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Health-related physical fitness in middle-aged men with and without metabolic syndrome

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Aim. **Objective of the study was to compare health-related physical fitness (HRPF) between men with and without metabolic syndrome (MS) and to evaluate the risk of being unfit associated with MS.**

Methods. **The study included 79 middle-aged civil servant men (46.2±8.4 years) who underwent a physical annual evaluation to access HRPF as follows: BMI; cardiorespiratory fitness by Ebbeling test (VO_2max), flexibility by sit-and-reach test (SRT), muscular strength by handgrip test (HDT) and vertical jump test (VJT) and muscular endurance by push-up test (PUT). MS was defined by the ATP III (2009) criteria. Comparisons were performed with the Mann-Whitney test and univariate General Linear Model was used for age-adjusted analysis. Odds ratio (OR-95% CI) was calculated to evaluate the odds of the MS group to be unfit and the odds of having MS according to the HRPF levels.**

Results. **Nineteen volunteers (24.1%) with MS were identified. After age adjustment, VO_{2max} and BMI were significantly different in the MS group than in the non-MS group: 39.7 *vs.* 44.8 mL·kg^{-1}·min^{-1} and 29.4 *vs.* 25.7 kg/m^2 ($P<0.05$) and PUT tended to be lower in men with MS (16 *vs.* 21 repetition; P=0.06). Blood pressure ≥130/85 mmHg was the most prevalent MS criterion, associated with lower VO_{2max} (40.3 *vs.* 45.6 mL·kg^{-1}·min^{-1}) and SRT (22.2 *vs.* 28 cm), and higher BMI (28.9 *vs.* 25.3 kg/m^2) ($P<0.05$). The OR of being unfit for VO_{2max} and BMI in the MS group were 6.5 (1.9-22.6) and 5.7 (1.2-26.8). The odds of having MS increased by 23% (3-45%) for each BMI unit increase, irrespectively to age.**

Conclusion. **MS group showed lower VO_{2max}, PUT, higher BMI and a greater risk of being unfit compared to the non-MS one. The proportion of MS was 3.4-fold higher within those with lower VO_2max. Small reductions on BMI may produce significant decrease on MS prevalence.**

Key words: Metabolic Syndrome X - Physical fitness - Muscle strength - Oxygen consumption - Body composition - Risk factors.

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The association between physical activity (PA), physical fitness and health has been widely explored.[1] Since the early 1970s, studies demonstrated that regular physical activity could have a protective effect against cardiovascular diseases.[1-3] Such evidence led the American College of Sports Medicine (ACSM) and the American Heart Association (AHA) to update their recommendations in 2007, stating that every healthy adult should engage on regular physical activity to promote and maintain health.[4] Despite increasing efforts to widespread PA recommendations, the global prevalence of physical inactivity, cardiovascular and other non-communicable diseases is still growing.[4-6]

Similarly, the relationship between low physical fitness and health has been an outstanding issue. Physical fitness is classically determined in terms of a health-related and a performance-related domain. Health-related physical fitness (HRPF) is defined as

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"[…] those specific components of physical fitness that have a relationship with good health […]", and comprises 5 components: cardiorespiratory fitness (CRF), body composition, muscle strength, muscular endurance and flexibility.[7] Adequate levels of HRPF are associated with a reduced risk for several cardiometabolic conditions, whereas an impaired cardiorespiratory fitness is an important risk factor for overall mortality, obesity and metabolic syndrome (MS).[4, 8-12] Metabolic syndrome is characterized as a combination of medical disturbances and is associated with an increased risk for cardiovascular diseases, diabetes and overall mortality.[13] Recent researches point to a link between HRPF and MS or its components, either in adults and in youth.[8, 12, 14, 15]

Many studies have evaluated the association between physical activity level or cardiorespiratory fitness with metabolic syndrome,[8, 12, 16, 17] but only a few have addressed its relations with other HRPF components.[14, 17] Investigating the influence of each HRPF component and their association with the MS parameters in different populations would provide valuable information for understanding their roles on this complex clinical condition. Meanwhile, little is known about this association among Brazilian civil servants.

