りがちで社会的に内向きである可能性が挙げられる．本稿にデータは掲載していないが，独居・孤食状態の4群のうち，この集団において「家族や友人とのつながり」や「生活の広がり」(Life Space Assessment) [8]が最も低い傾向にあった．同居者がいるにも関わらず1日に1度も誰かと共に食事をする機会が無いということは，同居者との関係が親密でない可能性があり，周囲からの関心が低いばかりか，高齢者自身への関心すら低くなると考えられる．故に，健康的な生活の維持に対する意欲の低下を招いた結果，野菜の摂取量が低下していると推察できる．ヘルスリテラシーが4群の中で最も低く，うつ傾向を示すGDS得点が最も高かった事実もこれを支持するものである．「同居かつ共食」群と比較して，自分で料理していた人の割合は多かったものの，1割程度の差であり，緑黄色野菜摂取量に影響してくるのは料理の手段的サポートの問題よりも，むしろ心理的な要因の方が大きい可能性が高い．「同居にも関わらず孤食」の集団においては，共食の集団と比較すると，同居者が配偶者である割合が低く，子供や子供の配偶者の割合が高い．これは，生活パターンの違いや年代差による同居者との心理的乖離，すなわち家庭内孤立が存在する可能性を示唆している．

本研究には主に4つの限界がある．第一に，横断的研究であるため，因果関係を示すためには縦断的検討を行う必要がある．第二に，食事摂取量の調査は栄養士による聞き取りではなく自記式で行ったため，高齢者の記憶違いによる過大・過小評価による誤差は否定できない．第三に，季節変動や日間変動が存在するため，本研究から得た知見の一般化には課題が残る．そして最後に，本研究は低野菜摂取がフレイルのリスクであるという仮説の下で実施したが，本標本からの仮説検証が必要であり，今後の課題とする．

緑黄色野菜摂取量の向上に対する『社会性』の介入指導の有用性を検証するため，ロジスティック回帰分析の結果を用いて「低摂取群」に入る集団の割合を試算したところ，「同居にも関わらず孤食」の集団が「共食」になった場合は約15%減，家族とのつながりがない集団がつながりを最大限に増やした場合も約15%減，従って単純計算で計30%近く低摂取群に入る集団の割合を削減することが可能という結果であった．当然本研究は因果関係まで言及できず，試算はあくまでも参考値であるが，『社会性』に対する介入の重要性を支持するものと考える．

以上のことから，『社会性』がバランスのとれた食事において重要な役割を果たしている可能性が示唆された．未病対策として，緑黄色野菜の摂取量の改善を通して良好な栄養状態を維持していくにあたり，社会的孤立，特に食事における孤立や家族との関係性に着目する必要性が示唆された．

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Social engagement and intake of green-yellow vegetables among community-dwelling older adults - From Kashiwa-study -

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Objective: To examine the association between social engagement (eating alone, living arrangement and social support network) and intake of green-yellow vegetables among community-dwelling older adults.

Methods: This study was based on 1,400 (724 male and 676 female) randomly selected community-dwelling older adults aged ≥65 (mean 73.7±5.4) years old who participated in the cohort health study in Kashiwa-city, Chiba-prefecture. Green-yellow vegetable intakes were assessed with the Food Frequency Questionnaire Based on Food Groups. For social engagement, social support network (Lubben Social Network Score) and eating alone by living arrangement were examined. Eating alone was evaluated with a question "Do you eat your meals with someone else, at least once a day?" and was crossed with the living arrangement (living alone or living with families). As covariates, age, gender, depressive symptoms (Geriatric Depression Scale≥6) and cognitive functions (Mini-Mental State Examination) were assessed.

Results: 349 (24.9%) subjects were in the "low intake" group. Binomial logistic regression analysis showed that the factors independently associated with low intake of green-yellow vegetables were: 'living with families yet eating alone' [odds ratio (OR)=1.95, 95% Confidence Interval(CI)=1.2-3.1], social ties with families [OR=0.953, 95% CI=0.92-0.99], age [OR=0.970, 95% CI=0.95-0.99], depressive symptoms [OR=1.49, 95% CI=1.1-2.0] and cognitive functions [OR=0.922, 95% CI=0.86-0.99].

Conclusion: The social ties with families and 'living with families yet eating alone' were independently associated with the low intake of green-yellow vegetables. This indicates the importance of preventive strategies that focus on alleviating social isolation, particularly during mealtimes and in relations with families.

Key words Social engagement, green-yellow vegetables, eating alone, community-dwelling older adults

第20回日本未病システム学会学術総会
■ プロシーディング 13

シニア世代の就労を介した身体活動量の増加と体組成への改善効果

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要 約

身体活動量の低下は虚弱のリスクを高めるが，退職後のシニアは身体活動量が低下しがちになり体組成のバランス悪化が危惧される．そこで再度の就労につくことで身体活動量がどのように変化し，その結果が心身にどのような影響があるかを調べた．

調査方法は定年退職した60歳以上のシニア16名に健康調査スタッフとして就労についてもらい，就労の前後で身体活動量・体組成・血管内皮機能の測定をした．また就労終了後に生活の質や健康についてのお気持ちの変化についてアンケートを実施した．

結果として3METs以上の活動時間は就労前21.5[13,33]分/日（中央値[IQR]）が就労後29.2[21,40]分/日となり，有意に増加した（p=0.020）．歩数は就労前5592[4568,7374]歩/日が，就労後は7223[4885,9750]歩/日となり有意に増加した（p=0.017）．四肢SMIは10.30[9.0,10.9] kg/m^{2}から10.33[9.0,10.8] kg/m^{2}と変化は見られなかった．体脂肪量は16.3[13,21]kgから13.6[13,20]kgへと就労前後で有意に減少した（p=0.004）．Flow Mediated Dilation値は就労前5.4[3,6]%であったが，就労後には5.7[4,6]%と若干改善した．アンケートでは生活の質や健康意識の改善がうかがわれる結果が得られた．

以上のように短期間であっても就労によって身体活動量が有意に増加し，その結果，体脂肪量が有意に減少した．また就労によって健康に対する意識が変わることで，就労が終了してからも身体活動量の増加が維持されたと考えられる．季節変動による血管内皮機能の低下が憂慮されたが，結果は変動が少なく血管内皮機能が維持される可能性があることが分かった．

以上より，シニア世代に対する就労は生きがいを感じると同時に，身体活動量の増加による体組成の改善にも寄与すると考えられる．

Key words　高齢者，虚弱，身体活動量，体組成，メタボリックシンドローム

1 諸 言

厚生労働省は「健康づくりのための身体活動基準2013」[1)]において身体活動量を増やすことがシニアの生活機能低下（ロコモティブシンドローム）のリスク低減につながるとし，身体活動量の低下は虚弱の危険因子としている．また同時にメンタルヘルスや生活の質についても言及している．

そこで本研究では身体活動量の低下に伴い身体能力の低下だけでなく，体組成のバランス悪化が危惧される退職後のシニアを対象とし，再度の就労につくことで身体活動量がどのように変化し，その結果が体組成・血管内皮機能の改善に寄与するかを調べた．さらに就労で体を動かし，口腔・栄養・運動・社会・心理に注目した健康調査のスタッフとしてかかわることで，健康に対する意識にどのような影響があるかをアンケートで調べた．

2 方 法

千葉県柏市在住の定年退職した60歳以上のシニアのうち，研究に同意した16名（平均年齢66.9±4.0歳，男：女=11:5）を対象とした．就労内容は同市内の大規模健康調査スタッフ（9月～11月）として，来場者の誘導や会場設営などであった．会場設営は各人の体力や健康状態に応じて机や椅子を運び，中強度以上の身体活動量が想定される．来場者の誘導業務は会場内を小刻みに移動し，シニア世代には適度な身体活動量となるよう配慮した．8月から9月上旬にかけて就労前検査を，11月下旬から12月にかけて就労後検査を実施した．検査内容は体組成測定と血管内皮機能の検査であり就労の前後での変化を解析

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した．また身体活動量の測定期間は就労開始日と終了日を基準として2回測定している．（後述）

本研究は東京大学の倫理審査委員会の承認を得て対象者全員の同意書を作成して実施した．

1. 身体活動量の測定

身体活動量の測定には日立製の身体活動量計を使用した．この身体活動量計はKen Kawamoto らによって[2]睡眠の解析にも用いられている．身体活動量計内には3軸の加速度センサが内蔵され，そのデータからMetabolic equivalents（以下METs）と歩数を算出した．

