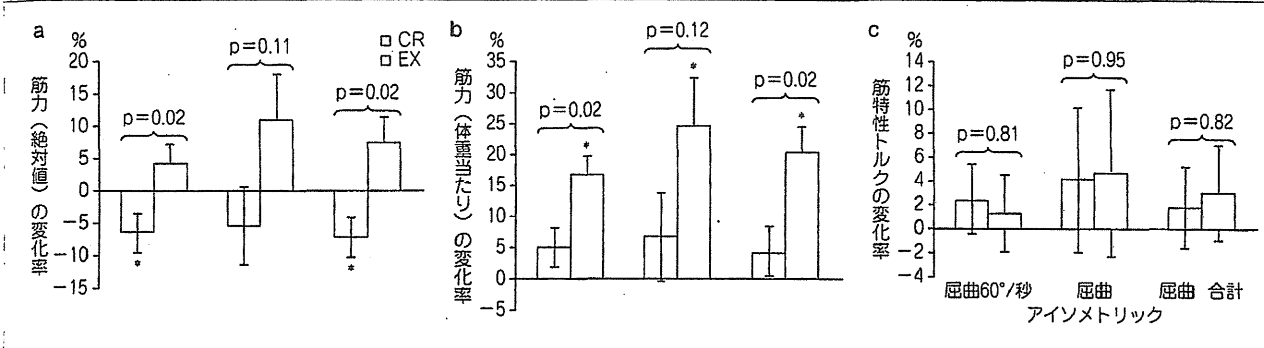

図5 ⇒ カロリー制限と運動トレーニングによる筋力の変化率

ち40％は血中アディポネクチンや炎症性マーカーの値が低かったにもかかわらず，糖負荷テストのグルコース応答は良好ではなかった(**図3**)．この耐糖能の不良はIGF-1，総テストステロン，トリヨードサイロニンの血液循環レベルが低かったことと関連していた．この傾向はラットなどのげっ歯類にみられるカロリー制限による寿命延長においてみられる適応現象と一致しており，非常に興味深い結果であった．

3．カロリー制限のみ，あるいは運動による体重減少が骨格筋および有酸素性能力に及ぼす影響

食事のみによるカロリー制限(CR)は体脂肪を減少させるが，同時に筋肉の減少も引き起こし，筋力と $\dot{V}O_2max$ の低下をもたらすことがこれまでの研究で明らかになっている．本研究では中年男女を対象として，1年間のCRと持久性運動(EX)による介入が下肢の筋量と筋力に及ぼす影響が検討された[8]．**図4**は体重と大腿部筋量の変化率の関係を示している．EX群では体重が減少したにもかかわらず大腿部筋量の減少はみられないが，CR群では顕著な大腿部筋量の減少が認められた．また，**図5**に示されているように，絶対値で示した筋力はCR群で減少し，体重当たりではEX群が顕著な増加を示したが，CR群では変化が認められなかった．これらの結果から，運動により消費エネルギーを増加させて体重を減少させようとすると，身体は身体機能を維持ないしは向上させようとする適応を引き起こすことが示唆された．

近年，骨格筋内の貯蔵脂肪とインスリン抵抗性

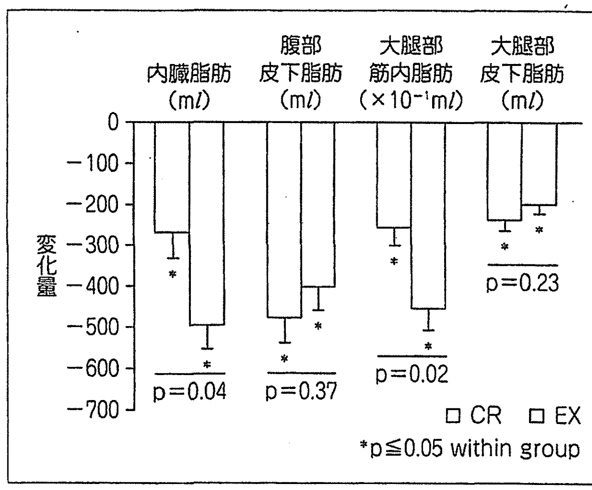

図6 ⇒ カロリー制限と運動トレーニングによる腹部と大腿部の脂肪量の変化

との関連が検討され，肥満者では非肥満者よりも筋内貯蔵脂肪が多いことが明らかになっている．しかし，持久性トレーニングをよく積んでいるアスリートでは肥満者と同レベルの筋内脂肪蓄積があることが明らかになっている．本研究ではカロリー制限のみによる減量と運動による減量が筋内と内臓の脂肪蓄積に及ぼす影響について検討されている[9]．その結果，カロリー制限と運動による体重減少のいずれもが，IMAT，VATを減少させるが，食事によるカロリー制限と比べて，運動による体重減少は筋内脂肪と内臓脂肪をより優れて減少させることが示唆された(**図6**)．

4．カロリー制限がミトコンドリア新生に及ぼす影響についての再検討

30％のカロリー制限を3ヵ月間行うと心臓，脳，肝臓，そして脂肪組織など身体諸器官のミト

コンドリア新生が高まるとの報告や，健康な人によるカロリー制限が筋ミトコンドリア新生を増強するとの報告を根拠として，カロリー制限がミトコンドリア新生を高めるとの考えは，広く受け入れられており，そのことが加齢の抑制や疾患の予防に対するカロリー制限の有効性を説明する理由とされてきている．しかし，身体の諸組織のミトコンドリアはエネルギー需要やエネルギー基質の供給の増減に応答して適応的に変化するということを考えると，このような現象はいささか不可思議である．

そこで，詳細な動物実験による検討が行われた[10)]．その結果，30％カロリー制限はPGC-1αに加えて，ミトコンドリアに局在する諸酵素のたんぱく量と活性の測定により，骨格筋を含む身体諸器官のミトコンドリアを増加させないことが明らかになった．

5．カロリー制限がさまざまなモデル生物の寿命や健康に及ぼす影響

Fontanaら[11)]は酵母からヒトに至るさまざまなモデル生物を対象として，寿命や健康に及ぼすカロリー制限の効果について総説を執筆している．それによると，カロリー制限による寿命や健康への影響はモデル動物によって大きく異なっている．ヒトにおける長期にわたるカロリー制限の影響は寿命の延長については，肥満，糖尿病，高血圧を予防し，癌や心臓病のリスクを低減することは明らかであるが，未だ解明されていないことも多く，今後の更なる研究が望まれる．また，この総説には酵母，線虫，ハエ，そして哺乳類に至る多様なモデル生物の寿命を制御している栄養シグナル経路が提示されており，食事制限は直接的に(酵母)，あるいはIGF-1レベルの低下を介して間接的に(線虫，ハエ，哺乳類)シグナル伝達経路の活性を低下させるとされている．さらに，加齢を促進するTORやS6Kは酵母，線虫，ハエ，そしてマウスにも保持されており，それらの機能についても記述されている．寿命を延長させる詳細な代謝的メカニズムについては以下のサイトを参照されたい(www.sciencemag.org/cgi/content/full/328/5976/321)．

おわりに－人の"健康・長寿"とライフスタイル－

平成22年国民健康・栄養調査結果の概要(厚生労働省，2012)によると，全国平均で20～60歳代の男性の肥満者(BMI 25以上)の割合は男性が30％程度で推移しており，40~60歳代の女性では22％程度であった(女性では20歳代のやせの者の割合が急増している)．しかし，同調査結果は生活習慣病の予防・改善を目的とした生活習慣の改善に取り組んでいる者も多いことを報告している．生活習慣病の予防・改善を目的とした生活習慣の改善に取り組んでいる者(30歳以上)の割合は，男性50％，女性58％であり，そのために普段の生活で心がけている内容は，男性では"食べ過ぎないようにしている(カロリー制限している)"(47％)が最も多く，以下，"野菜をたくさん食べるようにしている"(45％)，"脂肪(あぶら分)をとりすぎないようにしている"(39％)，"運動をするようにしている"(39％)が続いていた．一方，女性では，"野菜をたくさん食べるようにしている"(58％)が最も高く，"脂肪(あぶら分)をとりすぎないようにしている"(52％)，"食べ過ぎないようにしている(カロリー制限している)"(51％)がほぼ同じで高くなっていた．これらのことが継続的に実践され，中高年者が健康増進を図ることが強く望まれる．

