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Short Communication

Comparison of Muscle Strength between Japanese Men with and without Metabolic Syndrome

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We compared muscle strength between Japanese men with and without metabolic syndrome. We used data for 323 Japanese men with metabolic syndrome and 893 Japanese men without the syndrome. Metabolic syndrome was defined by a new criterion in Japan, and the parameters for muscle strength, *i.e.* grip strength, leg strength were measured. Leg strength was found to be significantly higher in subjects with metabolic syndrome than in those without, while muscle strength per body weight was significantly lower in subjects with the syndrome. Lower muscle strength per body weight may be one of the characteristic features in subjects with metabolic syndrome.

Key words: metabolic syndrome, grip strength, leg strength

Metabolic syndrome is a common disorder and has become a public challenge in Japan. For example, 30.7% of men and 3.6% of women have been diagnosed as having metabolic syndrome using the new criterion in Japan [1]. The metabolic syndrome has been associated with an increased risk of cardiovascular disease [2], proteinuria [3], and elevation of hepatic enzymes [4]. Lifestyle modifications, especially exercise, are important for preventing and improving metabolic syndrome. However, the link between metabolic syndrome using the new criterion in Japan and muscle strength remains to be investigated. In this study, we compared muscle strength between Japanese men with and without metabolic syndrome.

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Subjects and Methods

Subjects. We used the data for 1,216 Japanese men, aged 20–79 years, who met the following criteria, 1) received annual health checkups from June 1997 to May 2005 at Okayama Southern Institute of Health, 2) received fasting blood examination and muscle strength measurements, and 3) obtained written informed consent.

Anthropometric measurements. Anthropom etric parameters *i.e.* height, weight, and waist circumference were measured. The waist circumference was measured at the umbilical level.

Definition of metabolic syndrome. Meta-

bolic syndrome was defined, among men with a waist circumference in excess of 85 cm, as having 2 or more components from the following: 1) Dyslipidemia: triglycerides ≧ 150 mg/dl and/or HDL cholesterol < 40 mg/dl, 2) High blood pressure: blood pressure ≧ 130/85 mmHg, 3) Impaired glucose tolerance: fasting plasma glucose ≧ 110 mg/dl [5].

Measurements of muscle strength. To assess muscle strength, grip and leg strength were measured. Grip strength was measured by using THP-10 (SAKAI, Tokyo, Japan), while leg strength was measured by COMBIT CB-1 (MINATO, Osaka, Japan). Isometric leg strength was measured as follows: the subject sat in a chair, grasping the armrest in order to fix the body position. The dynamometer was then attached to the subject's ankle joint by a strap. They next extended the leg to 60 degrees [6]. In addition, to standardize the influence of the total body weight, we calculated the muscle strength (kg) per body weight (kg) [7].

Statistical analysis. Data are expressed as mean ± standard deviation (SD) values. A comparison of parameters between the 2 groups was made using the unpaired t-test and covariance analysis: $p < 0.05$ was considered to be statistically significant.

Results

A total of 323 men (26.6%) were diagnosed as having metabolic syndrome, and the measurements of muscle strength in subjects with and without metabolic syndrome (n = 893) are indicated in the Table. The age was significantly higher in subjects with metabolic syndrome and thus, to avoid the influence of age on muscle strength, we used the age as a covariate and compared the muscle strength using covariance analysis. In subjects with metabolic syndrome, leg strength was significantly higher compared with subjects without metabolic syndrome. However, muscle strength per body weight was significantly lower in subjects with metabolic syndrome.

We then analyzed the groups with and without each component of metabolic syndrome. The age was significantly higher in subjects with abdominal obesity, impaired glucose tolerance, dyslipidemia, and high blood pressure compared with the subjects without each component. Based on the comparison of muscle strength adjusting for age, leg strength was significantly higher in subjects with abdominal obesity, dyslipidemia, and high blood pressure. In subjects with impaired glucose tolerance, leg strength was significantly lower than in subjects without impaired glucose tolerance. In subjects with abdominal obesity, the left grip strength was significantly higher compared with subjects without abdominal obesity. However, the leg strength per body weight in subjects with abdominal obesity was significantly lower. In addition, the grip strength per body weight in subjects with abdominal obesity, dyslipidemia, and high blood pressure was also significantly lower.

Discussion

We compared muscle strength in metabolic syndrome men with that in non-metabolic syndrome men using the criterion in Japan.

In some literature, cardiorespiratory fitness is closely associated with metabolic syndrome [8, 9]. However, the relationship between muscle strength and metabolic syndrome, especially using the new criterion in Japan, has not been clearly investigated. Jurca R *et al.* have reported examining the associations for muscle strength and cardiorespiratory fitness with the prevalence of metabolic syndrome by cross sectional [10] and longitudinal study [11]. They concluded that muscle strength has an inverse association with metabolic syndrome prevalence using the National Cholesterol Education Program (NCEP) definition. In this study, by using the new criterion in Japan, leg strength was found to be significantly higher in subjects with metabolic syndrome than in those without the syndrome. However, muscle strength per body weight was significantly lower in subjects with metabolic syndrome than that in those without the syndrome. Leg strength per body weight in subjects with abdominal obesity was significantly lower, and grip strength per body weight in subjects with abdominal obesity, dyslipidemia, and high blood pressure was also significantly lower. These findings may stress the clinical significance of such components on muscle strength per body weight in subjects with metabolic syndrome. Although aerobic exercise has been advocated as the most suitable exercise for metabolic syndrome, it is difficult for subjects with