対象者は就労開始日を挟んだ前後の2週間と，終了日の前後2週間，計2回身体活動量計を装着し測定した．装着中対象者には記録をつけてもらい，就労についた日を特定した．2回の身体活動量測定のうち就労についた日を「就労日」として，就労開始時の身体活動量測定のうち「就労日」を除いた日を「就労前」として集計した．同様に就労終了時の身体活動量測定のうち就労日を除いた日付を「就労後」として集計した．

METsの集計方法は青柳幸利らの[3]METsと歩数の解析方法を参考とし，3METs以上の活動時間を「中強度活動時間」として集計した．

2. 体組成測定

従来体組成の測定にはDual-energy X-ray absorptiometry（二重エネルギーX線吸収測定法：以下DEXA）による骨密度の測定より副次的に得られるデータが利用されてきた．しかし近年は非侵襲で測定が簡便なBioelectrical Impedance Analysis（生体電気インピーダンス法：以下BIA法）が主流となっている．C Verdichらは[4]介入による食事制限での減量評価にBIAとDEXAを使用し各装置の測定結果を比較している．

本研究ではBIA法による体組成計（バイオスペース社製InBody430）を使用し測定した．測定項目はBody Mass Index（以下BMI）に加え，体脂肪量と四肢骨格筋量Skeletal Muscle Mass Index（以下四肢SMI）を算出した．

3. 血管内皮機能の測定

血管内皮機能の測定にはUNEX製FMD装置を使い，血流依存性血管拡張反応検査にてFlow Mediated Dilation（以下FMD値）を測定した．Maruhashi Tらは[5]本検査によるFMD値を心血管のリスクファクターとなりうるとしている．FMD値の測定は超音波画像より上腕の動脈径を測定する．その後前腕を5分間駆血し解放後に拡張した上腕の動脈径を測定する．駆血前の動脈径に対する駆血解放後の動脈径の拡張率をFMD値として%で表す．

4. 健康に対する意識調査

就労が終了したのちアンケート形式で生きがいや生活の質・生活範囲，食，睡眠，人間関係，活動意欲についてお聞きするとともに，自由記入形式で健康面・虚弱予防活動の意識変化について回答を得た．

有意差検定はIBM SPSS Statistics21を使いWilcoxonの符号付順位検定を用いた．有意水準は5%未満とした．

3 結 果

測定結果をまとめ（表1）に示す．

❑ 表1　就労前後での検査結果

			就労前		就労中		就労後		就労前後の有意差
			中央値	IQR	中央値	IQR	中央値	IQR	
身体活動量	中強度活動時間	分 / 日	21.5	13, 33	24.2	9, 44	29.2	21, 40	p=0.020
	歩数	歩 / 日	5592	4568, 7374	6599	4749, 8382	7223	4885, 9750	p=0.017
体組成	BMI	kg/m²	24.2	23, 26	NA	NA	23.9	23, 26	p=0.004
	四肢骨格筋指数	kg/m²	10.30	9.0, 10.9	NA	NA	10.33	9.0, 10.8	p=0.642
	体脂肪量	kg	16.3	13, 21	NA	NA	13.6	13, 20	p=0.004
血管内皮機能	FMD 値	%	5.4	3, 6	NA	NA	5.7	4, 6	p=0.277
身体活動量減少群	体脂肪量	kg	13.4	13, 19	NA	NA	13.4	12, 19	p=0.686
身体活動量増加群	体脂肪量	kg	18.2	15, 21	NA	NA	17.5	13, 20	p=0.004

※NA は “not available” を示す

1. 身体活動量

身体活動量計から算出された中強度活動時間・歩数ともに就労前-就労中-就労後と増加した. 特に就労前と就労後は中強度活動時間・歩数ともに有意差を持って増加している.

2. 体組成

四肢SMIは就労前後での変化は見られなかった. しかし, 体脂肪量は就労前後で有意に減少した. さらに就労前に比べ就労中の身体活動量が増加した群（11名）と減少した群（5名）に分けると, 身体活動量増加群での体脂肪率は有意に減少したが身体活動量減少群では有意差が見られなかった.

対象者に就労開始前でBMI18以下はいなかったが, BMIが就労後は有意に低下していた. なかでも就労前BMI25以上であった6名のうち4名にBMI低下が認められた.

3. 血管内皮機能

FMD値は就労後わずかな上昇がみられた.

4. 健康に対する意識

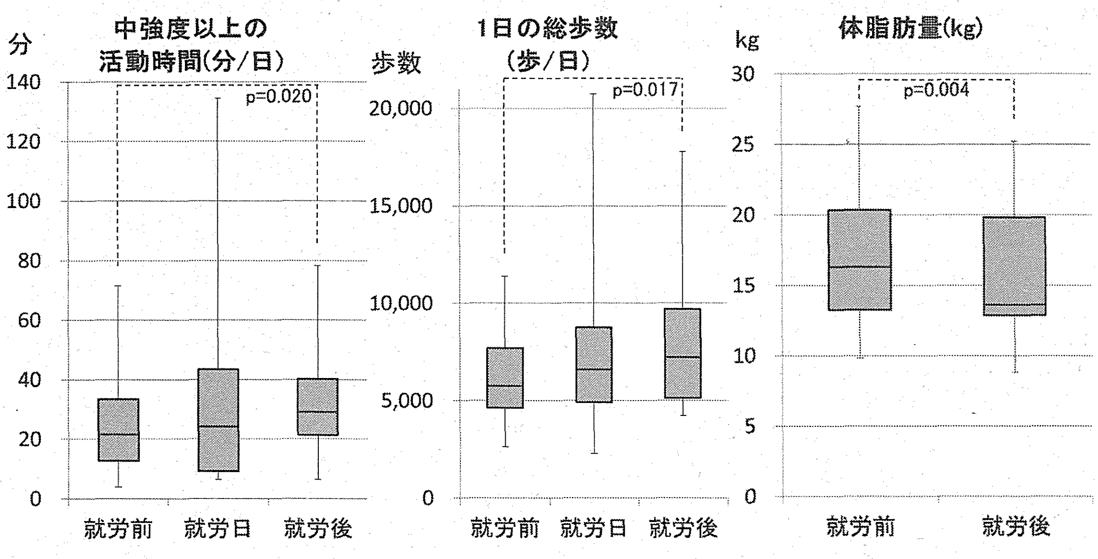
メンタルヘルスや生活の質の向上についての設問については9割以上が意識の向上を感じ, 自由記入では「健康に対する意識改善」「人とのつながり」「運動習慣の見直し」「生活の上での気持ちの向上」に関する記述が目立った.

4 考 察

退職後も何らかの社会参加の機会を望むシニアは多い. 本研究の就労はそのようなシニアのニーズにマッチし, 自然な形での身体活動量の増加に寄与できたと考える.

就労前と就労中の身体活動量の推移を見たときに, 就労中身体活動量が増加する群と低下する群があることが分かった. 就労後の聞き取りによると増加群では普段体を動かす機会が少なく, 就労が身体活動量を増加させるきっかけとなったことがうかがわれる. またこの群はもともと体脂肪量が高めであり, 体脂肪量減少の効果も高かった. 対して低下群では日常的にウォーキング・農作業・スポーツをしており, 日常活動より身体活動量の低い就労についたため身体活動量の低下につながった. この群はもともと体脂肪量が低くさらなる減少の効果は見られない. つまり体組成の改善も就労の効果として見据えるのであれば, 各人の日頃の身体活動量を加味して就労内容を決定する必要がる.