ところで，カナダのWillcox兄弟と鈴木信博士の共著による"The Okinawa Program"が"オキナワ式食生活革命"(飛鳥新社，2004)として翻訳出版され，"長寿王国・オキナワ"が世界的に注目されてから10年近くが経過した．そのなかで筆者らは「沖縄プログラムは，(中略)食事だけでも健康に長生きする強力な処方箋になる．植物性食品主体の低カロリーの食事は，アメリカの国立がん研究所(NCI)が勧めている食事と合致しているだけでなく，それよりさらに進んでいるし，アメリカのほかの科学的，医学的権威の多くが勧告している規準を上回っている．それは心臓病，がん，脳卒中を含めて老化が関連する多くの病気を防ぐ食事であり，生涯スリムで健康でありたいと願っている人には絶好のチャンスを与えてくれる」と

述べている．しかし，一方で，"沖縄が長寿でなくなる日"（沖縄タイムス「長寿」取材班編，岩波書店，2004）の冒頭では「沖縄県の働き盛り男性の死亡率は全国で最悪－．厚生労働省が発表した2000年の年齢階級別死亡率には，ショッキングな数字が並ぶ．35歳から44歳の死亡率は最も高く，50歳以下は軒並み全国平均を上回る．また男性の平均寿命は，1980年，85年には全国1位の座にあったものの，90年は5位，95年は4位となり，2000年は26位に急落した」ことが記載されている．沖縄が本土に復帰して今年（2012年）で40年である．平成22年国民健康・栄養調査結果の概要（厚生労働省，2012）も示しているように，男性（20～69歳）の肥満者（BMI：25以上）の割合は沖縄県が45.2％でワーストワン（全国平均31.1％）であり，歩数に関しても，20歳以上の男性が18位（7,214歩）で全国平均（7,225歩）と同レベルであり，女性では36位（5,823歩）と全国平均（6,287歩）をかなり下回っている．日常の食事と運動が影響するカロリー（エネルギー）の出納と肥満，健康・長寿という視点から，沖縄県の今後の健康指標の推移が注目される．

これまでの研究や調査による報告から，カロリー過多による肥満が健康，寿命にネガティヴな影響を及ぼすことは明らかであり，適切なカロリー制限と運動による十分なエネルギー消費が，健康・長寿に不可欠であることが，本稿で示したデータによって理解される．

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Health

Associations between muscular fitness and metabolic syndrome: Cross-sectional study of Japanese women and men

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ABSTRACT

Metabolic syndrome (MetS) is a complex interrelated risk factor for cardiovascular disease and type 2 diabetes mellitus. High cardiorespiratory fitness is known to contribute to prevention of MetS. However, little is known regarding the association between muscular fitness and MetS in Japanese adults. The purpose of this study was to examine the associations between muscular fitness and MetS in Japanese women and men. This cross-sectional study included 335 women and 209 men aged 30 - 79 y. MetS was determined according to the 2009 criteria of the International Diabetes Federation. Muscular fitness was evaluated by muscular fitness composite score (MFS), which was determined using Z scores from grip strength and sit-ups. Participants were classified by MFS tertile into low, middle, and high MFS groups. We used multiple logistic regression analysis to estimate odds ratios for the incidence of MetS in each group. The prevalence of MFS was 27.2% in women and 27.3% in men. Adjusted odds ratios for MetS prevalence in the low, middle, and high MFS groups, after adjusting for age, smoking status, alcohol intake, and exercise habits, were 1.0 (referent), 0.90 (95% confidence interval [CI], 0.50 - 1.62), and 0.49 (95% CI, 0.25 - 0.94; *P* for trend = 0.03) in women; in men, they were 1.0 (referent), 0.49 (0.23 - 1.04), and 0.42 (0.18 - 0.97; *P* for trend = 0.04), respectively. Muscular fitness is inversely associated with the prevalence of MetS in Japanese women and men.

Keywords: Muscle Strength; Muscle Endurance; Muscular Fitness; Metabolic Syndrome

1. INTRODUCTION

Metabolic syndrome (MetS) is a clustering of central obesity and cardiovascular disease (CVD) risk factors, including abnormal blood pressure, lipids, and blood glucose [1]. Insulin resistance occurring as a result of visceral fat accumulation is a key factor in MetS and is considered a strong predictor of CVD events [2]. Over the past 2 decades, the prevalence of MetS has increased in Japan as well as in Western countries. Because individuals with MetS have an elevated risk of developing type 2 diabetes [3,4] and CVD [5,6], strategies to prevent an epidemic of this syndrome are urgently required [7].

The primary management approach for MetS is healthy lifestyle promotion such as increased physical activity and diet modification [8]. Because physical fitness (*i.e.*, cardiorespiratory fitness [CRF] and muscular fitness) is primarily determined by physical activity, high physical fitness is thought to be effective for improving MetS. Previous studies have demonstrated an inverse association between CRF and MetS prevalence and suggested that CRF is an independent predictor of MetS incidence [9-11]. Compared with CRF, fewer studies have been conducted on the association between muscular fitness and MetS. While an inverse relationship between muscular strength and MetS has been previously illustrated in American [12,13], Australian [14], and European populations [15], this relationship has not been well studied in populations of Japanese adults [16-18], especially Japanese women. The purpose of this study was to examine the associations between muscular fitness and MetS in Japanese women and men.

2. METHODS

2.1. Subjects

The subjects were 335 women and 209 men, aged 30 -

79 y, who underwent a baseline preventive medical examination and physical fitness tests between 2006 and 2010 and were recruited to participate in a training program for health promotion at Fujisawa City Health and Medical Center. All subjects provided written informed consent before enrollment in the study. This study was approved by the Ethics Committee of Waseda University and conducted in accordance with the spirit of the Declaration of Helsinki.

2.2. Clinical Examination

All subjects received preventive medical examinations at the medical institution in Fujisawa City The exam included a measurement of height, body weight, waist circumference (WC), blood chemistry analyses (triglycerides, TG; high-density lipoprotein, HDL-c; fasting blood glucose, FPG), and resting blood pressure (BP; systolic blood pressure, SBP; diastolic blood presser, DBP). Body mass index (BMI) was calculated as body weight (kg) divided by height squared (m^2), and WC was measured at the umbilicus with subjects in the standing position.

2.3. Criteria for MetS

MetS was defined as meeting 3 or more of the following criteria [19]: abdominal obesity (WC ≥ 80 cm in women, WC ≥ 90 cm in men); high TG (≥150 mg/dL or taking medicine to lower TG); low HDL-c (<50 mg/dL in women, <40 mg/dL in men); high BP (SBP ≥ 130 mmHg or DBP ≥ 85 mmHg, or taking medicine to lower BP); and high FPG (≥100 mg/dL or taking medicine to lower FPG).

2.4. Muscular Fitness

Grip strength test, used as a proxy for overall strength [20], was assessed using a handgrip dynamometer (ED-D100PNR, Yagami, Nagoya, Japan) [21]. The subject stood with the arm completely extended and squeezed the dynamometer with maximum isometric effort. Grip strength was measured twice on each side. The best of the 4 grip measurements was use to characterize maximum muscle strength. To account for differences in body size, total handgrip was adjusted for body weight (kg).

Abdominal muscle endurance was evaluated by a sit-up test [21]. The subject started in a lying position with hands crossed over the chest, knees bent at a 90˚ angle, and heels and feet flat on the floor. The subject had to rise to a position with the elbows pointed forward until they touched the thighs. The total number of correctly performed and completed sit-ups within 30 s was counted.

Muscular fitness was evaluated by muscular fitness composite score (MFS), which was determined using Z scores from grip strength and sit-ups.

2.5. Confounding Variables

Several confounding variables were included in the analyses: age (y), smoking status (current, former, never), daily alcohol intake (g/day), and exercise habits (never, once/wk, 2 - 3 times/wk, 4 - 5 times/wk, 6 - 7 times/wk). These variables were assessed by means of a questionnaire.