Table 1 Comparison of parameters between subjects with and without metabolic syndrome

	Mean ± SD		*p* Unpaired t test	*p* Adjusting for age
	Metabolic syndrome (+)	Metabolic syndrome (−)		
Number of subjects	323	893		
Age	49.4 ± 11.0	45.4 ± 12.5	< 0.0001	
Right grip strength (kg)	44.3 ± 8.2	43.7 ± 8.4		0.3232
Left grip strength (kg)	42.3 ± 8.0	41.9 ± 7.6		0.1779
Leg strength (kg)	67.8 ± 17.7	65.2 ± 17.0		0.0016
Right grip strength(kg)/body weight(kg)	0.56 ± 0.10	0.65 ± 0.12		< 0.0001
Left grip strength(kg)/body weight(kg)	0.54 ± 0.10	0.62 ± 0.11		< 0.0001
Leg strength(kg)/body weight(kg)	0.86 ± 0.20	0.96 ± 0.22		0.0058
	Waist circumference (+)	Waist circumference (−)		
Number of subjects	600	616		
Age	47.6 ± 11.1	45.3 ± 13.1	0.0013	
Right grip strength (kg)	45.0 ± 8.3	42.7 ± 8.3		0.2376
Left grip strength (kg)	43.1 ± 7.8	40.9 ± 7.5		0.0130
Leg strength (kg)	69.0 ± 17.2	62.9 ± 16.6		0.0002
Right grip strength(kg)/body weight(kg)	0.58 ± 0.10	0.67 ± 0.12		< 0.0001
Left grip strength(kg)/body weight(kg)	0.55 ± 0.11	0.64 ± 0.11		< 0.0001
Leg strength(kg)/body weight(kg)	0.88 ± 0.20	0.99 ± 0.23		< 0.0001
	Impaired glucose tolerance (+)	Impaired glucose tolerance (−)		
Number of subjects	282	934		
Age	51.5 ± 10.7	44.9 ± 12.2	< 0.0001	
Right grip strength (kg)	41.7 ± 8.0	44.5 ± 8.3		0.0553
Left grip strength (kg)	39.9 ± 7.9	42.6 ± 7.6		0.1340
Leg strength (kg)	62.7 ± 17.7	66.9 ± 16.9		0.0221
Right grip strength(kg)/body weight(kg)	0.58 ± 0.11	0.64 ± 0.12		0.1935
Left grip strength(kg)/body weight(kg)	0.56 ± 0.11	0.61 ± 0.11		0.0565
Leg strength(kg)/body weight(kg)	0.87 ± 0.21	0.95 ± 0.22		0.4832
	Dyslipidemia (+)	Dyslipidemia (−)		
Number of subjects	577	639		
Age	47.6 ± 11.7	45.4 ± 12.6	0.0014	
Right grip strength (kg)	43.2 ± 8.5	44.4 ± 8.1		0.3572
Left grip strength (kg)	41.5 ± 8.0	42.4 ± 7.5		0.2205
Leg strength (kg)	65.3 ± 17.8	66.4 ± 16.6		0.0155
Right grip strength(kg)/body weight(kg)	0.60 ± 0.11	0.65 ± 0.11		0.0034
Left grip strength(kg)/body weight(kg)	0.57 ± 0.11	0.62 ± 0.11		0.0055
Leg strength(kg)/body weight(kg)	0.90 ± 0.22	0.97 ± 0.22		0.3452
	High blood pressure (+)	High blood pressure (−)		
Number of subjects	703	513		
Age	48.9 ± 11.8	43.1 ± 11.9	< 0.0001	
Right grip strength (kg)	43.7 ± 8.4	44.0 ± 8.2		0.2065
Left grip strength (kg)	42.0 ± 8.0	42.0 ± 7.4		0.0843
Leg strength (kg)	65.9 ± 17.7	65.9 ± 16.5		0.0001
Right grip strength(kg)/body weight(kg)	0.61 ± 0.11	0.65 ± 0.12		0.0006
Left grip strength(kg)/body weight(kg)	0.58 ±0.11	0.62 ± 0.11		0.0020
Leg strength(kg)/body weight(kg)	0.91 ± 0.22	0.97 ± 0.22		0.8945

lower leg strength per body weight to support their entire body weight, and it is also difficult to carry out aerobic exercise *i.e.* walking and jogging. In addition, resistance training increases muscle quantity and insulin action [12, 13] and reduces visceral adipose tissue [14]. These findings suggest that resistance exercise training should be considered in primary prevention of metabolic syndrome.

Potential limitations remain in our study. First, the cross-sectional study design in our study makes it difficult to infer causality between metabolic syndrome and muscle strength. Second, although reductions in basal leg blood flow [15] and resting metabolic rate [16] have been implicated in the pathogenesis of metabolic syndrome, we could not prove the mechanism of the link between metabolic syndrome and muscle strength. Therefore, our findings are applicable to clinical and public health practice settings. In conclusion, lower muscle strength per body weight is characteristic in Japanese men with metabolic syndrome. Further intervention studies are necessary to test the effects of the prevention and treatment of metabolic syndrome.

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