就労前に比べて就労後は全体として有意に身体活動量が増加しており (図1), 就労は一過性の介入手段にとどま



❑ 図1　就労による身体活動量と歩数・体脂肪の変化

らず就労が終了してからもその効果の継続が期待できる．一時的な外部からの介入による変化ならば，介入終了とともにその効果の減少が考えられる．しかし強制的な身体活動量の増加ではなくシニアの自発的な社会活動によるものならば，その効果の持続と長期的な就労を介することで永続的な効果が期待される．

体脂肪量の有意な減少は特に過体重傾向であった対象者に改善が見られた．この改善はSMIの減少が見られないことからも，筋肉減弱を伴わない理想的な変化である．Ryu Mらは[6]身体活動量とサルコペニアの関係を報告しているが，本研究からも身体活動量の増加が体組成の改善に寄与し，メタボリックシンドロームや潜在的な病気へのリスク低減が期待される．

また就労による身体活動量の増加は体組成の変化をもたらすだけではなく，アンケート結果から健康に対する意識の向上にも効果があることがうかがわれ，生活の質向上のきっかけとなりうることが分かった．同時にこの意識の向上が就労終了後も身体活動量が減少せず増加している一因となっているのではないかと思われる．

季節変動による血管内皮機能の低下が憂慮されたが，結果はほとんど変動がなかった．これはほぼ正常値である値が維持された可能性がある．

このようにシニアは退職後再度の就労につくことで，低下しがちな身体活動量を増加させることができる．その結果シニアが陥りがちな虚弱の防止となりうる体組成の改善につながることが分かった．

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Beneficial effects of active working during second life on physical activity and body composition in the elderly

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Retirement of elderly causes a decline in physical activity. It may be attributed to physical, mental and social frailty. We examined whether active working during second life beneficially affect physical activity and body composition in the elderly.

In this study, the participants worked as research staff of large-scale prospective cohort study, so called Dealing with community-dwelling older adults. The participants were over 60 years old, 11male and 5 female. The examinations, including physical activity, body composition and flow-mediated dilation (FMD), were performed before and just after the work of research staff.

Physical activity time of 3METs or more showed 21.5[13,33]min/day (Median [IQR]) before the work, and 29.2[21, 40] min/day just after the work. This increased difference was statistically significant (p=0.020). In addition step count showed 5592[4568, 7374]step/day before the work, 7223[4885, 9750]step/day just after the work. Its difference was also significantly increased (p=0.017). Notably, body fat mass showed 16.3[13, 21]kg before the work, and 13.6[13, 20]kg just after the work. This reduction was statistically significant (p=0.004). The significant improvement of FMD was not observed.

In summary, our observations might suggest that working during second life improves the body composition, especially body fat mass, via an increase in physical activity. This contribution to society with the sense of purpose may play a beneficial role in physical and mental healthcare in the elderly.

Key words physical activity, body composition, elderly, frailty, second life

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Metabolic Syndrome, Sarcopenia and Role of Sex and Age: Cross-Sectional Analysis of Kashiwa Cohort Study

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Abstract

Recent epidemiological evidence suggests that effects of cardiovascular risk factors may vary depending on sex and age. In this study, we assessed the associations of metabolic syndrome (MetS) with sarcopenia and its components in older adults, and examined whether the associations vary by sex and age. We also tested if any one of the MetS components could explain the associations. We conducted a cross-sectional analysis of the baseline data from the cohort study conducted in Kashiwa city, Chiba, Japan in 2012 which included 1971 functionally-independent, community-dwelling Japanese adults aged 65 years or older (977 men, 994 women). Sarcopenia was defined based on appendicular skeletal muscle mass, grip strength and usual gait speed. MetS was defined based on the National Cholesterol Education Program's Adult Treatment Panel-III criteria. The prevalence of sarcopenia was 14.2% in men and 22.1% in women, while the prevalence of MetS was 43.6% in men and 28.9% in women. After adjustment for potential confounders, MetS was positively associated with sarcopenia in men aged 65 to 74 years (odds ratio 5.5; 95% confidence interval 1.9–15.9) but not in older men or women. Among the sarcopenia components, MetS was associated with lower muscle mass and grip strength, particularly in men aged 65 to 74 years. The associations of MetS with sarcopenia and its components were mainly driven by abdominal obesity regardless of sex or age. In conclusion, MetS is positively associated with sarcopenia in older men. The association is modified by sex and age, but abdominal obesity is the main contributor to the association across sex and age.

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Introduction

Metabolic syndrome (MetS) is a constellation of cardiovascular risk factors which include abdominal obesity, dyslipidemia, hypertension and elevated glucose [1]. Insulin resistance and chronic inflammation are considered central mechanisms responsible for MetS [2] and inextricably correlate with each other to exert detrimental metabolic effects and lead to cardiovascular morbidity and mortality [3–5]. Accumulating epidemiological evidence suggests that both insulin resistance and chronic inflammation cause adverse effects on skeletal muscle. Diabetes, or even insulin resistance without diabetes, is associated with greater declines in skeletal muscle mass and strength [6,7]. A link between inflammation and muscle weakness has been reported in several studies [8,9]. Therefore, we postulate that MetS can accelerate age-related loss of muscle mass and strength, leading to the development of sarcopenia, a syndrome characterized by loss of skeletal muscle mass and function with a risk of physical disability [10]. Indeed, recent studies showed that MetS is associated with physical capacity impairment and increased risk of developing physical and functional disabilities [11–13].

Several recent studies have suggested that the effects of MetS may vary depending on age and sex. Cardiovascular risk factors, whose adverse effects have been established in younger people, may have different impacts in the elderly or frail population. Obesity did not seem to be a risk factor for increased mortality in elderly hospitalized patients with or without diabetes [14,15]. Elevated blood pressure was associated with lower mortality risk in physically frail elderly adults who could not walk 20 feet [16]. MetS was associated with lower probability of prevalent and incident functional disability in older adults [17]. The association between MetS and cardiovascular events was observed only in patients younger than 75, but not in patients aged 75 or over [18]. With regard to sex-related differences in the effects of MetS, MetS was associated with lower muscle strength in elderly men but not in elderly women [19]. However, data on sex- or age-related differences in the effect of MetS on sarcopenia are still scarce.

In the present study, we assessed the associations of MetS with sarcopenia and its components in functionally-independent community-dwelling Japanese older adults, and examined whether the associations were modified by sex or age. We hypothesized that MetS is positively associated with sarcopenia and its components, and that the associations are more pronounced in relatively young men. We also examined whether any of the individual MetS components could explain the associations and if the same MetS components contributed to the associations across sex and age.

Methods

Subjects

The Kashiwa study is a prospective cohort study designed to characterize the biological, psychosocial and functional changes associated with aging in a community-based cohort of 2044 older adults (1013 men, 1031 women). Those aged 75 and older accounted for 36.3% of men and 35.0% of women. The sampling and data collection process has been described in detail elsewhere [20]. Briefly, the inclusion criteria were age equal to or older than 65 years and functional independence (i.e., not requiring nursing care provided by long-term care insurance). The subjects were randomly selected from the resident register of Kashiwa city, Chiba, Japan, enrolled in 2012, and followed annually. The current study is a cross-sectional analysis of the Kashiwa study baseline data. Seventy three subjects who did not undergo bioimpedance analysis (BIA), usual gait speed or hand grip strength measurements were excluded, leaving an analytic sample of 1971 older adults (977 men, 994 women). Those excluded from the analysis were older compared to those included in the analysis (mean age 75.9 years vs. 72.9 years, $p = 0.001$), but did not significantly differ with respect to other characteristics including sex, height, weight, and prevalence of MetS.

The study was approved by the ethics committee of the Graduate School of Medicine, The University of Tokyo. All subjects provided written informed consent.

Definition of Sarcopenia

We followed the recommendations of the European Working Group on Sarcopenia in Older People (EWGSOP) for the diagnostic definition of sarcopenia [10]. The proposed diagnostic criteria required the presence of low muscle mass plus the presence of either low muscle strength or low physical performance. Muscle mass was measured by BIA using an Inbody 430 machine (Biospace, Seoul, Korea). Appendicular skeletal muscle mass (ASM) was derived as the sum of the muscle mass of the four limbs [10]. ASM was then normalized by height in meters squared to yield skeletal muscle mass index (SMI) (kg/m^2). SMI values lower than two standard deviations below the mean values of young male and female reference groups were classified as low muscle mass (SMI <7.0 kg/m^2 in men, <5.8 kg/m^2 in women) [21]. Muscle strength was assessed by hand grip strength, which was measured using a digital grip strength dynamometer (Takei Scientific Instruments, Niigata, Japan). Hand grip strength values in the lowest quintile were classified as low muscle strength in this study (cutoff values: 30 kg for men, 20 kg for women). Physical performance was assessed by usual gait speed. Subjects were instructed to walk over an 11-meter straight course at their usual speed. Usual gait speed was derived from 5 meters divided by the time in seconds spent in the middle 5 meters (from the 3-meter line to the 8-meter line) [22]. Usual gait speed values in the lowest quintile were classified as low physical performance in the current study (cutoff values: 1.26 m/s for each sex).