2.6. Statistical Analysis

Measured and calculated values are presented as mean ± SD or number (%). Participants were classified by MFS tertile into low, middle, and high MFS groups. Analysis of variance was used for continuous variables with a normal distribution, the Kruskal-Wallis test was used for continuous variables with a non-normal distribution, and the chi-square test was used for categorical variables. The association of muscular fitness with the risk of having MetS was estimated using multiple logistic regression analysis adjusted for age (Model 1), and further adjusted for smoking status, alcohol intake, and exercise habits (Model 2). The data were analyzed with SPSS 19.0 for Windows (IBM Japan, Tokyo, Japan). The statistical significance level was set at $P < 0.05$.

3. RESULTS

Table 1 shows the characteristics of individuals according to MFS level. Women with the highest MFS demonstrated a significantly lower body weight, BMI, WC, SBP, DBP, and TG level ($P < 0.05$) and a higher Grip strength, Sit-ups, and HDL-c level ($P < 0.01$). Men with the highest MFS were significantly younger and had a lower body weight, BMI, WC, and TG level ($P < 0.05$) and higher Grip strength, Sit-ups, and HDL-c level ($P < 0.05$). Women in the highest MFS tertile, but not men, had a lower prevalence of MetS.

Adjusted odds ratios (ORs) for MetS prevalence in the low, middle, and high MFS groups, after adjusting for age, were 1.0 (referent), 0.92 (95% confidence interval [CI]: 0.51 - 1.63), and 0.53 (95% CI, 0.28 - 0.99) (*P* for trend = 0.04) in women; in men, they were 1.0 (referent), 0.48 (95% CI, 0.23 - 1.01), and 0.42 (95% CI, 0.19 - 0.90) (*P* for trend = 0.02), respectively (**Figure 1**, Model 1). In addition, after further adjusting for smoking status, alcohol intake, and exercise habits, adjusted ORs were 1.0 (referent), 0.90 (95% CI, 0.50 - 1.62), and 0.49 (95% CI, 0.25 - 0.94) (*P* for trend = 0.03) in women; in men, they were 1.0 (referent), 0.49 (95% CI, 0.23 - 1.04), and 0.42 (95% CI, 0.18 - 0.97) (*P* for trend = 0.04), respectively (**Figure 1**, Model 2).

Table 2 shows age-adjusted and multivariate-adjusted

Table 1. The characteristics of individuals across MFS tertiles.

	Women (n = 335)			
	Low (n = 111)	Middle (n = 112)	High (n = 112)	
Age (y)	60.5 ± 8.8	60.6 ± 7.2	58.8 ± 7.1	
Height (cm)	155.3 ± 5.1	155.1 ± 5.1	156.2 ± 4.5	
Body weight (kg)	58.5 ± 8.2	54.6 ± 6.5	51.8 ± 5.6	**
BMI (kg/m^2)	24.3 ± 3.1	22.7 ± 2.5	21.2 ± 2.1	**
WC (cm)	86.1 ± 8.8	81.5 ± 7.7	77.4 ± 7.2	**
SBP (mmHg)	126.2 ± 14.4	127.2 ± 16.7	121.9 ± 17.2	*
DBP (mmHg)	76.6 ± 9.4	77.6 ± 11.2	74.0 ± 10.8	*
HDL-c (mg/dL)	63.6 ± 14.3	68.7 ± 16.1	74.6 ± 17.4	**
TG (mg/dL)	113.4 ± 68.9	112.6 ± 62.7	90.5 ± 48.7	**
FPG (mg/dL)	96.3 ± 13.7	93.2 ± 8.3	94.7 ± 14.7	
Grip strength (kg/BW)	0.41 ± 0.06	0.47 ± 0.05	0.57 ± 0.07	**
Sit-ups (times/30s)	7.7 ± 4.5	13.3 ± 3.2	17.4 ± 3.5	**
Prevalence of metabolic syndrome	36 (39.6)	34 (37.4)	21 (23.1)	*
Alcohol intake (g/day)	1.1 ± 2.5	1.4 ± 2.6	1.1 ± 2.2	
Smoking status				
Current	1 (16.7)	4 (66.7)	1 (16.7)	
Former	14 (37.8)	7 (18.9)	16 (43.2)	
Never	96 (32.9)	101 (34.6)	95 (32.5)	
Exercise habits (times/wk)				**
6 - 7	4 (25.0)	4 (25.0)	8 (50.0)	
4 - 5	6 (24.0)	11 (44.0)	8 (32.0)	
2 - 3	31 (26.5)	39 (33.3)	47 (40.2)	
1	33 (30.0)	39 (35.5)	38 (34.5)	
0	37 (55.2)	19 (28.4)	11 (16.4)	
	Men (n = 209)			
	Low (n = 69)	Middle (n = 70)	High (n = 70)	
Age (y)	66.6 ± 7.4	65.5 ± 6.9	62.7 ± 9.6	*
Height (cm)	167.3 ± 5.7	166.9 ± 5.9	165.8 ± 4.8	
Body weight (kg)	69.6 ± 10.0	67.5 ± 6.6	63.8 ± 8.5	**
BMI (kg/m^2)	24.9 ± 3.3	24.2 ± 1.9	23.2 ± 2.5	**
WC (cm)	88.4 ± 7.8	86.8 ± 5.6	81.5 ± 7.0	**
SBP (mmHg)	130.3 ± 17.1	132.0 ± 16.6	129.6 ± 15.4	
DBP (mmHg)	80.4 ± 10.6	80.5 ± 9.6	78.8 ± 11.6	
HDL-c (mg/dL)	54.8 ± 13.8	58.9 ± 12.8	62.5 ± 17.9	*
TG (mg/dL)	155.9 ± 72.1	120.4 ± 54.8	136.3 ± 82.5	*
FPG (mg/dL)	102.7 ± 16.9	98.2 ± 15.6	99.5 ± 13.3	
Grip strength (kg/BW)	0.50 ± 0.07	0.59 ± 0.06	0.69 ± 0.08	**
Sit-ups (times/30s)	11.9 ± 3.7	16.6 ± 2.7	21.2 ± 4.3	**
Prevalence of metabolic syndrome	26 (45.6)	16 (28.1)	15 (26.3)	
Alcohol intake (g/day)	4.9 ± 6.6	6.2 ± 5.6	5.5 ± 4.8	
Smoking status				
Current	12 (40.0)	10 (33.3)	8 (26.7)	
Former	39 (31.5)	45 (36.3)	40 (32.3)	
Never	18 (32.7)	15 (27.3)	22 (40.0)	
Exercise habits (times/wk)				**
6 - 7	1 (7.7)	3 (23.1)	9 (69.2)	
4 - 5	10 (23.8)	15 (35.7)	17 (40.5)	
2 - 3	19 (33.3)	20 (35.1)	18 (31.6)	
1	17 (29.8)	17 (29.8)	23 (40.4)	
0	22 (55.0)	15 (37.5)	3 (7.5)	

Data are mean ± SD or number (%). $^*P < 0.05$; $^{**}P < 0.01$; BMI: body mass index; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure; HDL-c: high-density lipoprotein cholesterol; TG: triglyceride; FPG: fasting plasma glucose; BW: body weight.

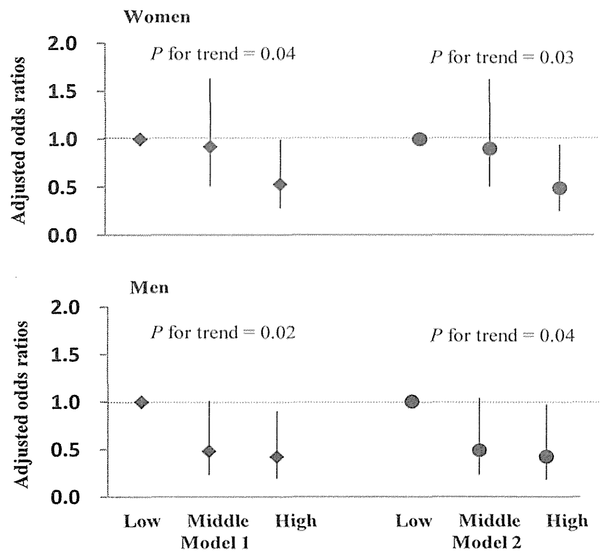

Figure 1. Adjusted odds ratios (ORs) for MetS prevalence in the low, middle, and high muscular fitness composite score (MFS) groups. Results are adjusted for age (Model 1), and additionally adjusted for smoking status, alcohol intake, and exercise habits (Model 2). Vertical bars indicate 95% CIs. Low: Low MFS; Middle: Middle MFS; High: High MFS.

