes. Likewise, sex and previous sport intensity did not reveal a significant association with the syndrome. However, both former elite [odds ratio (OR) 0.20, $p = 0.020$] and non-elite athletes (OR 0.50, $p = 0.044$) who after career termination engaged in the recommended amounts of physical activity, showed a reduced likelihood for the MetSyn.
Conclusions: Former athletes tend to adopt healthier lifestyles, which may give them an advantage regarding the risk factors that delineate the syndrome. Furthermore, physical activity engagement at recommended levels seems to play an important role in the association with MetSyn, even in subjects who have never been athletes.

Introduction

Metabolic syndrome (MetSyn) is a cluster of metabolic risk factors that directly promote the development of cardiovascular disease (CVD) [1] and also increase the risk for developing type II diabetes mellitus [2].

Physical Activity Guidelines for Americans [3] emphasize the association of physical activity with numerous health benefits, such as lower incidence of CVD [4] and type II diabetes mellitus [5]. This interaction occurs in part through components of the MetSyn [6] such as weight control and improved functioning of the cardiovascular system [7]. Likewise, long-term exercise favorably modifies several CVD risk factors, including blood lipids, obesity, blood pressure, and glucose tolerance [8]. Evidence also emphasizes vigorous exercise as more strongly associated with lower cardiovascular mortality than the less intense [9].

Former elite athletes represent a distinct group of individuals who have exercised for several years with heavy training loads [10] and regularly participate in competitions different from the general population during their sports careers [11]. Epidemiological studies suggest that they have a lower prevalence of CVD, diabetes, and hypertension [12,13], which can be explained because they tend to be more physically active and adopt healthier lifestyles [14,15]. However, other studies suggest that, regardless of competitive level reached or actual levels of physical activity engagement, former athletes tend to keep their fitness advantage over non-athletes well into middle age [16,17], which is inversely related to the prevalence of the syndrome [18]. Although strong evidence suggests that exercise favorably affects individual components of the MetSyn [19], these discrepancies raise the question of how the past and current engagements are associated with it. Furthermore, whether these former elite athletes' apparent advantages derive from the level achieved or coincide with others of lower-level, is not known.

Methods

We identified former elite athletes who represented Portugal in selected sports at least once in the Olympic Games, World or European championships, or other international competitions; former non-elite athletes who competed in selected sports at least for three consecutive years in their adult life, but at no time represented Portugal; and control subjects randomly selected in the Portuguese population, matched for age, and who were never athletes. All subjects had to be at least 30 years old. Former athletes competed during 1969–2005, and at the time of the study, had ended their

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career for at least three years. Sports federations provided and confirmed athletes' sports history.

In order to make known the study, describe the aims, and invite former athletes and controls to come to one of the laboratories which we provide for the collection of biochemical measures, we conducted a first interview by telephone (1378 subjects). After consent to participate (868 subjects), we mailed a questionnaire (preceded by a pilot study that attested the reliability) based on the World Health Organization STEPs approach [20]. This questionnaire, as well as the study protocol were approved by the local ethics committee, and included data on demographic information (age, sex, and occupation), behavioral and biological characteristics (tobacco use, alcohol consumption, diet, history of after the career physical activity, and history of raised blood pressure, cholesterol, triglycerides, glucose, and chronic diseases), physical (height, weight, waist, and blood pressure) and biochemical measurements [blood glucose, triglycerides, total cholesterol, high-density lipoprotein (HDL) cholesterol and low-density lipoprotein (LDL) cholesterol], as well as information regarding lifetime diagnosis of CVD (atherosclerosis, rheumatic heart disease, pulmonary embolism, peripheral artery disease, stroke or deep-vein thrombosis, acute myocardial infarction, or any other unspecified) or diabetes (we also questioned about these diagnoses among blood relatives of the first degree).

The response rate (with physical and biochemical data) was 78% for former elite, 71% for non-elite, and 64% for non-athletes, reducing the study population to 627 subjects. We excluded pregnant women ($n = 5$), individuals who currently had CVD, diabetes types I and II, cancer, or those who did not mention treatments that they were currently undergoing ($n = 131$). Thus, the successful study population consisted of 267 men and 224 women, for a total of 491 subjects (225 former elite athletes, 168 former non-elite athletes, and 98 non-athletes).