Definition of metabolic syndrome

MetS was defined based on the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria [1]. The presence of any three of the following five abnormalities constitutes a diagnosis of MetS: (i) abdominal obesity; (ii) elevated triglycerides (TG) with fasting plasma triglycerides ≥ 150 mg/dL; (iii) low high density lipoprotein cholesterol (HDL-C) with fasting HDL-C <40 mg/dL in men and <50 mg/dL in women; (iv) elevated blood pressure with systolic blood pressure ≥ 130 mmHg and/or diastolic blood pressure ≥ 85 mmHg; (v) elevated fasting plasma glucose with fasting plasma glucose ≥ 100 mg/dL. Abdominal obesity was defined by waist circumference using the thresholds recommended by the Japanese Obesity Society ($\geq$ 85 cm in men and ≥ 90 cm in women) [1].

Waist circumference was measured at the umbilical level using a measuring tape with the subject in an upright position. Blood pressure was measured using a standard technique with an HEM-7080IT automated measuring device (Omron Co., Tokyo, Japan). Blood samples were obtained after an overnight fast. Total cholesterol, HDL-C and TG were analyzed by enzymatic methods using a JCA-BM8060 automated analyzer (Japan Electron Optics Laboratory Ltd., Tokyo, Japan). Fasting plasma glucose level was measured using a JCA-BM9030 automated analyzer (Japan Electron Optics Laboratory Ltd.).

Other measurements

Demographic information, medical history of doctor-diagnosed chronic conditions, use of medication, and food intake were obtained using a standardized self-reported questionnaire. Physical activity was assessed using the Global Physical Activity Questionnaire, and metabolic equivalents (METs)-minute per week was computed [23]. Height and weight were measured with the subject wearing light clothing and no shoes using a fixed stadiometer and a digital scale, and used to compute body mass index (BMI).

Statistical Analysis

Differences in subject characteristics between those with and without sarcopenia were examined using Student's t-test or Wilcoxon rank-sum test (for continuous variables) and chi-square test (for categorical variables).

First, we employed logistic regression analysis to evaluate the association of MetS with sarcopenia. Our preliminary analysis suggested that the association of metabolic syndrome with sarcopenia was modified by sex ($p<0.01$), and therefore the following analyses were stratified by sex.

The model was initially adjusted for age only (model 1). We added height and weight to remove the confounding effect of body size (model 2). We then further adjusted for life-style risk factors for both sarcopenia and MetS, including physical activity and food intake (model 3). In the fully-adjusted model, the interaction between MetS and age was examined to test the hypothesis that the effect of MetS on sarcopenia varies by age.

To test if any MetS component could explain the MetS-sarcopenia association, we initially fitted a fully-adjusted logistic regression model to examine the association between each component of MetS and sarcopenia, followed by other logistic regression models between MetS and sarcopenia adjusted for MetS components.

Second, to examine the association of MetS with each component of sarcopenia (i.e., muscle mass, grip strength and usual gait speed), we employed multiple linear regression models. If the association between MetS and any one of the sarcopenia components was statistically significant, another multiple linear regression model with MetS components as independent variables

Table 1. Characteristics of all subjects and according to sarcopenia status in men and women.

	All	Sarcopenia	No sarcopenia	p
Men	**977**	**139 (14.2%)**	**838 (85.8%)**	
Age (years)	73.1±5.5	78.4±5.5	72.2±5.0	<0.001
Height (cm)	164.2±5.8	160.0±5.6	164.9±5.5	<0.001
Weight (kg)	62.8±8.6	54.1±7.2	64.3±8.0	<0.001
BMI (kg/m^2)	23.3±2.8	21.1±2.5	23.6±2.6	<0.001
SMI (kg/m^2)	7.28±0.68	6.34±0.48	7.44±0.58	<0.001
Hand grip strength (kg)	34.8±6.0	27.5±4.3	36.0±5.3	<0.001
Usual gait speed (m/s)	1.47±0.26	1.28±0.24	1.51±0.24	<0.001
MetS	43.6%	36.0%	44.9%	0.048
MetS components				
Abdominal obesity	55.5%	36.0%	58.7%	<0.001
High TG	22.7%	21.6%	22.9%	0.73
Low HDL-C	21.4%	20.9%	21.5%	0.87
High BP	90.4%	88.5%	90.7%	0.41
High FPG	51.0%	53.2%	50.6%	0.56
Food intake				
Very large	2.9%	1.4%	3.1%	<0.001
Large	15.3%	5.8%	16.8%	
Normal	65.4%	58.3%	66.6%	
Small	14.4%	30.2%	11.8%	
Very small	2.1%	4.3%	1.7%	
Physical activity (Mets)	3962.9±3981.0	3191.7±3612.2	4090.8±4026.7	0.01
Medical history				
Hypertension	47.2%	51.1%	46.5%	0.32
Diabetes	15.4%	18.0%	14.9%	0.36
Dyslipidemia	29.8%	31.7%	29.5%	0.60
Stroke	7.2%	12.2%	6.4%	0.01
CAD	8.0%	11.5%	7.4%	0.10
Cancer	19.0%	26.6%	17.8%	0.01
Medication use				
Statin	17.6%	18.7%	17.4%	0.71
Women	**994**	**220 (22.1%)**	**774 (77.9%)**	
Age (years)	72.8±5.4	76.2±5.8	71.8±4.9	<0.001
Height (cm)	151.4±5.5	148.2±5.6	152.3±5.1	<0.001
Weight (kg)	51.5±7.7	46.4±5.7	52.9±7.6	<0.001
BMI (kg/m^2)	22.5±3.2	21.1±2.6	22.8±3.2	<0.001
SMI (kg/m^2)	5.84±0.65	5.25±0.41	6.02±0.60	<0.001
Hand grip strength (kg)	22.4±3.9	18.4±3.2	23.6±3.3	<0.001
Usual gait speed (kg)	1.46±0.26	1.26±0.26	1.51±0.23	<0.001
MetS	28.9%	23.6%	30.4%	0.052
MetS components				
Abdominal obesity	24.0%	14.6%	26.7%	<0.001
High TG	17.9%	16.4%	18.4%	0.50
Low HDL-C	36.6%	33.2%	37.6%	0.23
High BP	84.2%	87.3%	83.3%	0.16
High FPG	33.7%	34.1%	33.6%	0.89
Food intake				
Very large	2.0%	1.4%	2.2%	<0.001

Table 1. Cont.

	All	Sarcopenia	No sarcopenia	p
Men	**977**	**139 (14.2%)**	**838 (85.8%)**	
Large	13.1%	9.6%	14.1%	
Normal	72.4%	64.1%	74.8%	
Small	11.2%	20.9%	8.4%	
Very small	1.3%	4.1%	0.5%	
Physical activity (Mets)	3722.7±3429.5	2748.0±2825.0	4000.0±3535.6	<0.001
Medical history				
Hypertension	39.8%	45.9%	38.1%	0.04
Diabetes	8.8%	8.2%	8.9%	0.73
Dyslipidemia	46.9%	45.5%	47.3%	0.63
Stroke	4.7%	5.9%	4.4%	0.35
CAD	4.9%	5.5%	4.8%	0.68
Cancer	11.2%	11.8%	11.0%	0.73
Medication use				
Statin	30.3%	29.1%	30.6%	0.66

Mean and standard deviation are shown for continuous variables, and proportions as percent for categorical variables. Percentages may not add up to 100 because of rounding.
Abbreviations: BMI, body mass index; SMI, skeletal muscle mass index; MetS, metabolic syndrome; TG, triglycerides; CAD, coronary artery disease; HDL-C, high density lipoprotein cholesterol; BP, blood pressure; FPG, fasting plasma glucose.
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instead of MetS was conducted to evaluate the association between MetS components and the sarcopenia component. Finally, each component of MetS was introduced as a covariate to the multiple linear regression model between MetS and the sarcopenia component to test if the MetS component could explain the association between MetS and the sarcopenia component. Considering that the number of combinations between MetS components and sarcopenia components is quite high, the analyses between MetS components and sarcopenia components were considered supplemental and carried out only when the association between MetS and any of the sarcopenia components was statistically significant, in order to decrease the possibility of finding associations that were significant just by chance alone.

There were no missing values of any variable in the entire analytic sample.

All analyses were conducted using SAS version 9.3 (SAS Institute Inc., Cary, NC) and R statistical software version 2.15.2 (R Foundation, Vienna, Austria). Two-sided $p<0.05$ was considered statistically significant.