We aimed to compare health-related physical fitness parameters from adult males with and without MS. Secondarily, we compared the same parameters between men with and without each one of the five individual MS components. We also compared the proportion of metabolic abnormalities by cardiorespiratory fitness categories. In this context, we hypothesized that a) patients with metabolic syndrome have impaired levels of health-related physical fitness; b) the proportion of metabolic abnormalities is higher among men with low cardiorespiratory fitness, and c) that MS is associated with an increased risk for being physically unfit.

Materials and methods

A cross-sectional study was performed with data obtained from standardized records of male civil servants from the security and transportation departments of the Brazilian Superior Labor Court (TST) who presented for the routine periodic health examination. All of them performed similar job tasks and underwent an obligatory annual physical fitness evaluation, as part of the Brazilian Superior Labor Court physical activity promotion program, named "TST on the move". Among the employees who presented for the periodic health examination and physical fitness evaluation, 79 passed the clinical requirements for performing the physical tests and therefore were included in the study. Those who had clinical contraindications that prevented physical activity, such as osteoarticular disabilities or uncontrolled arterial hypertension, were excluded (<10%).

All subjects gave their written informed consent to the use of the collected data for research purposes. An authorization from the Superior Labor Court was also properly obtained. All clinical and physical fitness evaluations were completed between August 1st 2009 and December 19th 2010.

HRPF tests were performed by every subject included in the study, except 2 for the lower limbs muscle strength test and the upper limbs muscle endurance test, and 1 for the flexibility test due to individual temporary restrictions, as muscle or back pain, thereby given a sample size of 77 and 78 for each of those tests, respectively.

Physical evaluation

By routine, all employees first underwent a medical clinical inquiry followed by a physical examination before being allowed to perform physical tests. Medical evaluation also included blood test, blood pressure measurement, 12-lead ECG and any other test or exam depending on physician judgment. The subjects were asked to refrain from caffeine, alcohol and exercise for 12 hours prior to the physical tests. They were initially submitted to questionnaires about physical activity (IPAQ Portuguese short-version),[18] lifestyle, quality of life and socioeconomic conditions, such as personal information's about work and housing characteristics, WHOQOL questionnaire (World Health Organization Quality of Life-Portuguese version) [19] and ACSM (American College of Sports Medicine) risk-stratification questionnaire.[20]

Health-related physical fitness components were assessed according to the TST on the move Program standardized protocol, as follows:

1. BMI: weight and height were measured using the Filizola® weighing-device with stadiometer while volunteers wore light clothing, without shoes;

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2) CRF was evaluated by the estimated maximum oxygen uptake (VO_{2max}) measured by the Ebbeling single stage treadmill test. The test consists of a submaximal 4-minute walking on a treadmill after a 4-minute warm-up period.[21] A Movement-LX160® treadmill (Movement, Brazil) was used. HR was continuously measured by a Polar S810® heart rate monitor during the test, while blood pressure was measured before and at the end of the test;

3) flexibility was evaluated by the Sit-and-Reach Test (SRT) following the ACSM recommended protocol;

4) muscle strength was evaluated by the Vertical Jump Test (VJT) for the lower limbs and by the Handgrip Dynamometer Test (HDT) for the upper limbs evaluation. The HDT was performed with the dynamometer Jamar® following the American Society of Hand Therapists protocol,[22] using the maximum value obtained after 3 trials with 1-min interval between each one. The VJT was also performed on a 3-trials procedure, following a previously described standardized protocol;[23]

5) muscular endurance for the upper limbs was assessed by the Push-Up Test (PUT) as described by the ACSM.