ORs. In women, MFS was inversely associated with HDL-c and WC. Age-adjusted ORs for the highest versus lowest tertiles were 0.17 (95% CI, 0.05 - 0.60; *P* for trend < 0.01) for HDL-c and 0.18 (95% CI, 0.10 - 0.32; *P* for trend < 0.001) for WC; multivariate-adjusted ORs for the highest versus lowest tertiles were 0.15 (95% CI, 0.04 - 0.55; *P* for trend < 0.01) for HDL-c and 0.17 (95% CI, 0.09 - 0.32; *P* for trend < 0.001) for WC. In men, MFS was inversely associated with TG and WC: age-adjusted ORs for the highest versus lowest tertiles were 0.39 (95% CI, 0.19 - 0.79; *P* for trend < 0.01) for TG and 0.06 (95% CI, 0.02 - 0.22; *P* for trend < 0.001) for WC. However, the MFS-TG relationship was attenuated after further adjustment for smoking status, alcohol intake, and exercise habits; multivariate-adjusted ORs for the highest versus lowest tertiles were 0.54 (95% CI, 0.25 - 1.14; *P* for trend < 0.09) for TG and 0.07 (95% CI, 0.02 - 0.25; *P* for trend < 0.001) for WC.

4. DISCUSSION

In this cross-sectional study, we examined the association between MFS levels and the prevalence of MetS and

Table 2. Adjusted odds ratios (95% CIs) for MetS risk factors across MFS tertiles.

	Women (n = 335)					
	Low (n = 111)	Middle (n = 112)		High (n = 112)		
		ORs	95%CI	ORs	95%CI	*P* for trend
BP						
Model 1	1.00	0.98	(0.57 - 1.67)	0.61	(0.36 - 1.05)	0.07
Model 2	1.00	0.94	(0.54 - 1.62)	0.58	(0.33 - 1.02)	0.06
HDL-c						
Model 1	1.00	0.85	(0.38 - 1.90)	0.17	(0.05 - 0.60)	<0.01
Model 2	1.00	0.84	(0.37 - 1.88)	0.15	(0.04 - 0.55)	<0.01
TG						
Model 1	1.00	1.26	(0.72 - 2.20)	0.86	(0.48 - 1.54)	0.60
Model 2	1.00	1.30	(0.74 - 2.30)	0.87	(0.48 - 1.59)	0.62
FPG						
Model 1	1.00	0.46	(0.24 - 0.87)	0.62	(0.33 - 1.15)	0.10
Model 2	1.00	0.44	(0.23 - 0.84)	0.56	(0.30 - 1.06)	0.06
WC						
Model 1	1.00	0.38	(0.21 - 0.68)	0.18	(0.10 - 0.32)	<0.001
Model 2	1.00	0.37	(0.21 - 0.68)	0.17	(0.09 - 0.32)	<0.001
	Men (n = 209)					
	Low (n = 69)	Middle (n = 70)		High (n = 70)		
		ORs	95%CI	ORs	95%CI	*P* for trend
BP						
Model 1	1.00	1.50	(0.74 - 3.04)	1.16	(0.57 - 2.33)	0.68
Model 2	1.00	1.28	(0.62 - 2.65)	0.84	(0.39 - 1.81)	0.70
HDL-c						
Model 1	1.00	0.98	(0.27 - 3.57)	0.98	(0.26 - 3.64)	0.98
Model 2	1.00	1.27	(0.33 - 4.87)	0.90	(0.21 - 3.79)	0.80
TG						
Model 1	1.00	0.27	(0.13 - 0.54)	0.39	(0.19 - 0.79)	0.01
Model 2	1.00	0.30	(0.15 - 0.62)	0.54	(0.25 - 1.14)	0.09
FPG						
Model 1	1.00	0.36	(0.18 - 0.74)	0.68	(0.34 - 1.34)	0.24
Model 2	1.00	0.36	(0.17 - 0.74)	0.73	(0.35 - 1.54)	0.38
WC						
Model 1	1.00	0.69	(0.34 - 1.43)	0.06	(0.02 - 0.22)	<0.001
Model 2	1.00	0.72	(0.34 - 1.51)	0.07	(0.02 - 0.25)	<0.001

Model 1 is adjusted for age; Model 2 is adjusted for age, smoking status, alcohol intake, and exercise habits; BP: blood pressure; HDL-c: high-density lipoprotein cholesterol; TG: triglyceride; FPG: fasting plasma glucose; WC: waist circumference.

MetS risk factors in Japanese women and men. The primary findings of this study were that 1) low MFS levels were associated with greater risk of incident MetS in women and men, and 2) low MFS levels were associated with higher prevalence of several MetS risk factors after adjustment for age, smoking status, alcohol intake, and exercise habits.

The inverse association between muscle strength and the prevalence of MetS found in the present study is consistent with the results of previous investigations [12-14]. Jurca *et al.* reported this association in adult men using a study of cross-sectional design. They found that muscle strength (measured by one repetition maximal leg press and bench press) was associated with a significantly lower risk of developing MetS in men [12]. Further longitudinal analyses in adult men obtained comparable results [13]. In addition, Atlantis *et al.* reported an inverse association between muscle strength (handgrip strength per lean mass of the arm) and the prevalence of MetS in men [14]. The present study has extended the previous results by revealing inverse associations between MFS and the prevalence of MetS in both women and men.

By contrast, other previous studies have reported a relationship between muscle strength and MetS risk factors [15,22]. Wijndaele *et al.* reported that muscular strength assessed by measuring isometric knee extension and flexion peak torque was associated with the MetS risk factors of TG, HDL-c, and clustered MetS risk factors in women, and associated with clustered MetS risk factors in men [15]. Aoyama *et al.* examined the relationship between grip strength and individual and clustered MetS risk factors in Japanese men and women and found that grip strength was inversely associated with plasma glucose levels and clustered MetS risk factors in women [18]. Similar to previous studies, MFS was also associated with lipid profiles and WC in this study.

Although their results are not directly comparable with ours, Katzmarzyk *et al.* found a significant inverse relationship between musculoskeletal fitness composite score (calculated from the scores for sit-ups, push-ups, grip strength, and trunk flexibility) and all-cause mortality [22] and the incidence of type 2 diabetes among a Canadian population [23]. In addition, Sawada *et al.* observed a significant inverse relationship between muscular and performance fitness index composite scores (summed Z scores of sit-ups, side step, and functional reach) and the incidence of type 2 diabetes in Japanese men [24]. In their previous study, a significant inverse relationship was observed between muscular fitness and all-cause mortality and type 2 diabetes. These results suggest that maintaining a high level of MFS may prevent the development of MetS and reduce the risk of type 2 diabetes and mortality.

Strength training may lower MetS risk, including improvement in TG and HDL-c [25], BP [26], central adiposity and body composition [27], and whole-body insulin action and glucose uptake [28,29]. The metabolic effects of reduced muscle mass secondary to aging, decreased physical activity, or both contribute to the presence of obesity, insulin resistance, type 2 diabetes, dyslipidemia, and hypertension [30]. Skeletal muscle, the primary tissue for glucose and triglyceride metabolism, is a determinant of resting metabolic rate, and changes in muscle mass may reduce multiple CVD risk factors [31]. Therefore, with the maintenance of high muscle strength, such as that achieved by resistance training, may prove effective for the prevention and treatment of MetS.

This study has some limitations. First, the causality of relationships cannot be determined due to its cross-sectional design. Longitudinal or interventional studies are required to demonstrate this association further. Second, our sample size is small. In order to better clarify these relationships, future research should be done to increase the sample size.

In conclusion, this study suggests that muscular fitness is inversely associated with MetS in Japanese women and men aged 30 - 79 y. This finding may indicate a protective effect of muscular fitness on MetS. Furthermore, muscle fitness was associated with a better profile for several risk factors of MetS.