Results

Subject characteristics

The prevalence of sarcopenia was 14.2% in men and 22.1% in women, and 43.6% of men and 28.9% of women were classified as having MetS. The characteristics of the study subjects by the sarcopenia status in each sex are shown in Table 1. Those with sarcopenia were older and had smaller body size compared with those without sarcopenia in each sex. Those with sarcopenia were physically less active and had smaller food intake in each sex. The prevalence of MetS was higher in those without sarcopenia, but

Table 2. Adjusted associations of metabolic syndrome with sarcopenia in men and women.

	Men		Women	
	OR (95% CI)	p	OR (95% CI)	p
Model 1	0.58 (0.38, 0.87)	0.008	0.55 (0.38, 0.79)	0.001
Model 2	2.05 (1.21, 3.47)	0.007	1.06 (0.69, 1.65)	0.79
Model 3	2.08 (1.22, 3.54)	0.007	1.03 (0.66, 1.61)	0.89
Model 3a	1.49 (0.80, 2.76)	0.21	1.02 (0.57, 1.85)	0.94
Model 3b	4.99 (1.73, 14.40)	0.003	1.03 (0.52, 2.04)	0.93

Abbreviations: OR, odds ratio; CI, confidence interval.
Model 1: adjusted for age.
Model 2: adjusted for age, height and weight.
Model 3: adjusted for age, height, weight, physical activity and food intake.
Model 3a: Adjusted for the same covariates as in Model 3, restricted to those aged 75 or over.
Model 3b: Adjusted for the same covariates as in Model 3, restricted to those aged 65 to 74.
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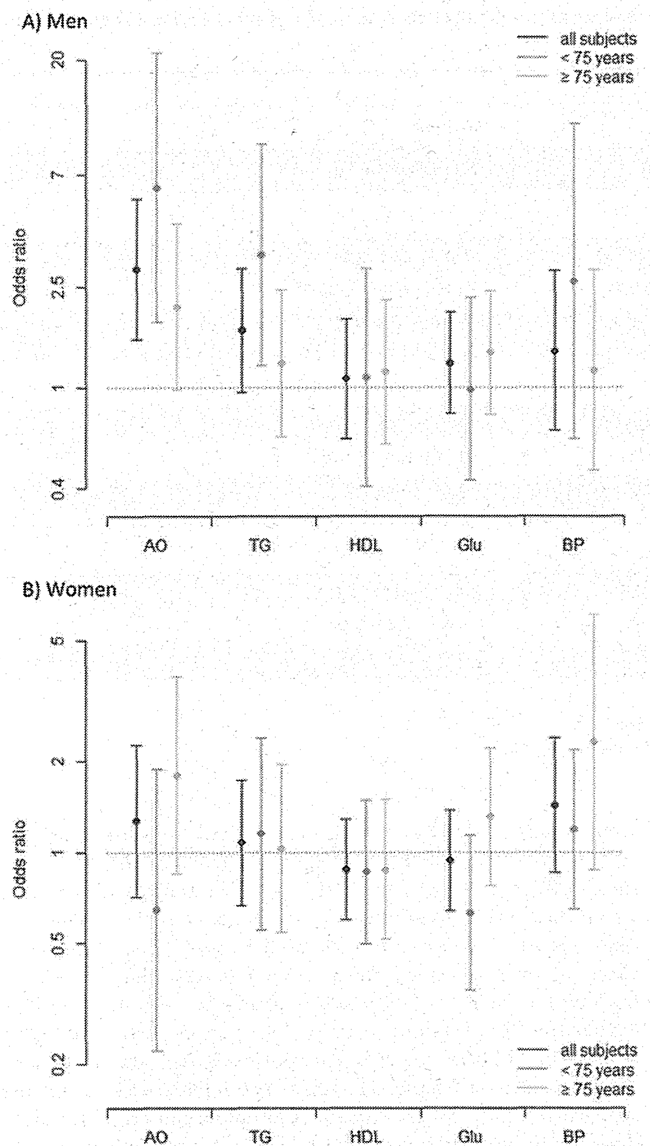

Figure 1. Fully adjusted odds ratio and 95% confidence interval of sarcopenia by individual metabolic syndrome components in all subjects and according to age group. Black bars: all subjects, dark-gray bars: subjects aged 65 to 74 years, light-gray bars: subjects aged 75 years or over. All models are adjusted for age, height, weight, physical activity and food intake. AO, abdominal obesity; TG, elevated triglycerides; HDL, low high density lipoprotein; Glu, elevated fasting plasma glucose; BP, high blood pressure. A) Men. B) Women.

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the difference was significant only in men (p = 0.048 in men, 0.052 in women). Among the five MetS components, abdominal obesity was significantly more prevalent in those without sarcopenia in each sex.

Association between MetS and sarcopenia

In multiple logistic regression adjusted for age, MetS was significantly associated with *decreased* risk of sarcopenia in each sex (Table 2, Model 1). However, after additional adjustment for body size (i.e., height and weight), MetS was significantly associated with *increased* risk of sarcopenia in men, while the association between MetS and sarcopenia became non-significant in women (Table 2, Model 2). Further adjustment for life-style risk factors had little effect on the association (Table 2, Model 3). Exclusion of subjects who did not meet the criteria for MetS but had one or two MetS components (i.e., comparing those with MetS and those with *no* MetS component) yielded stronger MetS-sarcopenia association in men (OR 8.25, 95% CI 2.17–31.37, p = 0.002), but the association remained non-significant in women (OR 1.10, 95% CI 0.48–2.94, p = 0.83). In the fully adjusted model, the interaction between MetS and age was statistically significant in men (p = 0.02), suggesting that the effect of MetS on sarcopenia may vary by age. We then divided the subjects into two groups according to age: "young old" (65–74 years) and "old old" (≥75 years). The characteristics of the subjects by the sarcopenia status in each subgroup (young-old and old-old) are shown in Table S1. In the age-stratified analysis, MetS was significantly associated with sarcopenia in "young old" men only (Table 2, Model 3b).

Associations of MetS components with sarcopenia

Multiple logistic regression models demonstrated that, of the five MetS components, only abdominal obesity was significantly associated with increased risk of sarcopenia in men (odds ratio [OR] 2.98, 95% confidence interval 1.55–5.63, p≤0.001) while none of the MetS components was significantly associated with sarcopenia in women (Figure 1). Abdominal obesity was significantly and independently associated with sarcopenia in men in the model including all five MetS components simultaneously (OR 2.89, 95% CI 1.51–5.53, p = 0.001). When abdominal obesity was added as a covariate to the logistic regression model between MetS and sarcopenia, the MetS-sarcopenia association became statistically non-significant (p = 0.12), suggesting that the MetS-sarcopenia association was mainly mediated by abdominal obesity. In the age-stratified analysis, abdominal obesity and elevated TG were significantly associated with sarcopenia (OR 6.22, 95% CI 1.82–21.22, p = 0.004 and OR 3.37, 95% CI 1.23–9.28, p = 0.02, respectively) in young-old men, but no significant associations were observed between MetS components and sarcopenia in old-old men or women. Abdominal obesity and elevated TG remained significantly associated with sarcopenia in young-old men in the model including all five MetS components simultaneously (OR 6.32, 95% CI 1.81–22.06, p = 0.004 and OR 3.30, 95% CI 1.19–9.13, p = 0.02, respectively). Addition of abdominal obesity and elevated TG to the model between MetS and sarcopenia in young-old men made the MetS-sarcopenia association statistically non-significant (p = 0.13).

Associations of MetS with sarcopenia components

In fully-adjusted multiple linear regression models, MetS was associated with lower grip strength in each sex and lower muscle mass in men (Table 3). When analysis was stratified by age, the inverse associations of MetS with muscle mass and grip strength in men remained significant except for the association between MetS and muscle strength in the old-old group, which became statistically non-significant (Table 3). In women, the inverse association between MetS and grip strength was observed in the old-old group only. The association between MetS and muscle mass became significant in old-old women in the age-stratified analysis.

In the subsequent supplementary analysis, abdominal obesity was significantly associated with lower grip strength in each sex and with lower muscle mass in men (Table S2). In addition, low HDL-C was associated with lower grip strength, and high TG was associated with lower muscle mass in men. These associations observed in men were significant in the young-old group only in

Table 3. Adjusted associations of metabolic syndrome with individual sarcopenia components in all subjects and according to age groups in men and women*†.