Apart from the analysis of each HRPF test, an overall health-related physical fitness index (OHRPFI) was constructed using the sum of the z-scores of all HRPF tests. For the OHRPFI calculation the BMI z-score value direction (positive or negative) was inverted in order to follow the negative association between excess weight and health. This procedure was adopted since no volunteer showed BMI under the minimum normal value (18.5 kg/m²), situation where a negative z-score could represent a negative association with health outcomes, and because the fact that even small reduction on BMI z-score seem to be associated with improvement on health outcomes.[24] So,

$$\text{OHRPFI} = [VO_2 \text{ z-score} - (\text{BMI z-scorre}) + \text{SRT z-score} + \text{PUT z-score} + \text{VJT z-score} + \text{HDT z-score}].$$

Metabolic syndrome definition criteria

Metabolic syndrome was defined by the ATP III report criteria, harmonized in 2009 by expert organizations, including the International Diabetes Federation (IDF), the AHA and the National Heart, Lung, and Blood Institute (NHLBI).[25] Volunteers were included in the MS group when they fulfilled at least 3 of 5 criteria: waist circumference (WC) ≥94 cm; triglycerides (TG) ≥150 mg/dL; HDL-c <40 mg/dL; SBP ≥130 mmHg and/or DBP ≥85 mmHg or antihypertensive drug treatment; fasting glucose (FG) ≥100 mg/dL or on antidiabetic treatment. The blood biochemical parameters were obtained from their medical report, and were the most recent laboratory examination done as part of their clinical evaluation. The date of the last blood test usually corresponded to the last six months but could vary depending on individual profile and upon physician judgment.

Statistical analysis

Since some HRPF and MS components values showed a nonparametric distribution after evaluated by the Shapiro-Wilk test, data are presented as median (extreme) values. Unadjusted comparisons of HRPF variables between groups were analyzed with the Mann-Whitney test. Adjusted analysis was performed using univariate General Linear Model (GLM) with age as the only covariate, since it was the sole variable of interest with difference between those with and without MS groups. Sequentially, we proceeded to a multivariate analysis including all variables that had a significance level $P>0.02$ in the bivariate analysis (BMI as categorical variable, age, CRF, PUT and VJT), using logistic regression. In part of the analysis, volunteers were categorized into an Unfit group (those with HRPF maximum tested value under the median fitness category for age and gender proposed by the ACSM [20] or into a Fit group (those with HRPF value equal or above the proposed median value). Absolute and relative proportion of MS components were calculated and compared between cardiorespiratory fitness groups. Odds ratio (OR) with 95% confidence interval (95% CI) was calculated, by a two-by-two contingency table analysis, to evaluate the odds of the MS group to be unfit as compared to the group without MS, which was considered the reference group. Because not all analyzed HRPF variables have standardized fitness category for age and gender, OR was calculated only for VO_2max, BMI (18.5<BMI<25 *vs* BMI≥25 kg/m²) PUT and SRT. Crude and age-adjusted odds ratios (95% CI) for the presence of metabolic syndrome by

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TABLE I.—*Median (min-max) subjects characteristics values comparing MS group (N.=19) and non-MS Group (N.=60).*

	MS	non-MS	P*
Age (yrs)	52.0 (34-61)	46 (24-62)	<0.001
BMI (kg/m²)	29.4 (19.6-34.7)	25.7 (19.3-36.6)	<0.001
SBP (mmHg)	132 (100-145)	120 (100-145)	<0.05
DBP (mmHg)	90 (72-100)	82 (70-100)	<0.05
WC (cm)	98 (70-108.3)	87.6 (72.5-106.5)	<0.05
TG (ng/dL)	208 (73-404)	113.5 (45-700)	<0.05
FG (ng/dL)	102 (83-209)	90.5 (70-120)	<0.05
HDL (ng/dL)	36 (30-59)	47.5 (35-85)	<0.05

MS: metabolic syndrome; SBP: systolic blood pressure; DBP: diastolic blood pressure; WC: waist circumference; TG: triglycerides; FG: fasting glucose; HDL: high density lipoprotein cholesterol; * Mann-Whitney test - the variables in which “age” was different between MS and no-MS groups (BMI, WC and HDL) maintain their statistical difference after age adjustment (P<0.05).

the overall health-related physical fitness index and each of the index components were also calculated by logistic regression. Processing and data analysis were performed using the IBM SPSS Statistics® v17 (IBM Corporation, USA) software package.