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第2章

ロコモの概念
──その操作的定義とロコモ度テスト

Key words　移動機能障害，ハイリスクアプローチ，ポピュレーションアプローチ

Point① ▶ロコモは移動機能障害を中心に運動器の病理像が機能障害につながるプロセスを包括した考え方の上に成り立っている。また，同時にスクリーニングから精査・治療・効果判定といった運動器の健康に対する予防と治療の流れを形成するものであり，ロコモの評価方法は重要な役割を持つ。

Point② ▶2013年に発表されたロコモ度テストは「立ち上がりテスト」「2ステップテスト」「ロコモ25」から構成され，それぞれ「歩く機能」「立ち上がる機能」「運動器の主観的健康度」を反映している。

Point③ ▶ロコモ度テストについては，運動器疾患を持たない人の年代別平均値が報告されている。今後，ロコモの調査や指導の際にロコモ度テストの3項目を加えることで，調査間の比較が可能になる。

Point④ ▶ロコモを判定するための基準となる各テストの点が確定するには，さらなる調査による実証が必要である。

1 ロコモの概念

ロコモティブシンドローム(以下，ロコモ)とは運動器の障害によって，移動機能の低下をきたした状態を示すものであるが，各運動器に生じる病態と切り離して移動機能を評価し，それを論じる，というものではない。ロコモの根底には骨・関節・筋・神経といった運動器を構成する組織レベルの病理がある。組織レベルの病理像はその広がりや程度に応じて，脊柱変形や筋収縮力の低下といった病態として顕在化し，そうした病態が複数関連し，さらにそれに伴う痛みや代償動作などが加わり，個人の歩行・バランス機能が規定される。すなわち，様々な疾患や病態を移動機能という軸で包括的に位置づけようとするのがロコモの特徴のひとつである。もちろん，この移動機能が超高齢化が急速に進むわが国の介護予防対策において重要であることは言うまでもない。

もう1つの重要な点は，こうした運動器の障害に対してどのように対策を行い，その効果を評価するか，という視点がロコモの概念に含まれていることである。他の医療分

野で行われているように，運動器の対策も健康への啓発と自発的予防行動，スクリーニング，生活指導，医療機関での精査・治療，そして状態の維持，といった形で社会の中で意識づけられていくことが望まれる。こうした対応方法の体系化においても，やはり移動機能が中心となり，上述のプロセスとは逆に，スクリーニングで問題ありとなったケースは，その病態が検討され，病理像の診断に至り，治療を受ける経過をたどる。

すなわち，ロコモの概念は移動機能障害を軸として，運動器の病理から日常生活動作(activities of daily living：ADL)障害を呈するまでの過程と，そのスクリーニングから治療に至るまでの過程との双方を含んでいることになる(図1)。

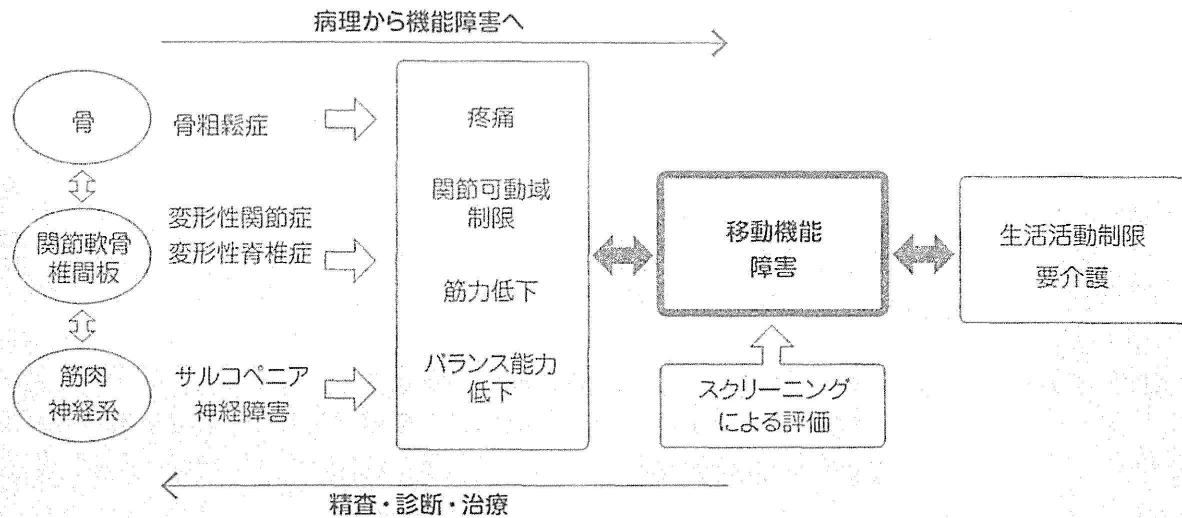

図1 ロコモティブシンドロームの概念図

各運動器の病理から移動機能障害につながるプロセスには「痛み」も含まれている。移動機能の評価はスクリーニングと同時に，介入効果の判定基準の役割も担う。

2 ロコモの操作的定義

上記のようにロコモは運動器疾患を包括的にとらえる概念の上に語られるものであるが，実際に臨床現場で「ロコモ」という概念を用いるためにも，明確な定義が必要である。一般に，ロコモは「運動器の障害により，日常生活の自立度が低下し，要介護状態または要介護状態になるおそれがある状態」とされている。さらに一般化した視点では，「運動器の障害により，移動機能の障害をきたした状態」とも言うことができる。「運動器の」という部分については，図1に示したように骨・関節・筋・神経がその構成要素である。一方，「移動機能」の定義は「立ち上がり」「歩く」機能ととらえることができる。

では，具体的にどの程度の移動機能の障害をもってロコモと呼ぶのだろうか。この点は現時点ではまだ確定はしていない，というのが正しいと思われる。なぜなら，「要介

護状態になる恐れがある状態」とあるように，ロコモの定義が将来のリスクに言及しているため，厳密には縦断的研究によって要介護リスクを判断するのに相応しい基準値についてのエビデンスが得られて，初めて具体的な値が妥当性を得ると考えられるためである。今後のロコモ研究の重要な課題のひとつとも言える点である。

また，広義な意味でのロコモ（移動機能障害）の定義についても，今後，立ち上がり機能と歩行機能についてのデータが蓄積され，「正常範囲」が設定されることが期待される。こうした正常値の設定により，移動機能が正常から逸脱し，要介護リスク域に移行していくのを早期に発見して予防するロコモ対策が推進されることが期待される。

3 ロコモを評価するということ

適切な評価法を設定することは，医学分野の問題解決の重要な要素であることは言うまでもない。それでは，ロコモはどのように評価するのが適切なのであろうか。

ロコモは様々な身体要因の結果として生じる状態であるから，それ自体を客観的なスケールで直接計測することは困難である。ただ，最も正確に移動機能の状態を評価する方法として，総合的な専門家の判断が想定される。実際にロコモを計測する指標として開発された質問票「ロコモ25」の開発においては，質問票で得られる評点と専門家による評価との比較を行うことで，その妥当性を確認している[1)2)]。これまで様々な運動機能テストがロコモの評価に用いられており，その一部はロコモ25の点数との関連性が調べられている。それらはロコモという状態に対して，様々な角度から物差しを当てているととらえることができる（図2）。