	Men		Women	
	beta (95% CI)	p	beta (95% CI)	p
Skeletal muscle mass index				
All	−0.14 (−0.20, −0.09)	<0.001	−0.05 (−0.10, 0.007)	0.09
Old-old	−0.13 (−0.24, −0.03)	0.009	−0.10 (−0.19, −0.005)	0.04
Young-old	−0.15 (−0.22, −0.08)	<0.001	−0.02 (−0.09, 0.05)	0.57
Grip strength				
All	−0.98 (−1.68, −0.28)	0.006	−0.61 (−1.11, −0.10)	0.02
Old-old	−0.65 (−1.76, 0.45)	0.25	−0.84 (−1.64, −0.05)	0.04
Young-old	−1.26 (−2.17, −0.34)	0.007	−0.38 (−1.04, 0.27)	0.25
Usual gait speed				
All	−0.02 (−0.06, 0.01)	0.22	−0.01 (−0.05, 0.02)	0.55
Old-old	−0.006 (−0.06, 0.05)	0.83	−0.03 (−0.08, 0.03)	0.36
Young-old	−0.03 (−0.07, 0.009)	0.13	0.004 (−0.04, 0.05)	0.86

Abbreviations; CI, confidence interval.
*All the models were adjusted for age, height, weight, physical activity and food intake.
†The young-old group refers to those aged 65 to 74 and the old-old group to those aged 75 or older.
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the age-stratified analysis. For women, the only significant association observed was between high TG and lower muscle mass in the old-old group.

The association between MetS and grip strength became statistically non-significant after introduction of abdominal obesity into the model in each age group and sex. The introduction of abdominal obesity attenuated the association between MetS and muscle mass (i.e., decreased the magnitude of the regression coefficient) in each age group and sex by more than 10%, more markedly than did any other MetS component, consistent with abdominal obesity dominating the association of MetS with sarcopenia components (data not shown).

Discussion

In this cross-sectional analysis of 1971 functionally-independent, community-dwelling adults older than 65, MetS was associated with *increased* risk of sarcopenia, particularly in "young-old" men (aged 65 to 74), after adjustment for potential confounders including body size. Without adjustment for body size, MetS was associated with *decreased* risk of sarcopenia, suggesting that body size can confound the association between MetS and sarcopenia and should be taken into account when considering the impact of cardiovascular risk factors on muscle.

We demonstrated that MetS was associated with lower muscle mass and lower muscle strength, but the effects varied by sex and age. The adverse effects of MetS on muscle mass and strength were mainly observed in the young-old group for men. In stark contrast, women were mostly insusceptible to adverse effects of MetS on muscle, except for the marginally statistically significant associations of MetS with muscle mass and strength in the old-old group (age 75 or older). The mechanisms underlying the age- and sex-related differences in the associations between MetS and muscle mass/strength need to be explored in future research, but possible explanations may include the effects of sex hormones on skeletal muscle. MetS is associated with lower testosterone level [24]. Considering that testosterone is positively related to muscle strength [25], it is conceivable that one of the pathways through which MetS exerts its adverse effects on muscle is via testosterone. Since testosterone decreases with age [26] and is lower in women than in men, younger men, with relatively high levels of testosterone, may be especially vulnerable. Another possible explanation is cytokines secreted by adipose tissue, so-called adipokines. Adipose tissue produces and releases adipokines such as adiponectin and leptin as well as pro-inflammatory cytokines such as IL-6 [27]. Skeletal muscle is an important target tissue for these molecules, and circulating levels of such molecules are influenced by the amount of adipose tissue as well as age and sex [28,29].

Several studies have reported an inverse association between MetS and muscle strength in younger men and women [30,31]. One small cross-sectional study of older adults revealed an inverse association between MetS and muscle strength in men, but not in women [19]. This study also demonstrated that the association between MetS and muscle strength was more pronounced in men aged 65–74 compared to men aged 75 or older, consistent with our findings. Low muscle mass, with or without the presence of obesity, is associated with MetS in younger men and women [32–34]. Several studies in older adults showed an inverse association between MetS and muscle mass [35,36], but these studies did not assess men and women separately.

We also demonstrated that the observed associations of MetS with the summary definition of sarcopenia or its individual components were mainly driven by abdominal obesity regardless of sex and age. Neither high BP nor elevated FPG showed a statistically significant association with sarcopenia or its components. Only a few studies have assessed which MetS components are main contributors to the association between MetS and the summary definition of sarcopenia or its components. An inverse association between MetS and physical performance was found in the cross-sectional analysis of a large-scale cohort study of older men, with obesity having the highest regression coefficient on physical performance among five MetS components [37]. Likewise, another large-scale cohort study of older adults found an association between MetS and poor physical performance, with abdominal obesity explaining the largest fraction of the variation in physical performance [38]. Our findings confirmed these previous studies and additionally demonstrated that abdominal obesity may be the main contributing factor for the associations of MetS with sarcopenia and its individual components regardless of sex and age, suggesting that there is a common mechanism underlying the adverse effects of MetS on muscle, for which abdominal obesity may partly be a marker, and that additional factors are at play causing sex- and age-related differences. Visceral fat accumulation, or abdominal obesity, is hypothesized to play an essential role in the development of MetS, given its propensity to cause insulin resistance, chronic inflammation and lower adiponectin levels [39–42]. All these factors may also be involved in the pathophysiological process of development of sarcopenia [6–9,28], and we postulate that abdominal obesity may represent a clinical phenotype that is associated with increased risk of developing both MetS and sarcopenia. This study had several limitations. First, it could not be free of unmeasured or uncontrolled confounders due to its observational nature. In addition, since this study was cross-sectional, we could not infer a causal relationship between MetS and sarcopenia. Low muscle mass is associated with physical inactivity [10] and insulin resistance [43], and therefore could lead to the development of MetS. We speculate that, in reality, sarcopenia and MetS are deeply intertwined and cause adverse effects on each other, leading to frequent co-existence of these two syndromes. Second, medical history, use of medication and food intake were self-reported. Even though we used a standardized questionnaire, reporting bias was possible. Third, we did not collect information on or adjust for food composition such as total calories, which may confound the sarcopenia-MetS association. Finally, since the subjects were exclusively functionally-independent Japanese older adults, our findings may not be able to be generalized to older adults from other racial/ethnic groups.

In conclusion, this study comprehensively examined the associations of MetS with sarcopenia and its individual components in older adults, with particular attention to the modifying effects of sex and age. We demonstrated associations of MetS with sarcopenia, particularly muscle mass and strength. The associations were modified by sex and age, but were mainly driven by abdominal obesity regardless of sex and age. This study adds to the growing knowledge on the adverse effects of MetS on muscle. Further research is needed to elucidate the underlying mechanisms of the sex- and age-related differences in the association between MetS and sarcopenia.

Supporting Information

Table S1 Characteristics of subjects according to sarcopenia status and age in men and women.
(DOCX)

Table S2 Adjusted associations of metabolic syndrome components with individual sarcopenia components.
(DOCX)

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Author Contributions

Conceived and designed the experiments: SI KI MA. Analyzed the data: SI. Contributed reagents/materials/analysis tools: SI. Contributed to the writing of the manuscript: SI. Contributed substantially to revision: SI KI T. Tanaka MA YO T. Tuji KI. Contributed to data collection: SI KI T. Tanaka T. Tuji.

