MAYO CLINIC

ORIGINAL ARTICLE

Association of Resistance Exercise, Independent of and Combined With Aerobic Exercise, With the Incidence of Metabolic Syndrome

Esmée A. Bakker, MSc; Duck-chul Lee, PhD; Xuemei Sui, MD, PhD; Enrique G. Artero, PhD; Jonatan R. Ruiz, PhD; Thijs M.H. Eijsvogels, PhD; Carl J. Lavie, MD; and Steven N. Blair, PED

Abstract

Objective: To determine the association of resistance exercise, independent of and combined with aerobic exercise, with the risk of development of metabolic syndrome (MetS).

Patients and Methods: The study cohort included adults (mean ± SD age, 46±9.5 years) who received comprehensive medical examinations at the Cooper Clinic in Dallas, Texas, between January 1, 1987, and December, 31, 2006. Exercise was assessed by self-reported frequency and minutes per week of resistance and aerobic exercise and meeting the US Physical Activity Guidelines (resistance exercise ≥2 d/wk; aerobic exercise ≥500 metabolic equivalent min/wk) at baseline. The incidence of MetS was based on the National Cholesterol Education Program Adult Treatment Panel III criteria. We used Cox regression to generate hazard ratios (HRs) and 95% CIs.

Results: Among 7418 participants, 1147 (15%) had development of MetS during a median follow-up of 4 years (maximum, 19 years; minimum, 0.1 year). Meeting the resistance exercise guidelines was associated with a 17% lower risk of MetS (HR, 0.83; 95% CI, 0.73-0.96; P=.009) after adjusting for potential confounders and aerobic exercise. Further, less than 1 hour of weekly resistance exercise was associated with 29% lower risk of development of MetS (HR, 0.71; 95% CI, 0.56-0.89; P=.003) compared with no resistance exercise. However, larger amounts of resistance exercise did not provide further benefits. Individuals meeting both recommended resistance and aerobic exercise guidelines had a 25% lower risk of development of MetS (HR, 0.75; 95% CI, 0.63-0.89; P<.001) compared with meeting neither guideline.

Conclusion: Participating in resistance exercise, even less than 1 hour per week, was associated with a lower risk of development of MetS, independent of aerobic exercise. Health professionals should recommend that patients perform resistance exercise along with aerobic exercise to reduce MetS.

 ■ Mayo Clin Proc. 2017;■■(■):1-9

One-third of US adults have metabolic syndrome (MetS).[1] Cardiometabolic disorders, such as glucose intolerance, insulin resistance, central obesity, dyslipidemia, and hypertension, are its key components.[2,3] Therefore, MetS is an important risk factor for type 2 diabetes mellitus[4,5] and cardiovascular diseases (CVDs).[6,7] Increasing physical activity (PA) is a cornerstone for preventing and treating MetS.[3,8] Several intervention studies have reported the benefits of aerobic exercise for improving metabolic risk factors.[9,10]

Previous studies, mostly cross-sectional, have identified negative associations of muscular strength[11-14] or resistance exercise[15-17] with the prevalence of MetS. Furthermore, recent cohort studies have indicated that higher levels of resistance exercise were associated with lower risks of type 2 diabetes mellitus in men and women,[18-20] which suggests that increasing resistance exercise might be a potential target for preventing MetS. However, there is very little evidence from large epidemiological studies regarding the effects of resistance exercise on the development of MetS. Therefore, the aim of this study was to examine the association of resistance exercise, independent of and combined with aerobic exercise, with the risk of development of MetS in relatively healthy

From the Department of Physiology, Radboud University Medical Center, Nijmegen, The Netherlands (E.A.B., T.M.H.E.); Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, United Kingdom (E.A.B., T.M.H.E.); Department of Kinesiology, Iowa State University, Ames, IA (D.L.); Department of Exercise Science (X.S., S.N.B.) and Department of Epidemiology and Biostatistics (S.N.B.), University of

Affiliations continued at the end of this article.

middle-aged adults. We hypothesized that resistance exercise lowers the risk of development of MetS and that the combination of resistance and aerobic exercise might be more strongly associated with lower risk than either one independently.

PATIENTS AND METHODS

Study Population

The Aerobics Center Longitudinal Study is a cohort of men and women who received extensive preventive medical examinations at the Cooper Clinic in Dallas, Texas, between January 1, 1987, and December 31, 2006. Of the 10,243 participants, we excluded 836 individuals with a history of myocardial infarction, stroke, or cancer and 1989 individuals with MetS at baseline. Our final sample included 7418 individuals (1384 women [19%]). The participants were predominantly non-Hispanic whites, well educated, and employed in, or retired from, professional or executive positions.[21] The Cooper Institute institutional review board approved the study annually, and written informed consent was obtained from participants before data collection at baseline and during follow-up examinations.

Clinical Examination

All participants underwent comprehensive medical examinations at baseline, including body composition assessments, blood chemistry analyses, blood pressure measurements, electrocardiography, physical examination, and detailed medical history questionnaire. Body mass index (BMI) was calculated from measured weight and height squared (kg/m^2). Waist circumference was measured with anthropometric tape at the umbilicus level. Blood chemistry analyses, measuring triglyceride, high-density lipoprotein cholesterol (HDL-C), and fasting glucose levels, were obtained with automated bioassays after 12-hour fasting. Resting systolic and diastolic blood pressure were measured by standard auscultatory methods after 5 minutes of seated rest and calculated as the average of at least 2 readings separated by 2 minutes.

Age, sex, smoking status, alcohol consumption, personal history of physician-diagnosed CVD, cancer, and parental history of CVD, hypertension, and diabetes were assessed by a medical history questionnaire. Heavy alcohol drinking was defined as more than 14 alcoholic drinks per week for men and more than 7 for women.[22] The medical history questionnaire included a PA section on self-reported leisure time PA or recreational PA during the preceding 3 months. We classified aerobic exercise into 4 categories: inactive (0 metabolic equivalent [MET] min/wk), insufficient (1-499 MET min/wk), medium (500-999 MET min/wk), and high (≥1000 MET min/wk) based on the 2008 US Physical Activity Guidelines.[23]

Assessment of Resistance Exercise

Self-reported resistance exercise was assessed in the medical history questionnaire. Participants were asked about the weekly frequency and average exercise duration (minutes) for each session of muscle-strengthening PA using either free weights or weight training machines over the preceding 3 months. We used frequency (0, 1, 2, 3, 4, or ≥5 times/wk) and total amount (0, 1-59, 60-119, 120-179, and ≥180 min/wk) of resistance exercise as well as meeting the 2008 Physical Activity Guidelines for resistance exercise (≥2 times/wk[23]) as our main exposures. The total amount of resistance exercise was calculated by multiplying frequency of exercise with the average minutes per session.

Ascertainment of MetS

Participants were classified as having MetS using the criteria of the National Cholesterol Education Program Adult Treatment Panel III[3] at both baseline and follow-up. MetS was based on the presence of 3 or more of the following risk factors: (1) abdominal or central obesity (waist circumference >102 cm in men and >88 cm in women), (2) fasting hypertriglyceridemia (triglyceride level ≥150 mg/dL [to convert to mmol/L, multiply by 0.0113]), (3) low HDL-C level (<40 mg/dL in men and <50 mg/dL in women [to convert to mmol/L, multiply by 0.0259]), (4) high blood pressure (≥130/85 mm Hg or history of physician-diagnosed hypertension), and (5) high fasting glucose level (≥100 mg/dL [to convert to mmol/L, multiply by 0.0555] or history of physician-diagnosed diabetes). Follow-up time was calculated from the baseline examination to the first event of MetS or