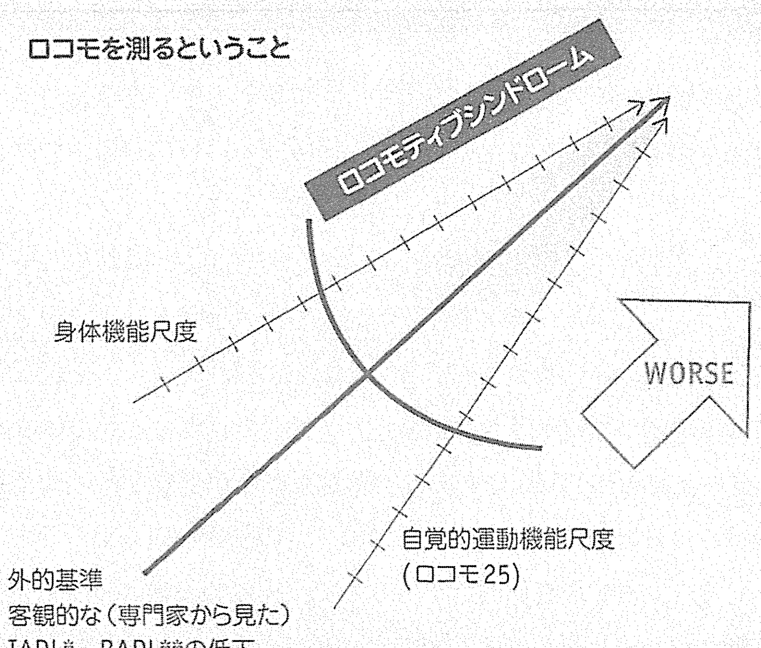

図2 ロコモとその評価
ロコモを直接計測しうる尺度としては専門家の総合的評価が今のところ一番近い。その代替として様々な方向から測ることで真の値に近づこうとするのがロコモの評価である。重症例であるとどの尺度でも正確にとらえることができるが，軽症（若年）であるほどその移動能力を直接測ることは困難である。

*IADL：instrumental activities of daily living
**BADL：basic activities of daily living

上述のようにロコモを規定する具体的数値はまだ定まっていないが，今後，ロコモ25やその他の運動機能評価（「立つ機能」「歩く機能」の評価）を受けた被験者集団の追跡調査によって，たとえば3年以内に要介護となるリスクが高まる閾値のようなものが定まっていくことが期待される。あるいは，いくつかの指標の組み合わせでそれは規定されるかもしれない。

4 ロコモは高齢者だけの問題か？

高齢化の進む日本において，要介護となる主要因のひとつが移動機能の障害であることから，ロコモ対策は要介護予防の観点で意識されることが多い。しかし，その一方で予防医学的な視点に立つと，ロコモの境界領域になる高齢者のみを対象にする（ハイリスクアプローチ）だけでなく，より若い世代も含めた人口全体に対して運動器の健康度を高めることが社会にとって将来的なリスク軽減につながると考えられる（ポピュレーションアプローチ）。40～50歳代でも足腰の不安が自覚的・他覚的にある人は少なくないため，それをどのように指導していくかは重要な問題である。

2013年に見直された厚生労働省の政策のひとつである「健康日本21（第二次）」では，運動器障害の改善が具体的な目標として挙げられており，日頃の運動習慣の目安も提示されており参考になる[3]。そして，さらに踏み込んだ対策をつくるためには，各自の運動機能をどのように評価し，その程度に応じたガイドラインを作成するかが求められる。

5 ロコモ度テストとは

このようにロコモを考える際に，その評価をどのようにして行うかという点は非常に重要である。ロコモの概念を包括し，スクリーニングから治療へとつなげる過程での利用が可能で，64歳以下でも使える評価系，といったことが必要になる。

このような背景をもとに，2013年5月に日本整形外科学会から発表された「ロコモパンフレット2013年度版」には「ロコモ度テスト」として①立ち上がりテスト，②2ステップテスト，③ロコモ25質問票，が掲載されている[4]。また，同パンフレットには運動器に障害のない健常者の年齢別平均値が示されており，各指標の目安となっている。

立ち上がりテストは「立ち上がる機能」を反映する。立ち上がりが可能な段の高さに応じた段階的な点数がつけられるため，計測のレンジには一定の限界があるものの，坐位から立ち上がれるかというシンプルな評価内容であるので，一般の人にとっても自分の立ち上がり能力を知る機会になると思われる。中でも，40cmからの片脚立ちは60歳

代までは半数以上の人が実施可能であるため，日常診療の中でも外来への来院者の機能を評価する目安ともなる（図3a）。

2ステップテストはロコモの概念の中の「歩く機能」を評価する。その特徴は，幅広い計測レンジを持つことで，若年から高齢まで値が上下に振り切れることなく評価可能なことである。その値は10m歩行時間と高い相関を示すことが村永ら[5]によって報告されており，2ステップは短時間に限られたスペースで移動能力を評価する指標として位置づけることができる。実際の計測値を見ると，男女とも年齢とともに平均値が漸減していく傾向がある（図3b）。これは，骨密度が20歳代をピークとして，それ以降は下がっていくことにも似ており，加齢による身体機能の低下を反映していると考えられる。

ロコモ25の質問票は，運動器の主観的健康度を示す。もともと高齢者向けに開発されたものであり，若い世代では下限値に値が集まること（床効果）が懸念されたが，筆者らの実施した調査では明らかな床効果はなく，世代別の平均点も年齢とともに増加傾向を示すなど，若い世代でもこの質問票が利用可能であることを裏づける結果が得られている。

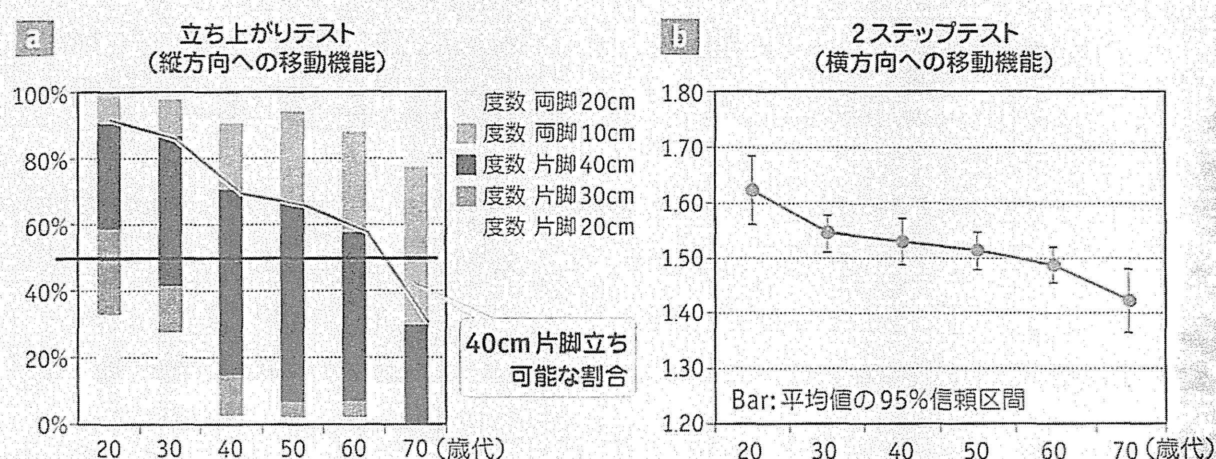

図3 立ち上がりテスト，2ステップテストの年齢別スコア

いずれの運動機能テストも年齢とともに低下する（グラフは女性のみを示す）。年齢ごとの平均値あるいは50％の人が実施可能なレベルを維持できているかが，若年における運動器の健康度評価の目安になりうる。

（文献4より改変）

6 ロコモ度テストの利用法

ロコモ度テストの3つの指標とその年代別平均値が示されたことを受けて，今後のロコモはどのように変わるのだろうか。まず，評価法の統一が挙げられる。ロコモに限らず，運動器に関連する調査や治療の効果判定には様々な尺度が用いられるため，調査同士の比較をすることが難しい場合がある。今後もそれぞれの調査に最も適した尺度が調査法に組み込まれることは当然であるが，この3つの指標を各調査項目に入れることで，調査の対象がどのような機能レベルの集団であったかを知ることができ，他の調査

と比較可能になると期待される。

また，64歳以下にも利用可能なスクリーニング法とその年代別平均値が提示されたことが，運動器の健康を維持することの重要性を若い世代に啓発することにつながると期待される。自治体や会社での健康診断に取り入れることによって，運動器に問題を持つ人を検出して，生活指導や受診紹介へとつなげていくことが可能となる。特に肥満を中心とするメタボリックシンドロームとロコモは関連性がすでに指摘されており，今後，生活習慣病の健診と運動器の健診とが相互に連動性を持ちながら形成されていくことも予想される。

7 ロコモ度テストの注意点

一方，注意点として現時点で「この点数を超えたらロコモ」という基準値が確定していないことを忘れてはいけない。今後，実施される調査結果を経て，エビデンスに裏づけられた基準値が設定されることが期待される。一方，若い世代，たとえば40歳代の人にとって，30年後に介護になるかもしれないリスクを語ることは，実証不能であることもあって，あまり意味を持たない。今後も，何らかの世代別平均値が運動器の健康維持の指標となっていくと思われる。