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高齢者の生活機能評価の考え方とその実際

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1. 高齢者の生活機能のレベルは若年者と異なり，疾病だけでなく加齢変化によっても修飾されるため，生活範囲や人々との交流なども含めた幅広い検査に基づく総合的な評価が必要である．
2. 高齢者では状態が悪化すると回復が困難になりがちであり，障害が起こる前に現れる様々な兆候に敏感になり将来起こる生活機能の障害を予測していくことも重要である．
3. 日常生活での読書や新しい情報への興味といった高いレベルの生活機能は，それに続く生活機能に大きな影響を与える．そのため，従来の理学療法では重要視されなかった高いレベルの生活機能を評価することが高齢期の正しい生活機能評価につながると考えられる．

はじめに

若年者の生活機能のレベルは主に疾病によって修飾されるが，高齢者の生活機能は疾病だけでなく加齢による参加制限によって修飾される．つまり，若年者に比較して高齢者では，生活の範囲や人々との交流など幅広い検査に基づく総合的な評価が必要と考えられる．

また，高齢者では一度状態が悪化すると回復するのが難しくなりがちであることから，前段階に現れる様々な兆候に敏感になり将来起こる生活障害を予測していくことも重要となる．このように考えると，これまで理学療法士は生活機能低下が引き起こされてから評価を行ってきたが，その恐れのある者に対して評価するといった観点も重要となってくる．例えば，日常生活で本を読んだり，新しい情報に興味を持って探したりということをしなくなることについて，従来の理学療法はあまり大きな情報量を持っていなかったが，高齢者の生活機能評価ではこうした日常生活での些細な変化が引き続く生活機能障害に大きな影響を与える．

このような意味では，より高次の生活機能について理学療法士の知識をブラッシュアップしておくことが高齢期の正しい生活機能評価につながると考えられる．本稿では，従来の理学療法と差異のある評価を中心に実践的に紹介する．

高齢者の生活機能評価の実際

1 “心身機能・構造”の評価

ICFモデルにおける“心身機能・構造”の評価は，理学療法では主に病態や筋力・バランス機能といった運動機能，関節可動域などの評価によってなされてきた．高齢期の生活機能の低下は単に運動機能の低下によって起こるのではなく，口腔機能や栄養状態，心理機能，認知機能など複数の要因によって引き起こされる．そのため，運動機能の評価だけではなく，包括的な評価が必要である．

1）運動機能の評価

(1) 5m歩行速度（通常歩行，最大歩行）

高齢者の歩行能力の測定に用いられる．測定は，3mの助走区間および減速区間と5mの測定区間を設定して実施する．対象者には，「普段通りのスピードで歩いてください」（通常歩行），

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「できるだけ速く歩いてください」(最大歩行)と教示し,それぞれ2回計測し最良値を測定値とする[1].通常歩行の速度は,将来のADL(Activities of Daily Living:ADL)低下,IADL(Instrumental Activities of Daily Living:IADL)低下の予測因子[2]であり,遅いほど障害が起こることが報告されている.

(2) Timed up & Go test(TUG)

動的バランスの指標であり,立つ・歩く・回る・座るといった高齢期の日常生活に必要な複合能力を評価する指標である.測定では,椅子の背もたれに背中をつけた状態を開始肢位とし,背中が離れた時点から,3m先に設置したコーンを折り返し,再び椅子に腰かけるまでの時間を測定する.教示は「どちら回りでも構わないので,できるだけ速く回って下さい」とし,2回計測し最良値を測定値とする[1].

2) 口腔機能の評価(機能的嚥下障害スクリーニングテスト(the Repetitive Saliva Swallowing test:RSST)[3])

機能的嚥下障害の臨床的スクリーニングテストとして用いられる.高齢者を対象として実施される.測定では,椅子座位において嚥下運動を30秒間反復させ,触診で咽頭挙上を確認し,その回数を数える.「なるべく速く,繰り返して飲み込むこと」と教示する.測定時間は約5分である.日本人高齢者の平均嚥下回数は5.9回/30秒と報告されている[4].また,誤嚥(誤嚥量と誤嚥頻度)のカットオフ値は2/3回であり,その感度は0.98,特異度は0.66と報告されている[5].

3) 栄養状態の評価(食品摂取の多様性評価票[6](表1))

食品摂取の多様性の評価に用いる.対象は高齢者である.評価方法は自記式であり,すべての回答に要する時間は約5分である.アンケート調査表の構造は10項目の4件法であり,魚介類,肉類,卵,牛乳,大豆・大豆製品,緑黄色野菜類,海草類,いも類,果物,および油脂類の項目毎に,摂取頻度「ほとんど毎日」が1点,「2日に1回」,「一週間に1~2回」,「ほとんど食べない」が0点で,合計得点は10点,得点範囲は0点~10点である.合計得点が高いほど食品摂取の多様性

表1 食品摂取の多様性評価票(文献6より著者作成)

ふだんの食事についてお伺いします.あなたは次にあげる10食品群を週に何日ぐらい食べますか.ここ一週間ぐらいの様子についてお伺いします.		
1	魚介類(生鮮,加工品を問わずすべての魚介類です)	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない
2	肉類(生鮮,加工品を問わずすべての肉類です)	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない
3	卵(鶏卵,うずらなどの卵で,魚の卵は含みません)	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない
4	牛乳(コーヒー牛乳,フルーツ牛乳は除きます)	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない
5	大豆・大豆製品(豆腐,納豆などの大豆を使った食品です)	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない
6	緑黄色野菜類(にんじん,ほうれん草,かぼちゃ,トマトなどの色の濃い野菜です)	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない
7	海草類(生,乾物を問いません)	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない
8	いも類	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない
9	果物類(生鮮,缶詰を問いません.トマトは含みません.トマトは緑黄色野菜とします)	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない
10	油脂類(油炒め,天ぷら,フライ,パンに塗るバターやマーガリンなど油を使う料理です)	1. ほとんど毎日 2. 2日に1回 3. 一週間に1~2回 4. ほとんど食べない

表 2 高齢者抑うつ尺度短縮版（Geriatric Depression Scale：GDS short version）（文献 8 より著者作成）

1.	自分の生活に満足していますか.	はい	いいえ
2.	これまでやってきた事や興味のあった事の多くを，最近やめてしまいましたか.	はい	いいえ
3.	自分の人生は空しいものと感じますか.	はい	いいえ
4.	退屈と感じることがよくありますか.	はい	いいえ
5.	ふだんは気分の良いほうですか.	はい	いいえ
6.	自分に何か悪いことが起きるかもしれないという不安がありますか.	はい	いいえ
7.	あなたはいつも幸せと感じていますか.	はい	いいえ
8.	自分が無力と感じることがよくありますか.	はい	いいえ
9.	外に出て新しい物事をするより，家の中にいるほうが好きですか.	はい	いいえ
10.	他の人に比べ記憶力が落ちたと感じますか.	はい	いいえ
11.	いま生きていることは素晴らしいと思いますか.	はい	いいえ
12.	自分の現在の状態はまったく価値のないものと感じますか.	はい	いいえ
13.	自分は活力が満ちあふれていると感じますか.	はい	いいえ
14.	今の自分の状況は希望のないものと感じますか.	はい	いいえ
15.	他の人はあなたより恵まれた生活をしていると思いますか.	はい	いいえ

が高いことを示す．日本人高齢者の男女別の平均得点は男性が 6.5±2.2 点（n＝235），女性が 6.7±2.2 点（n＝373）と報告されており，食品摂取の多様性は食品摂取習慣の総合的な評価指標の 1 つと考えられる．また，食品摂取の多様性が，老研式活動能力指標の「知的能動性」と「社会的役割」の 1 年後の得点低下に対して防御的に作用することが示されている．

4）心理機能の評価（高齢者抑うつ尺度短縮版（Geriatric Depression Scale：GDS short version）（表 2）[7〜11]）

高齢者の抑うつ度の評価に用いられる．対象は高齢者である．評価方法は自記式であり，すべての回答に要する時間は約 10 分である．アンケート調査表の構造は 15 項目の 2 件法である．配点は「はい」が 1 点，「いいえ」が 0 点，項目 2，3，4，6，8，9，10，12，14，15 は逆転項目となっている．合計得点は 15 点，範囲は 0 点〜15 点で，合計得点が高いほど抑うつ度が高いことを示す．抑うつ傾向のカットオフ値は 5/6 点であり，その感度は 97，特異度は 96 と報告されている[11]．

5）認知機能の評価（Montreal Cognitive Assessment 日本語版（MoCA-J：Version 2.2）（図）[12〜14]）

軽度認知機能低下（Mild Cognitive Impairment：MCI）の鑑別に用いる．評価は対面で行い，すべての回答に要する時間は約 10 分である．配点の際，教育年数が 12 年以下なら 1 点追加し，合計得点は 30 点，範囲は 0 点〜30 点である．得点が低いと認知機能の低下が疑われる．下位項目として，Trail Making Test（0〜1 点），立方体の図形模写（0〜1 点），時計描画（0〜3 点），命名課題（0〜3 点），数字の順唱と逆唱（0〜2 点），Target Detection 課題（0〜1 点），計算（0〜3 点），復唱課題（0〜2 点），音韻語想起課題（0〜1 点），類似課題（0〜2 点），5 単語遅延再生課題（0〜5 点），見当識（0〜6 点）がある．