Results

The mean age and BMI of the subjects included in the study were 46.2±8.4 years and 26.7±3.9 kg/m², respectively. Sixty-one men (77.2%) were insufficiently active or sedentary and 18 (22.8%) were physically active. The proportion of active participants with MS (18.8%) was similar to the one of those without MS (23.2%) and all HRPF values were similar between active and insufficient active groups (0.1<P<0.79).

Nineteen volunteers (24.1%) were identified with MS. Subject’s characteristics and comparison between MS group and non-MS group for age and MS components are shown in Table I. As expected, the MS group showed impaired values for all MS components as compared to non-MS group, even after age adjustments for variables in which “age” was different between MS and no-MS groups (BMI, WC and HDL) (P<0.05).

The most frequent MS component was elevated blood pressure (43%; N.=34), followed by WC ≥94 cm (38%; N.=30), high triglyceride level (34%; N.=27), elevated fasting glucose level (27%; N.=21), and low HDL cholesterol level (25%; N.=20).

Comparative analysis of the HRPF components between men with and without MS, and between men separated by each MS criteria is shown on Table II. MS group showed significantly higher BMI values, lower values for cardiorespiratory fitness (P<0.05) and a tendency for lower muscular endurance after age adjustment (P=0.06). After multivariate analysis, only BMI and age remained statistically different between those with and without MS (P<0.05).

The most significant difference in HRPF components was found in men with elevated blood pressure, in which VO_{2max}, BMI and SRT test showed worse values as compared to those with normal BP, after age adjustment. Similarly, men with WC ≥94 cm had lower VO_{2max} values and higher BMI. Subjects with FG ≥100 ng/dL also had impaired upper limbs muscular endurance as measured by the Push-Up Test.

The comparison of the OHRPFI between groups showed that those with MS had reduced median (min/max) values: -2.6 (-5.8/3) as compared to those without MS: 1 (-5.7/8.2) (P=0.048 after age adjustment). Crude and age-adjusted odds ratios (95% CI) for the presence of MS by the OHRPFI and each of its components are presented on Table III. For each BMI unit increase there was significant increase (23%) on the odds of having MS, irrespectively to age. Apart from that, it should be highlighted on Table III that there was a statistical tendency for a reduction in the odds of having MS associated with the OHRPFI and almost all OHRPFI components.

The comparison between absolute and relative proportions of cardiometabolic abnormalities (MS criteria) stratified by cardiorespiratory fitness showed that the proportion of men with MS was 3.4-fold higher in the unfit group (57.1%) as compared to the fit one (16.9%). Moreover, every unfit volunteer had at least one of the MS criteria while almost one third of the fit group (29.2%) was free from all MS criteria.

Finally, we observed that the odds ratio (95% CI) for being physically unfit were higher on the MS

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TABLE II.—*Comparison between HRPF median (min-max) values between MS and non-MS groups and between groups divided by each MS criteria.*