また，各テストの平均値はいずれも運動器疾患を持たない人を対象に得られたデータであることに，十分留意する必要がある。整形外科外来を受診する人たちを対象とした場合はもっと数値が悪いことが予想されるため，外来での指導において患者に説明する数値としてロコモパンフレット2013年度版で発表された数値を使用する際は注意を要する。一方，同一症例に対して継時的な変化を追うための利用については問題がないと思われる。

今後，立ち上がりテスト，2ステップテスト，ロコモ25を軸としての調査や介入試験が蓄積するとともに，基準値が明確になっていくことが期待される。したがって，正しい検査法を理解した上で，値についての情報をアップデートしていくことが重要である。

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Q1

ロコモティブシンドロームとサルコペニアは何が違うのか？

Answer どちらも移動機能障害の原因になるという点では類似点がある。サルコペニアは栄養障害や不活動を通じて各臓器の適応能力が低下する「老人虚弱（geriatric frailty）」という，より広い疾病概念の中に位置づけられている。ロコモでは，その中の不活動の主要原因である移動機能障害をクローズアップし，関節軟骨，神経調節，痛みといったサルコペニアには含まれないものの運動器機能に影響する要素も含めてとらえている。実際には，老人虚弱に至るプロセスの中で健常者がロコモに移行するフェーズがある，と考えてよいであろう。

Q2

50歳代の患者さんに「ロコモが心配で」と言われた時どのように対応すべきか？

Answer 50歳代の人にとって，要介護への移行が眼前にある問題であることは稀である。ただ，ロコモはある日急に生じる状態ではなく，徐々にその状態に近づいていくものと考えられる。そうならないようにするひとつの目安が，ロコモ度テスト3項目の点数と年齢別平均値との関係である。平均値を下回るようであれば，原因が何かを確認し，必要に応じて局所の治療，あるいは運動習慣の導入を指導する。

Q3

ロコチェック7項目は今後どのように使えばよいのか？

Answer ロコモパンフレット2013年度版のロコモ度テストには，ロコチェックは含まれていない。しかし，自己判定スクリーニング法としてのロコチェックの有用性は高く，今後も高齢者に対するスクリーニング調査において，ロコチェック7項目中で該当する項目がいくつあるかという活用が行われると思われる。

Q4

ロコモ度テストにはバランステストが入っていないが，評価しなくてよいのか？

Answer バランス機能はロコモの重要な要素のひとつで，ロコモ25の質問の中にはバランスに関する項目が含まれている。また，2ステップテスト，立ち上がりテストともに柔軟性やバランス機能も含んだ複合機能テストと考える。バランス評価に用いられることが多い片脚立ちテストは若年者に対する識別力が低い傾向があるが，測定対象の年齢層によっては評価項目に加えることも有用と考えられる。

✎緒方 徹

Spine

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EPIDEMIOLOGY

Identification of Risk Factors for New-Onset Sciatica in Japanese Workers

Findings From the Japan Epidemiological Research of Occupation-Related Back Pain Study

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Study Design. Two-year, prospective cohort data collected for the Japan epidemiological research of Occupation-related Back pain study were used for the analysis.

Objective. To identify potential risk factors for the development of new-onset sciatica in initially symptom-free Japanese workers with no history of sciatica.

Summary of Background Data. Although the associations between individual and occupational factors and cases of new-onset sciatica are established, the effect of psychosocial factors on the development of sciatica has still not been adequately clarified.

Methods. In total, 5310 participants responded to a self-administered baseline questionnaire (response rate: 86.5%). Furthermore, 3194 (60.2%) completed both 1- and 2-year follow-up questionnaires. The baseline questionnaire assessed individual characteristics, ergonomic work demands, and work-related psychosocial factors. The outcome of interest was new-onset sciatica with or without low back pain during the 2-year follow-up period. Incidence was calculated for participants who reported no low back pain in the preceding year and no history of lumbar radicular pain (sciatica) at baseline. Logistical regression assessed risk factors associated with new-onset sciatica.

Results. Of 765 eligible participants, 141 (18.4%) reported a new episode of sciatica during the 2-year follow-up. In crude analysis, significant associations were found between new-onset sciatica and age and obesity. In adjusted analysis, significant associations were found for obesity and mental workload in a qualitative aspect after controlling for age and sex. Consequently, in multivariate analysis with all the potential risk factors, age and obesity remained statistically significant (odds ratios: 1.59, 95% confidence interval: 1.01–2.52; odds ratios: 1.77, 95% confidence interval: 1.17–2.68, respectively).

Conclusion. In previously asymptomatic Japanese workers, the risk of developing new-onset sciatica is mediated by individual factors. Our findings suggest that the management of obesity may prevent new-onset sciatica.

Key words: sciatica, new-onset, prospective study, obesity, industrial health, risk factors, Japanese workers, asymptomatic, low back pain, psychosocial factors.

Level of Evidence: 3

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Sciatica is a symptom, rather than specific diagnosis,[1] characterized by low back pain (LBP) radiating below the knee.[2,3] The condition is also known as lumbosacral radicular syndrome, radiculopathy, nerve root pain, and nerve root entrapment or irritation. A variety of pathologies lead to sciatica: although lumbar disc herniation with nerve root compression is the main cause, lumbar spinal stenoses and tumors have also been reported.[2] The lifetime prevalence of sciatica ranges from 12.2% to 43% and can be influenced by varying definitions of sciatica and/or methods of assessing the condition.[1] Sciatica is usually more persistent and severe than nonspecific LBP, which is not attributable to any identifiable pathology in the spine. Although the symptoms usually improve within several weeks of onset, 40% still experience restriction in work 3 months after new-onset sciatica, and more than 30% continue to experience restriction in work 1 year after new-onset cases.[4] Sciatica often leads to deterioration in individual well-being, prolonged absence from work, and a significant health care burden.[4–8]

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Prior research has identified individual and occupational factors that act as risk factors for the development of sciatica. For example, strong associations were found with age,[9] height,[10] obesity,[11] smoking, driving,[10] leisure-time physical activity,[9,11] occupation,[11] and twisting of the trunk at work.[8] Unlike individual and occupational factors, the association between psychosocial factors and the development of new-onset sciatica is still ambiguous due to both a lack of research in the area and inconsistencies in results.[9,10,12,13]

Serious cases of sciatica impact both individuals and society in the context of the workplace and health care burden inflicted. Therefore, identification of risk factors is highly important. However, research is limited, particularly on the effect of psychosocial factors on the development of sciatica. Therefore, this study aimed to examine the associations between new-onset sciatica and individual factors, ergonomic work demands, and work-related psychosocial factors in initially symptom-free Japanese workers.

MATERIALS AND METHODS

Data Source

The study analyzed a 2-year prospective cohort of the Japan epidemiological research of Occupation-related Back pain study. Ethical approval was granted by the review board of the Minister of Labour, Health and Welfare (MLHW) of Japan. Participants for the Japan epidemiological research of Occupation-related Back pain study were recruited at 16 local offices of participating organizations in or near Tokyo. The occupations of the participating employees were diverse (*e.g.*, office workers, nurses, sales/marketing personnel, and manufacturing engineers). Self-administered baseline questionnaires were dispersed among the employees by the board of each participating organization. Participants provided written informed consent for participation and returned completed questionnaires, along with their name and address for the purpose of follow-up, directly to the study administration office.

Baseline questionnaires on a prior diagnosis of lumbar radicular pain (sciatica) by an orthopedician, experience of pain and/or numbness radiating below the knee with or without LBP, episodes and severity of LBP, individual characteristics (*e.g.*, age, sex, obesity, height, smoking habits, education), ergonomic work demands (*e.g.*, manual handling at work, frequency of bending, twisting, hours of driving per day), and work-related psychosocial factors (*e.g.*, interpersonal stress at work, job control, reward to work, somatization, depression). To evaluate psychosocial factors, the Brief Job Stress Questionnaire (BJSQ) developed by the MLHW of Japan[14,15] was used. This questionnaire contains 57 questions and assesses 19 work-related factors: mental workload (quantitative aspect), mental workload (qualitative aspect), physical workload, interpersonal stress at work, work environmental stress, job control, utilization of skills and expertise, job fitness, job satisfaction, vigor, anger, fatigue, anxiety, depressed mood, somatic symptoms, support by supervisors, support by coworkers, support by family or friends, and daily-life satisfaction. Work-related stress factors were rated on a 5-point Likert scale ranging from the lowest score of 1 to the highest score of 5.

