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Leisure-Time Physical Activity is Associated with a Reduced Risk for Metabolic Syndrome

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PURPOSE: The objective of this study was to evaluate the cross-sectional relationship between leisure-time physical activity and the prevalence of metabolic syndrome in the Korean population.
METHODS: The study population included 11,925 participants (6,878 men and 5,047 women), aged 30–79 years. Metabolic syndrome was defined based on the National Cholesterol Education Program criteria of having three or more cardiovascular risk factors, with a modified obesity index. Self-reported leisure-time physical activity was calculated using metabolic equivalents (MET) scores. Logistic regression was used to estimate the association between leisure-time physical activity and the prevalence of metabolic syndrome, with adjustment for other risk factors.
RESULTS: The prevalence of metabolic syndrome was 18.2% in men and 8.5% in women. After adjustments for age and education levels, household income, smoking status, and alcohol consumption, the prevalence of metabolic syndrome among participants in the middle and top tertiles of leisure-time physical activity was significantly lower than that among those with no physical activity; the odds ratios (95% confidence intervals) were 0.84 (0.71–0.99) and 0.75 (0.62–0.89), respectively, in men and 0.54 (0.39–0.76) and 0.65 (0.48–0.88), respectively, in women.
CONCLUSIONS: These results suggest that increasing levels of leisure-time physical activity, in terms of duration or intensity, are linearly associated with a reduced risk for metabolic syndrome.
Ann Epidemiol 2009;19:784–792.

KEY WORDS: Physical Activity, Metabolic Syndrome, Exercise.

INTRODUCTION

Metabolic syndrome is defined as a cluster of cardiovascular risk factors, including disturbed insulin and glucose metabolism, hypertension, overweight and abdominal obesity, and dyslipidemia (elevated triglycerides and decreased high-density lipoprotein (HDL) levels) (1). This syndrome predicts the development of type 2 diabetes, cardiovascular disease, all-cause mortality in non-diabetic subjects (1), and some cancers (2–4).

Primary prevention of cardiovascular disease can be achieved by lifestyle changes that modify the individual risk for metabolic syndrome. The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) suggested a number of therapeutic lifestyle changes to reduce the prevalence of metabolic syndrome and identified the importance of increasing physical activity and reducing dietary intake of saturated fat and cholesterol (5, 6). Previous cross-sectional and prospective studies suggest that physical activity protects against the development of diabetes (7, 8), cardiovascular disease (9, 10), and metabolic syndrome (11, 12).

However, the intensity at which physical activity may be of benefit in reducing the risk for metabolic syndrome remains unknown. It is also unknown whether moderate or vigorous activities, based on quantitative measurements of both intensity and duration, are beneficial. Furthermore, most studies to date have been conducted in North American or European populations, and few studies have examined Asian populations with different lifestyles and disease occurrence patterns.

Thus, the purpose of this study was to examine the association between leisure-time physical activity and the prevalence of metabolic syndrome in a Korean study population and to assess the efficacy of leisure-time physical activity in preventing metabolic syndrome.

MATERIAL AND METHODS

Study Subjects

The source population comprised 14,531 men and women who underwent cancer screening examinations at the

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Received December 26, 2008; accepted June 10, 2009.

360 Park Avenue South, New York, NY 10010
1047-2797/09/$–see front matter
doi:10.1016/j.annepidem.2009.06.010

Selected Abbreviations and Acronyms

HDL = high-density lipoprotein
NCEP = National Cholesterol Education Program
MET = metabolic equivalent

Center for Cancer Prevention and Detection of the National Cancer Center in South Korea from August 2002 to May 2007. Subjects with missing information regarding physical activity (n = 2,167) and those who were under 30 years of age (n = 231) were excluded. Subjects who were missing information on one or more of the components of metabolic syndrome were also excluded (n = 208). After these exclusions, 11,925 subjects, aged 30 to 79 years, were selected for the final analysis. Written informed consent was obtained from all subjects, and all procedures were approved by the Institutional Review Board of the National Cancer Center.

Data Collection

All participants were asked to complete a self-administered questionnaire about their sociodemographic characteristics (e.g., age, education, occupation, household income, and marital status), cigarette smoking habits, alcohol drinking habits, regular exercise habits, disease history, and medications used for hypertension or diabetes and dyslipidemia.

At the time of screening, blood pressure was measured in the seated position after 15 minutes of rest by a registered nurse using an automatic blood pressure monitor (FT-200S, Jawon Medical, Kyungsan, Korea). For each subject, height and weight were measured using InBody 3.0 (Biospace, Seoul, Korea), and body mass index (BMI) was calculated as weight (kg)/height (m^2).

Physical Activity Questionnaire

Leisure-time physical activity was evaluated using questions covering the type of activity, frequency (times per week), and duration (in minutes). A metabolic equivalents (MET) value was assigned to each sports activity based on the compendium of physical activities (13). Time spent per week performing each activity was multiplied by the MET value of the activity to obtain total MET-minutes per week. A combined MET-minutes/week score was calculated by multiplying the weekly frequency, duration, and intensity of the physical activity, according to the formula:

$$\begin{aligned}\text{Total MET(minutes/week)} = {} & \text{intensity of activities(METs)} \\ & * \text{duration(minutes)} \\ & * \text{frequency}\left(\text{days/week}\right)\end{aligned}$$

The subjects were categorized into four groups. Those having a total MET score of 0 constituted the reference group. The remaining subjects, who exercised regularly, were categorized into tertiles based on total MET score. After exclusion of those demonstrating a total MET score of 0, the 33rd and 67th percentile cut-off values for the MET-minutes/week were 990 and 1,515, respectively, for men and 945 and 1,440, respectively, for women.

Biomarker Measurements

For clinical chemistry assays, blood samples were collected from a peripheral vein after 8 hours of fasting. Biomarkers for metabolic syndrome, such as triglycerides, HDL cholesterol (Kyowa Medex, Tokyo, Japan), and fasting glucose (Denka Seiken, Tokyo, Japan) were measured using the Chemistry Analyzer TBA-200FR (Toshiba, Tokyo, Japan). Laboratory data quality control was in accordance with the procedures of the Korean Association of Laboratory Quality Control.

Metabolic Syndrome Diagnosis

According to the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria (6), a diagnosis of metabolic syndrome can be established if three or more of the following cardiovascular risk factors are present: 1) waist circumference $\geq$102 cm (40 inches) for men or $\geq$88 cm (37 inches) for women; 2) triglyceride level $\geq$150 mg/dL; 3) HDL cholesterol level $<$40 mg/dL for men or $<$50 mg/dL for women; 4) blood pressure $\geq$130/85 mm Hg; 5) fasting glucose $\geq$110 mg/dL.

In the present study, the abdominal obesity criterion was modified for use in our Asian population; instead of the waist circumference criterion, a BMI $\geq$25.0 kg/m^2 was used (14–16).

Statistical Analyses

Linear regression analysis was performed to evaluate the association between physical activity level and other clinical variables with adjustments for age. The p for trend was calculated from generalized linear models adjusted for age as a continuous variable, and Mantel-Haenszel chi-square tests adjusted for the age groups as categorical variables. To assess the association between leisure-time physical activity and metabolic syndrome, multiple logistic regression models were used to calculate odds ratios (ORs) and 95% confidence intervals (CIs). The p for trends for the ORs was calculated by using the order of each physical activity category as a continuous variable. Analyses were conducted using SAS software version 9.1 (SAS Institute Inc, Cary, NC). All analyses were performed separately for