	N.	VO_2max ml·kg⁻¹·min⁻¹	BMI kg/m²	PUT reps	SRT cm	VJT cm	HDT kgf
MS	YES (N.=19)	39.7 (31-48.2)* †	29.4 (19.6-34.7)*†	16.0 (3-26)*‡	23.2 (15-36.6)	42.5 (30-55)	52 (39-66)
	NO (N.=60)	44.8 (32.7-58.4)	25.7 (19.3-36.6)	21.0 (1-39)	25.4 (4.5-47.5)	46 (27-71.5)	52 (36-70)
WC ≥94	YES (N.=30)	39.3 (31-49.2)*†	29.4 (26.4-36.6)*†	16.0 (3-36)*	22.3 (13.1-47.5)	44.5 (30-68)	52.8 (38-66)
	NO (N.=49)	45.6 (34.2-58.4)	24.8 (19.3-30.1)	20.0 (1-39)	26.3 (4.5-45.5)	46 (27-71.5)	51 (36-70)
TG ≥150	YES (N.=27)	41.6 (31-51.6)*‡	26.2 (19.6-34.7)	17 (1-38)*	24.6 (10-37.7)	46.3 (27-71.5)	51 (42-70)
	NO (N.=52)	43.9 (32.7-58.4)	26.4 (19.3-36.6)	20 (8-39)	24.6 (4.5-47.5)	45.0 (31-68)	52 (36-65)
HDL <40	YES (N.=20)	43.0 (32.6-50.3)	28.5 (19.6-34.6)	18 (8-38)	24.3 (14.5-37.7)	44.5 (30-57.5)	50.5 (39-70)
	NO (N.=59)	43.6 (31-58.4)	26.2 (19.3- 36.6)	19 (1-39)	24.6 (4.5-47.5)	45.3 (27-71.5)	52.2 (36-65)
BP ≥130 /85	YES (N.=34)	40.3 (31-49.2)*†	28.9 (20.4-36.6)*†	18 (1-39)	22.2 (10-36.6)*†	45.0 (27-68)	53.5 (39-66)
	NO (N.=45)	45.6 (34-58.4)	25.3 (19.3- 34.6)	19 (2-38)	28 (4.5-47.5)	46.3 (32.5-71.5)	51 (36-70)
FG ≥100	YES (N.=21)	40.2 (32.6-50.8)*	28.5 (19.4-33.7)	16 (2-21)* ‡	25.4 (13.2-37.5)	41.4 (30-55)*	52 (39-65)
	NO (N.=58)	44.8 (31-58.4)	25.8 (19.3-36.6)	21 (1-39)	24.6 (4.5-47.5)	46.5 (27-71.5)	52 (36-70)

VO_2max: estimated cardiorespiratory fitness; BMI: body mass index; PUT: push-up test; SRT: Sit-and-reach test; VJT: vertical jump test; HDT: handgrip dynamometer test; MS: metabolic syndrome; WC: waist circumference; TG: triglycerides; HDL: high density lipoprotein cholesterol; BP: blood pressure; FG: fasting glucose; YES: presence of the criteria; NO: absence of the criteria; "P" values refer to the comparison between "YES" and "NO" groups in each MS and HRPF components *: P<0.05 = P value for unadjusted Mann-Whitney non-parametric test; †: P<0.05 = P values adjusted for age by univariate General Linear Model (GLM); ‡: 0.05<P<0.1 = P values in the range of statistical tendency after adjustment for age by logistic regression.

group, as compared to the non-MS one, for VO_{2max}: 6.5 (1.9-22.6) and for BMI: 5.7 (1.2-26.8). The same analysis for PUT and SRT showed no difference: 3.2 (0.9-12.1) and 1.7 (0.6-4.8), respectively.

Discussion

The data presented in this study from 79 Brazilian male middle-aged civil servants showed a strong association between metabolic syndrome and poor health-related physical fitness. These findings are of note since they refer to a very homogenous sample, as regards to its peculiar occupational selection criteria. In these men, age-adjusted data revealed that subjects with MS had significantly lower VO_{2max} (-11.4%), higher BMI (+14.4%) and a global physical fitness strongly reduced (OHRPFI -3.6 z-score) than those without metabolic syndrome. After age adjustment, there was also a statistical tendency for the reduced muscular endurance (-23.8%) (P=0.06). We also found that MS group had a huge 6.5-fold elevated risk of having a VO_2max under the minimum predicted value for the mean performance category proposed by the ACSM for a good health. Another important finding was the fact that the odds of having MS increased 23% for each BMI unit increase, after age adjustment (Table III). On a scenario where obesity and MS prevalences represent major public health problems, our findings suggest that controlling BMI could be a very good option to reduce MS prevalence in middle-aged men. Our results corroborate some previous findings suggesting a strong association between metabolic syndrome and poor health-related physical fitness.[8, 12, 16, 26]

Accordingly, the MS group showed a 5.7-fold in-

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TABLE III.—*Crude and age-adjusted odds ratios (95% confidence intervals [95% CI]) for the presence of metabolic syndrome (MS) by the overall health-related physical fitness index and each of the index components.*

