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Letter to the Editor

The Effects of Physical Fitness and Obesity Levels on the Risk of Metabolic Syndrome among Middle-Aged Korean Men and Women

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Dear Editor-in Chief

Low levels of physical activity due to an increase in sedentary lifestyles have consequently increased obesity incidence and decreased physical fitness. Such changes can exacerbate the risk of various diseases, including metabolic syndrome (1). Physical fitness can be classified into flexibility, body composition, cardiorespiratory endurance, muscular strength and muscular endurance. In particular, there has been an abundance of research on the relationship between metabolic syndrome and cardiorespiratory endurance, among the variables of physical fitness (2). Nevertheless, an increase in awareness regarding the importance of other physical fitness variables, such as muscular strength, balance, and muscular endurance, has led to an increase in research efforts examining the relationship between physical fitness and metabolic syndrome based on the other physical fitness indicators (3). Therefore this study aimed to identify the effects of physical fitness considering all physical fitness indicators, such as muscular strength, muscular endurance, balance, and flexibility, and obesity on the risk factors and risk of incidence of metabolic syndrome.

We analyzed the data of 994 participants from the National Health Insurance Corporation biennial examinations who participated in an exercise program at the National Health Promotion Center (Table 1). In order to measure the physical fitness indicators identified in this study, the participants were assessed for grip strength, sit-ups, standing on one leg with eyes closed, and bending forward. Finally, risk factors for metabolic syndrome were measured according to standard in a local hospital providing annual testing under the National Health Insurance Service. Statistical analysis was performed using the SPSS/Window 26.0 program (Chicago, IL, USA). Average values of the variables in each group by gender were comparatively analyzed using the independent *t*-test in order to examine the characteristics of the research participants. Lastly, the participants were divided into two groups, upper and lower, based on total physical fitness and obesity (standard: 23kg/m^2). Each group was then further classified into ① high fitness & normal weight (HN), ② high fitness & overweight (HO), ③ low fitness & normal weight (LN), and ④ low fitness & overweight (LO), and the risk factors for metabolic syndrome in each group were comparatively analyzed using ANCOVA, controlling for age and gender. Statistical significance was set at $P<0.05$ for all analyses.

Differences in risk factors for metabolic syndrome between the groups are listed in Table 2.

Table 1: Physical characteristics of the subjects (n=994)

Variable	*Male (n=178)*	*Female (n=816)*	*P-value*
Age (yr)	57.17±10.77	55.95±7.23	0.152
Height (cm)	168.53±5.47	155.93±5.25	<0.001
Weight (kg)	71.89±8.85	60.50±8.62	<0.001
WC (cm)	86.79±7.37	79.73±7.61	<0.001
BMI (kg/m^2)	25.29±2.72	24.87±3.25	0.074
SBP (mmHg)	124.46±12.62	121.60±14.92	0.018
DBP (mmHg)	76.89±9.47	74.82±9.79	0.010
TG (mg/dl)	154.17±100.47	130.56±74.36	0.003
HDL-C (mg/dl)	49.64±11.48	55.17±13.63	<0.001
Glucose (mg/dl)	104.89±26.43	99.24±26.90	0.011
Standing on one leg with eyes closed (Sec)	11.80±13.13	11.35±13.20	0.684
Bending forward (No)	4.76±8.50	14.72±7.12	<0.001
Sit-ups (No)	14.72±5.22	7.93±5.48	<0.001
Grip strength (kg)	40.41±6.78	24.90±4.63	<0.001

Values are Mean±SD, WC: Waist circumference, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, TG: Triglycerides, HDL-C: High density lipoprotein cholesterol

Table 2: Combined association of regular participation in walking activity and BMI on metabolic syndrome

Variable	*High total-fitness*		*Low total-fitness*	
	BMI < 23kg/m^2 (n=137)	23kg/m^2 ≤ BMI (n=363)	BMI < 23kg/m^2 (n=160)	23kg/m^2 ≤ BMI (n=334)
WC (cm)	74.36±0.54	83.14±0.35*	75.16±0.51#	84.16±0.36*^
SBP (mmHg)	119.67±1.22	121.96±0.79*	119.53±1.14	124.52±0.81*#^
DBP (mmHg)	73.77±0.83	75.35±0.53	74.35±0.77	76.00±0.55*
TG (mg/dl)	111.69±6.77	139.26±4.36*	128.21±6.33	142.56±4.47*
HDL-C (mg/dl)	57.44±1.12	52.72±0.72*	57.06±1.05#	53.04±0.74*^
Glucose (mg/dl)	96.18±2.28	98.43±1.47	102.78±2.13*	102.70±1.50*
No. of participants with MS (%)	14/137(10.2)	101/363(27.8)*	28/160(17.5)*#	136/334(40.7)*#^

Values are mean±SE, BMI: Body mass index, WC: Waist circumference, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, TG: Triglycerides, HDL-C: High density lipoprotein cholesterol, MS: Metabolic syndrome, *significantly different from high total-fitness & low BMI group, #significantly different from high total-fitness & high BMI group, ^significantly different from low total-fitness & low BMI group, Adjusted for age and sex, $P<0.05$

Upon analysis with controlled age and gender, the HN group demonstrated significantly lower values of waist circumference, systolic and diastolic blood pressure, triglycerides, fasting blood glucose levels, and incidence of metabolic syndrome as compared to the LO group, notably showing significantly higher levels of HDL-C. Similar to the findings of this study, previous studies have reported that higher levels of obesity and lower levels of fitness had a negative impact on the risk factors of metabolic syndrome, consequently increasing incidences of cardiovascular disease, hypertension, and hyperlipidemia (2, 3). Such findings indicate that although weight loss can have a positive impact on these risk factors, the improvement of the aforementioned physical fitness variables through physical activity may be equally important.

In conclusion, this study identified weight loss and improved fitness as a method to effectively prevent risk factors for metabolic syndrome among middle-aged men and women, along with

the importance of engaging in diverse types of exercise that can improve muscular strength, muscular endurance, balance, and flexibility, other than aerobic exercise aimed to increase cardiorespiratory fitness.

Conflict of interest

The author declares that there is no conflict of interest.

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