The BJSQ incorporates questions from various standard questionnaires such as the JCQ (Job Content Questionnaire),[16] the NIOSH (National Institute for Occupational Safety and Health),[17] the POMS (Profile of Mood States),[18] the CES-D (Center for Epidemiologic Studies Depression Scale),[19] the STAI (State-Trait Anxiety Inventory),[20] the SSD (Screener for Somatoform Disorders),[21] and the SUBI (Subjective Well-Being Inventory).[22] Standardized scores were developed for the 19 individual factors based on a sample of approximately 10,000 Japanese workers. The BJSQ has been shown to have internal consistency, reliability, and criterion validity with respect to the Job Content Questionnaire and NIOSH.[23]

The follow-up questionnaire was distributed 1 and 2 years after the baseline assessment. The follow-up questionnaires included questions on the experience of pain and/or numbness radiating below the knee with or without LBP (sciatica) in the past year, episodes of LBP, and severity of LBP.

Data Analysis

The outcome of our interest was the development of new-onset sciatica during the 2-year follow-up period. In this study, new-onset sciatica was defined if a participant reported no LBP in the preceding year as well as no history of lumbar radicular pain (sciatica) diagnosed by an orthopedician at the time of completion of the baseline questionnaire, but subsequently reported new-onset sciatica with or without LBP in the year before either the 1-year or 2-year follow-up survey. Workers were excluded from the analysis if they had lower extremity trauma, osteoarthritis, or peripheral arterial disease during the follow-up period.

For data analysis, the following factors were initially included: (1) individual characteristics, (2) ergonomic work demands, and (3) work-related psychosocial factors. Individual characteristics included age, sex, obesity (body mass index (BMI) $\geq$ 25 kg/m^2), smoking habits (Brinkmann Index $\geq$ 400), education, hours of sleep, exercise habits, flexibility, experience at current job, working hours per week ($\geq$60 hr per wk of uncontrolled overtime), work shift, employment status, and family history of LBP with disability. Ergonomic work demands included manual handling at work; bending, twisting, lifting, pushing ($\geq$½ of the day as frequent), hours of driving per day, hours of desk work ($\geq$6 hr was determined as static posture), and monotonous work (the presence of feelings of monotony or boredom at work). Psychosocial factors were assessed with the BJSQ. The 5-point Likert scale was reclassified into 2 categories: the "not feeling stressed" category, where low, slightly low, and moderate were combined, and the "feeling stressed" category, where slightly high and high were combined.

The MLHW of Japan defines obesity as a BMI of 25 kg/m^2 or higher[24] whereas the World Health Organization definition of obesity is BMI of 30 kg/m^2 or higher.[25] The Japan Society for the Study of Obesity recommends the lower cutoff point for BMI because it is more appropriate for Japanese due to low prevalence and mild degree of obesity.[26] For the same reasons, the World Health Organization reported that in some Asian countries including Japan lower cutoff points for BMI may be more appropriate.[27] To assess smoking habits, the Brinkmann Index[28] was calculated on the basis of the total number of cigarettes smoked per day multiplied by duration of smoking in years. A Brinkmann Index value of 400 or higher indicated that a participant was a heavy smoker, whereas a value of less than 400 indicated that a participant was a nonheavy smoker. Participants were defined as flexible if their wrists could reach beyond the knees but the fingertips could not reach the ankles, and not flexible if their wrists could not reach beyond the knees.[29]

In addition to descriptive statistics, the baseline characteristics of the participants who followed-up (the follow-up group) and those who did not follow-up (the non–follow-up group) were compared using the χ^2 test. Next, logistic regression was run to examine the associations between risk factors and new-onset sciatica. Crude and adjusted odds ratios (ORs) and the respective 95% confidence intervals were calculated to assess potential risk factors. Age and sex were included in the model because both are well-established potential confounders. Subsequently, multivariate logistical regression analysis was run and included both the potential confounders and all potential risk factors for sciatica, which were reported at a significant level of $P < 0.1$ according to the initial crude and adjusted ORs. All the factors selected in the final model were statistically significant with a P value of less than 0.05. All tests were 2-tailed. The software package STATA 9.0 (StataCorp LP, College Station, TX) was used for all statistical analyses.

RESULTS

Baseline Characteristics of the Follow-up Group and the Non–Follow-up Group

The baseline questionnaire was distributed to 6140 workers and a response rate of 86.5% was achieved (5310 workers). Of these participants, 3194 workers successfully completed and returned both 1-year and 2-year follow-up questionnaires (a follow-up rate of 60.2%) (Figure 1).

The characteristics of the follow-up group and non–follow-up group at baseline were summarized. With regards to age, 37.7%, 31.1%, and 31.2% of the follow-up groups were aged less than 40; between 40 and 49; and 50 or more, respectively, with respective proportions of 58.5%, 23.7%, and 17.9% for the non–follow-up group. Males accounted for the vast majority of individuals in both the follow-up and non–follow-up groups (80.7% *vs.* 82.4%, respectively). The majority of the follow-up group and the non–follow-up group were not obese (76.4% *vs.* 73.7%, respectively). In respect to the distribution of manual handling at work, 72.6% of the follow-up group did not engage in manual handling at work, 9.9% engaged in manual handling of objects less than 20 kg, 17.6% engaged in manual handling of objects 20 kg or more or worked as a caregiver. The respective values for the non–follow-up group were 65.3%, 13.9%, and 20.7%. The majority of the follow-up group and the non–follow-up group undertook desk work without manual handling. However, in the category of manual handling of objects less than 20 kg, the majority of the follow-up group and non–follow-up group worked in manufacturing/engineering, whereas those who fell into the category of manual handling of objects 20 kg or more were predominantly involved in nursing or worked as caregivers. There were statistically significant differences between the follow-up and non–follow-up groups in age ($P < 0.001$), obesity ($P = 0.013$), and manual handling at work ($P < 0.001$), whereas no significant difference was found in sex (Table 1).

Baseline Characteristics of the Participants for This Study

Of the 3194 participants, 765 who reported no LBP during the preceding year and had no history of sciatica at the time of completing the baseline questionnaire were included in the analyses (Figure 1). In the distribution of age groups, 37.6% were less than 40; 29.6% were between 40 and 49; and 32.8% were 50 or more. The majority were males (n = 661; 88.5%). The number of obese participants was 164 (22.1%). The jobs of 569 participants (78.4%) did not involve manual handling. However, 77 (10.6%) participants manually handled objects

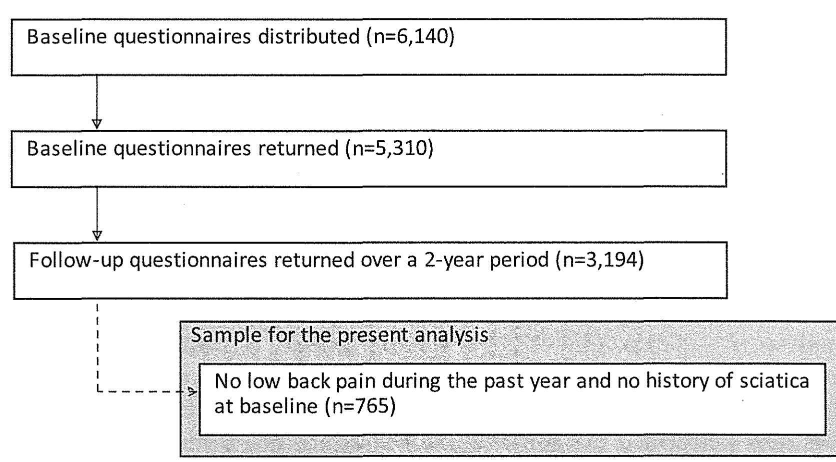

Figure 1. Flow chart of the sample selection for this analysis.