HRPF components	MS N. (%)	Non-MS N. (%)	OR (95% C.I.) Crude	OR (95% C.I.) Adjusted*
OHRPFI	58 (77.3)	17 (22.7)	0.71 (0.57-0.88)	0.81 (0.63-1.05)
VO_2	60 (75.9)	19 (24.1)	0.82 (0.73-0.92)	0.89 (0.77-1.01)
BMI	60 (75.9)	19 (24.1)	1.27 (1.08-1.48)	1.23 (1.03-1.45)
PUT	59 (76.6)	18 (23.4)	0.88 (0.81-0.96)	0.92 (0.84-1.01)
SRT	60 (75.9)	19 (24.1)	0.86 (0.75-0.99)	0.95 (0.81-1.11)
VJT	59 (76.6)	18 (23.4)	0.95 (0.88-1.02)	0.99 (0.92-1.08)
HDT	60 (75.9)	19 (24.1)	1.01 (0.93-1.08)	1.00 (0.92-1.09)

MS: metabolic syndrome; OHRPFI: overall health-related physical fitness index; VO_2max: estimated cardiorespiratory fitness; BMI: Body mass index; PUT: push-up test; SRT: sit-and-reach test; VJT: vertical jump test; HDT: handgrip dynamometer test; * adjusted for age.

creased risk of having a BMI above the recommended upper limit for health (≥25 kg/m^2). Although CRF and physical activity level are different concepts that could be independently associated with MS,[27] the proportion of active and insufficiently active participants were similar between those with and without MS and there were no statistical differences in none of the HRPF when groups where compared by their physical activity level.

Differently from the majority of previous studies, we went beyond the cardiorespiratory component. We included an analysis of each of the 5 HRPF components and each of the 5 MS criteria (Table II). Supporting our hypothesis, previous studies have described the necessity of reducing the cardiometabolic risk and thereby cardiovascular diseases by targeting the individual components of MS.[28, 29] However, the association of each MS criterion with the HRPF components is not well established yet. In this scenario, we found that 4 of the 5 MS criteria had worse values in at least one HRPF components, as compared to its correspondent negative criteria subgroup (Table II). This interesting finding suggests that targeting each MS criterion could be important not only to reduce cardiometabolic risk but also to positively influence the HRPF components.

Our results are in keeping with the Quebec Family Study as regards to the finding that the prevalence of MS among the less fit men was six times higher than those with better physical fitness. In that study, physical fitness was evaluated by a workload capacity on a cycle ergometer at fixed heart rate.[30] Meanwhile, our CRF findings are also in agreement with the results of a 9-year cohort study that indicated a relationship between a higher cardiorespiratory fitness and a reduced risk of MS.[31] Similarly, Crist *et al.*[32] found that improving aerobic fitness, evaluated by heart rate response during treadmill tests performed at baseline and after 6 and 18 months of lifestyle intervention, was associated with a reduction on MS prevalence. These authors have also identified an association between lower fitness performance and a higher prevalence of MS at baseline, 6, and 18 months of follow up.

Our findings also corroborate a recent study in a large cohort of US firefighters, in which Baur *et al.*[12] showed that the prevalence of MS among the less fit firefighters (≤10 METs) was almost 10-fold higher than that of their more fit peers (>14 METs) (51.2% *vs.* 5.2%). They also showed that every 1-MET increase on a maximal exercise testing was associated with a 31% reduction of the odds of having MS. Similarly, we found a statistical tendency for a protection effect (-11%) of having MS for each VO_2 unit increment (Table III). Concurrently, Grundy *et al.*[8] observed that a decrease in cardiorespiratory fitness was associated with increases in obesity, blood pressure, diabetes and MS.