MCI 高齢者 30 人，軽度アルツハイマー患者 30 人，健常高齢者 36 人を対象とした報告において，MCI のカットオフ値は 25/26 点とされ，MCI の感度・特異度は 93/89，軽度アルツハイマー病では 100/89 と報告されている[13]．

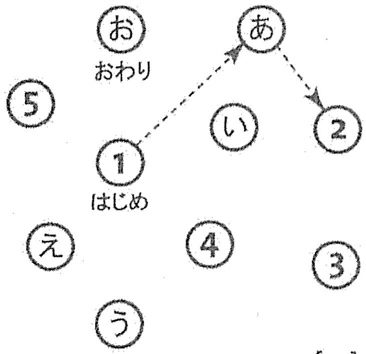
2 “活動”の評価

ICF のモデルにおける “活動” は生活レベルとされており，個人が生活を送る上で必要な機能がこの部分に当たる．Barthel Index や Functional Independence Measure を用いて基本的 ADL の評価がよく行われているが，ここでは，手段的

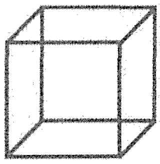
Japanese Version of
The MONTREAL COGNITIVE ASSESSMENT (MOCA-J)

氏名：
教育年数：　　　　生年月日：
性別：　　　　検査実施日：

視空間／実行系



[ ]

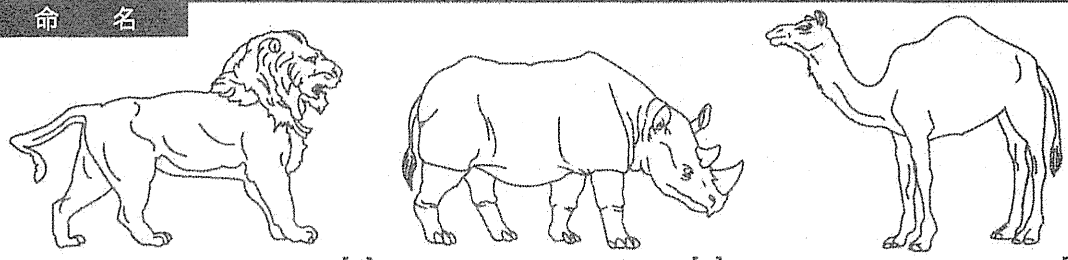


図形模写 [ ]

時計描画（11時10分）（3点）

[ ] 輪郭　[ ] 数字　[ ] 針　　__/5

命　名



[ ]　[ ]　[ ]　　__/3

記　憶

単語リストを読み上げ，対象者に復唱するよう求める。2試行実施する。5分後に遅延再生を行う。

	顔（かお）	絹（きぬ）	神社（じんじゃ）	百合（ゆり）	赤（あか）
第1試行					
第2試行					

配点なし

注　意

数唱課題（数字を1秒につき1つのペースで読み上げる）　順唱 [ ] 2 1 8 5 4　逆唱 [ ] 7 4 2　　__/2

ひらがなのリストを読み上げる。対象者には“あ”の時に手もしくは机を叩くよう求める。2回以上間違えた場合には得点なし。
[ ] きいあうしすああくけこいあきあけえおあああくあしせきあおい　　__/1

対象者に100から7を順に引くよう求める。[ ] 93　[ ] 86　[ ] 79　[ ] 72　[ ] 65
4問・5問正答：3点、2問・3問正答：2点、1問正答：1点，正答0問：0点　　__/3

言　語

復唱課題　太郎が今日手伝うことしか知りません。[ ]
犬が部屋にいるときは，猫はいつもイスの下にかくれていました。[ ]　　__/2

語想起課題 ／ 対象者に“か”で始まる言葉を1分間に出来るだけ多く挙げるよう求める。[ ] ____ 11個以上で得点　　__/1

抽象概念

類似課題　例：バナナ - ミカン＝果物 [ ] 電車 - 自転車 [ ] ものさし-時計　　__/2

遅延再生

自由再生（手がかりなし）	顔 [ ]	絹 [ ]	神社 [ ]	百合 [ ]	赤 [ ]	自由再生のみ得点の対象	__/5
参考項目　手がかり（カテゴリ）							
参考項目　手がかり（多肢選択）							

見当識

[ ] 年　[ ] 月　[ ] 日　[ ] 曜日　[ ] 市（区・町）[ ] 場所　　__/6

www.mocatest.org　健常 ≧ 26/30　合計得点 __/30
教育年数12年以下なら1点追加

MoCA-J 作成：鈴木宏幸　監修：藤原佳典
version 2.2

検査実施者________

図 Montreal Cognitive Assessment 日本語版（MoCA-J：Version 2.2）（文献14より転載）（http://www.mocatest.org/pdf_files/test/MoCA-Test-Japanese_2010.pdf よりダウンロード可能）

表3 老研式活動能力指標（The Tokyo Metropolitan Institute of Gerontology Index of Competence：TMIG-IC）（文献15より著者作成）

毎日の生活についておうかがいします．以下の質問のそれぞれについて「はい」「いいえ」のいずれかに○をつけてお答えください．質問が多くなっていますが，ご面倒でも全部の質問にお答えください．		
1. バスや電車を使ってひとりで外出できますか．	1. はい	2. いいえ
2. 日用品の買い物ができますか．	1. はい	2. いいえ
3. 自分で食事の用意ができますか．	1. はい	2. いいえ
4. 請求書の支払いができますか．	1. はい	2. いいえ
5. 銀行預金，郵便貯金の出し入れが自分でできますか．	1. はい	2. いいえ
6. 年金などの書類が書けますか．	1. はい	2. いいえ
7. 新聞を読んでいますか．	1. はい	2. いいえ
8. 本や雑誌を読んでいますか．	1. はい	2. いいえ
9. 健康についての記事や番組に関心がありますか．	1. はい	2. いいえ
10. 友達の家を訪ねることがありますか．	1. はい	2. いいえ
11. 家族や友達の相談にのることがありますか．	1. はい	2. いいえ
12. 病人を見舞うことができますか．	1. はい	2. いいえ
13. 若い人に自分から話しかけることがありますか．	1. はい	2. いいえ

ADLの評価を紹介する．

高次生活機能の評価（老研式活動能力指標（The Tokyo Metropolitan Institute of Gerontology Index of Competence：TMIG-IC）（表3）[15,16]）

手段的自立（手段的ADL）に加え，知的能動性，社会的役割を評価することができる高次生活機能の評価尺度である．地域在住高齢者の実際の生活機能の測定に用いられ，対象は高齢者である．評価方法は自記式であり，すべての回答に要する時間は約5分である．アンケート調査票の構造は13項目の2件法で，配点は「はい」が1点，「いいえ」が0点で，合計得点は13点となっている．得点範囲は0点～13点となっており，合計得点が高いほど能力が高いことを示す．下位項目として，手段的自立（IADL）（項目番号1～5），知的能動性（項目番号6～9），社会的役割（項目番号10～13）を測定することができる．手段的自立は家事や金銭管理といった生活に必要な能力について，知的能動性は余暇活動や好奇心といった能力について，社会的役割は友人や家族とのつきあいや家庭内外での役割などについてそれぞれ評価している．65歳以上の日本人高齢者の平均総合得点は，男性が11.0±3.0点（n＝782），女性が10.6±3.1点（n＝1,027）と報告されている[17]．

3 "参加"の評価

1）生活空間の評価（日本語版LSA（Life-Space Assessment：LSA）（表4）[18,19]）

介護予防を必要とする高齢者の生活空間の広がりについて評価する．対象は高齢者である．評価は対面にて実施され，すべての回答に要する時間は約10分である．合計得点は120点であり，範囲は0点～120点である．生活空間を5つのレベルに区分する．すなわち，レベル5「この4週間，町外に外出しましたか」，レベル4「この4週間，近隣よりも離れた場所（ただし町内）に外出しましたか」，レベル3「この4週間，自宅の庭またはマンションの建物以外の近隣の場所に外出しましたか」，レベル2「この4週間，玄関外，ベランダ，中庭，（マンションの）廊下，車庫，庭または敷地内の通路などの屋外に出ましたか」，レベル1「この4週間，あなたは自宅で寝ている場所以外の部屋に行きましたか」のそれぞれについて，外出の有・無（2件法），その頻度（4件法），補助具等の使用の有・無（2件法），そして介助の有・無（2件法）を評価する．

介護予防事業に参加した65歳以上の地域在住高齢者の男女別の平均総合得点は，男性が54.3