Procedures and categorization

We grouped the athletes classifying the sports they had participated in according to the Compendium of Physical Activities [21], based on the intensity of exercise performed between each sport, with their respective metabolic equivalent (MET) intensity levels. Sports were categorized according to the model proposed by Pate et al. [22] as moderate (3–6 METs; volleyball, gymnastics, archery, field events – throwing and jumping) and vigorous (>6 METs; judo, canoeing/rowing, sprint running, middle- and long-distance running, triathlon, decathlon, swimming, basketball, handball, and soccer).

We computed after career (adulthood for non-athletes) physical activity engagement in moderate and vigorous intensity based on structured questions regarding participation in three dimensions: recreational, traveling to and from places (walk or bicycle), and at work. These questions contemplated items such as the activity performed in each dimension, the average number of days per week, as well as its average duration. According to the adult recommendations from the American College of Sports Medicine and the American Heart Asociation [23], subjects were considered to have lower physical activity than recommended (Lower PAR) if after career termination they engage in less than 30 min d^{-1} on 5 d wk^{-1} of moderate-intensity aerobic, or less than 20 min d^{-1} on 3 d wk^{-1} of vigorous-intensity aerobic activity. If engagement had been at least 30 min d^{-1} on 5 d wk^{-1} of moderate-intensity aerobic, or 20 min d^{-1} on 3 d wk^{-1} of vigorous-intensity aerobic activity, we considered participants as meeting physical activity recommendations (Meet PAR).

We adopt the WHO guidelines regarding frequency and pattern of drinking [24] and categorized subjects as hazardous drinkers (if in one single occasion of the past 30 days they had drunk 5 for men or 4 for women standard alcoholic drinks; alternatively, if they usually consume alcoholic rarely or never with meals), moderate drinkers (if they have not drunk 5 for men or 4 for women standard alcoholic drinks in one single occasion of the past 30 days; and if consumption is typically at mealtimes), and abstainers (if they never consumed an alcoholic drink).

By separately multiplying the weekly frequency of consumption by the number of servings consumed per day and dividing it by seven, we have estimated the daily average consumption of fruits and vegetables. We considered subjects amid the insufficient fruit and vegetables consumption category if they reported less than five daily servings of both.

The subject's smoking status was based on a detailed smoking history, and we classified them into three categories: never, ex, or current smokers.

Socio-economic/occupational groups had the following categories: government employee, nongovernment employee, self-employed, retired, unemployed-able to work, and unemployed-unable to work. For employed subjects we assessed data regarding physical activity at work.

For questions related to standard alcohol drink, fruit and vegetables servings, and after the career physical activity engagement, we provided examples and the measurement protocol (one serving, one standard drink; vigorous and moderate physical activity).

We asked participants to self-measure height and weight, in order to provide current values.

We requested the height measurement to be conducted by a second person, and instructed the subjects to stand barefoot (also for weight measurement), leaning against a wall and looking forward. We calculated body mass index (BMI in kg/m^2) based on self-reported height (m) and weight (kg), and considered overweight/obese within the body mass index between 25 and 29.9, and $\geq$30, respectively.

For the abdominal circumference, we requested the measurement to be carried out without clothes; that is, directly over the skin, halfway between the lowest rib and the top of the hipbone. Sample images were available.

Biochemical data and blood pressure measurements were collected at the laboratory with participants having fasted for at least 12 h and recorded in the questionnaire form. Measurements obtained on fasting in the last 12 months, and carried out in specialized laboratories, were also accepted.

In the history of physical activity, data on sports and level of competition were obtained. For these variables, we used the cut-off values of MetSyn definition to create the categories (with or without each one of the risk factors).

Metabolic syndrome definition

We defined MetSyn according to the joint interim statement of the International Diabetes Federation and the American Heart Association/National Heart, Lung, and Blood Institute [2] as $\geq$3 of any of the following: abdominal obesity (waist circumference >102 cm in men or >88 cm in women); hyperglycemia (fasting glucose $\geq$100 mg/dL or current use of insulin or oral hypoglycemia medication); hypertriglyceridemia $\geq$150 mg/dL; low HDL cholesterol <40 mg/dL in men or <50 mg/dL in women; elevated blood pressure (systolic blood pressure/diastolic blood pressure $\geq$ 130/85 mmHg) or regular use of antihypertensive medication. We adopted the European Cardiovascular Societies cut point for European population to define abdominal obesity [25].

Statistical analysis

Main characteristics of the study subjects were analyzed with ANOVA and Chi-square test. To test differences in clinical and