In the present study, it is noteworthy that men with MS were older than those without. The association of MS with age has been well defined.[26, 33] Despite the inherent limitations of the cross-sectional design, the worse HRPF from the MS group may be associated either with age or with the MS condition itself, since some HRPF components remained impaired (BMI, VO_2max and the OHRPFI) or showed a statistical tendency to be impaired (PUT) in the MS group, even after age adjustment. Accordingly, the unfit *vs* fit analysis has also considered the effect of age, since the used standardized values for a good physical fitness also takes age into account.

Taking our data in perspective, it is also important to observe that the median difference of 5.1 mL/kg/min for the VO_2max between groups corresponds to a decrease in performance of almost 1.5 METs in the MS group. Myers *et al.*[9] in a longitudinal study of men referred for exercise testing, showed that the exercise capacity was a powerful predictor of mortality, and that every 1-MET increase in exercise capacity was associated with a 12% improvement in survival.

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Accordingly, the small decrease in cardiorespiratory capacity (-1.5 MET) in men with MS may represent an important negative issue for health.

After age adjustment, elevated blood pressure (EBP) was shown to be the MS component associated with the most impaired HRPF, with a -11.6% difference on VO_{2max}, -20.7% on flexibility and +14.2% on BMI; second was the WC ≥94 cm that was associated with the greatest impairments of VO_2max (-13.8%) and on BMI (+18.5%). These interesting results suggest that those two MS components may play important roles on the negative impacts for health among men with MS. However, this hypotheses must be tested on longitudinal studies.

Another key point to be considered is the lack of a consensual definition of the WC cut point for the Brazilian population, which could have influenced the analysis. Since our aim was to evaluate the hypothesis of a HRPF impairment associated with MS itself and with MS components, we used the more stringent criteria (WC ≥94 instead of 102 cm) from the widely used criteria for MS definition.[25, 29] This conservative approach is coherent with the probability of a highest WC cut point being inversely associated with physical performance. In this sense, our data showed that even with a lower WC cut point, some important HRPF components, as well as the risk of being unfit, were significantly different between men with and without MS. Moreover, the prevalence of MS in our study was similar or slightly smaller than previous studies, indicating that the lower WC reference value did not overestimate it.[12, 33, 34] It is also important to note that only 4 individuals would not have met the MS criteria if the WC cut-point ≥102 cm had been used instead of 94 cm.

Finally, it is important to consider possible limitations related to the cross-sectional study design and the sample size and characteristics, which prevent extrapolations. Albeit the limited sample size, the observed prevalence of MS (24.1%) was similar or just somewhat lower than those found on previous studies.[12, 33-35] Nevertheless, the MS group and even the MS criteria subgroups tended to have impaired values of all HRPF parameters when compared to the correspondent non-MS or non-MS criteria group. It should also be observed that the multivariate analysis comparing the odds of having MS showed a statistical tendency for reduced odds associated with the overall HRPF index and for some of its components, specially the cardiorespiratory fitness (VO_2) and the muscular endurance (PUT) (Table III). These statistical levels of significance for the odds of having MS may have been limited by the sample size. Moreover, longitudinal studies should be conducted to clarify those interrelationships and possible casual relations.

Conclusions

In summary, in a sample of 79 middle-aged civil servant men, we found a negative association between MS and important health-related physical fitness components, such as cardiorespiratory fitness, muscle endurance, body composition and the overall physical fitness index. This association was also observed for the majority of individual MS components, especially for elevated blood pressure and waist circumference. We also observed that men with MS had a higher risk of being unfit, and that the proportion of MS was higher among individuals with lower cardiorespiratory capacity. Conversely, in the fit group, almost one third of men did not have any of the 5 MS criteria. Our findings contribute to better understand the magnitude of the possible negative effects of metabolic syndrome for physical health. A causality relationship is tempting to speculate, but needs further investigation with longitudinal and prospective designs. Considering the well-known importance of HRPF for different health outcomes, including autonomy and daily life tasks, our data highlight that MS can be an important issue for a globally impaired quality of life. On the other hand, the observed 23% increase on the odds of having MS per BMI unit, irrespectively to age, opens a good public health perspective since it indicates that even small reductions on BMI may contribute significantly to reduce the prevalence of MS in middle-aged men.

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