表1　85歳以上の高齢者の有訴率上位5症状および通院率上位5傷病
（厚生労働省平成16年度国民生活基礎調査）

		第1位	第2位	第3位	第4位	第5位
有訴率の上位5症状	男性	聴こえにくい 21.2%	腰痛 17.7%	もの忘れ 16.4%	手足の動きが悪い 16.1%	咳や啖が出る 13.8%
	女性	聴こえにくい 19.7%	もの忘れ 19.0%	腰痛 18.3%	手足の動きが悪い 18.0%	手足の関節が痛む 17.8%
通院率の上位5傷病	男性	高血圧症 20.2%	白内障 10.8%	腰痛症 10.5%	前立腺肥大症 9.5%	狭心症・心筋梗塞 8.0%
	女性	高血圧症 25.7%	白内障 13.6%	腰痛症 11.7%	骨粗鬆症 8.9%	関節症 8.2%

は21,820人で，初めて2万人を超えた．女性の百寿者が1万人を超えたのは2000年で，たった5年で倍増した．1963年には百寿者は日本全体で153人しかいなかったことを考えると，驚くほどの増加である．

90歳以上の人口は1,016,000人に達し，初めて100万人の大台を超えた．1996年には47万人であった90歳以上の人口は8年で倍増し，2010年には134万人に，2040年には450万人に増加するものと推定されている．

超高齢者の健康状況・疾病

2004年度の国民生活基礎調査では，要介護者のうちの14.9％が90歳以上の超高齢者である．気になる自覚症状がなく，また日常生活活動に支障もなく，通院もしていない，まったくの健康状態にある人は85歳以上の高齢者の約10％にすぎない．85歳以上の61.8％が病気のために医療機関に通院しており，52.9％が心身に何らかの症状がある．85歳以上の高齢者の罹患疾病は男女ともに第1位は高血圧症，第2位は白内障，第3位は腰痛症で，男性では第4位が前立腺肥大症，第5位が狭心症・心筋梗塞，女性では第4位が骨粗鬆症，第6位が関節症となっている．高血圧症は男性で20.2％，女性で25.7％の人たちが受診している．

自覚症状は男女ともに1位は「聴こえにくい」であり，約20％の高齢者が訴えを持っている．「もの忘れ」「腰痛」「手足の動きが悪い」などの症状も多い(表1)．

超高齢者の死因

厚生労働省の人口動態調査による平成16年度の年齢階級別死因は，60～84歳までで，悪性新生物，心疾患，脳血管疾患の順であり，40～64歳までは脳血管障害の代わりに自殺が上位にあるのが特徴である．死因としては中年者でも高齢者でも基本的には大きな違いはない．しかし90歳以上では悪性新生物による死亡の割合が低下し，心疾患，脳血管疾患による死亡の割合が増加する．肺炎による死亡が男性では第1位，女性では第3位の死因となり，男女ともに肺炎による死亡が超高齢者では増加している．また死因としての「老衰」が男女ともに第5位に登場しているのも超高齢者の特徴である(表2)．

超高齢者医療の重要性

超高齢者の数は，これまではきわめて少数であり，臨床上の問題になかなかならなかった．しかし超高齢者人口は今後，加速度的に増加していく．一般高齢者よりもさらに多くの疾患や症状を

表2 中高年者の性・年齢階級別にみた死因順位
（厚生労働省平成16年度人口動態調査）

男性

年齢(歳)	第1位	第2位	第3位	第4位	第5位
40～44	自殺	悪性新生物	心疾患	不慮の事故	脳血管疾患
45～49	悪性新生物	自殺	心疾患	脳血管疾患	不慮の事故
50～54	悪性新生物	心疾患	自殺	脳血管疾患	不慮の事故
55～59	悪性新生物	心疾患	自殺	脳血管疾患	不慮の事故
60～64	悪性新生物	心疾患	脳血管疾患	自殺	不慮の事故
65～69	悪性新生物	心疾患	脳血管疾患	肺炎	不慮の事故
70～74	悪性新生物	心疾患	脳血管疾患	肺炎	不慮の事故
75～79	悪性新生物	心疾患	脳血管疾患	肺炎	不慮の事故
80～84	悪性新生物	心疾患	脳血管疾患	肺炎	不慮の事故
85～89	悪性新生物	肺炎	心疾患	脳血管疾患	慢性閉塞性
90以上	肺炎	心疾患	悪性新生物	脳血管疾患	老衰

女性

年齢(歳)	第1位	第2位	第3位	第4位	第5位
40～44	悪性新生物	自殺	心疾患	脳血管疾患	不慮の事故
45～49	悪性新生物	自殺	脳血管疾患	心疾患	不慮の事故
50～54	悪性新生物	脳血管疾患	心疾患	自殺	不慮の事故
55～59	悪性新生物	脳血管疾患	心疾患	自殺	不慮の事故
60～64	悪性新生物	心疾患	脳血管疾患	自殺	不慮の事故
65～69	悪性新生物	心疾患	脳血管疾患	不慮の事故	肺炎
70～74	悪性新生物	心疾患	脳血管疾患	肺炎	不慮の事故
75～79	悪性新生物	心疾患	脳血管疾患	肺炎	不慮の事故
80～84	悪性新生物	心疾患	脳血管疾患	肺炎	不慮の事故
85～89	心疾患	悪性新生物	脳血管疾患	肺炎	老衰
90以上	心疾患	脳血管疾患	肺炎	悪性新生物	老衰

持ち，寝たきりや要介護の頻度も高い．また，感染症に対する抵抗力が低下しており，肺炎などの重篤な感染症にかかりやすい．脱水や電解質異常などに対しても細心の注意が必要だ．

世界保健機関(WHO)と国際高血圧学会(ISH)による降圧治療のガイドラインでは，80歳代後半の超高齢者については，高血圧が循環系に直接悪影響を及ぼす場合を除いては，生活改善にとどめるべきとしている．

しかし，このような超高齢者への治療の指針を含むガイドラインの設定は，まだまだ少ない．超高齢者の健康対策，疾病予防，的確な治療の方法を確立させることが急務であろう．平均寿命が延びても，寝たきりの超高齢者が増加しては，介護や看護の負担が大きくなるばかりである．

一方で，超高齢者のターミナルケアのあり方にも配慮が必要だ．超高齢者の死因に「老衰」があるように，超高齢では天寿という考え方がある．しかし，医学が進歩した現在，人の命がどこまでが天寿なのかがわからなくなってきている．超高齢だからといって治療するのはまったく無駄だというのは間違いだろう．

医師にはすべての人にできる限りの治療をしていく義務がある．寝たきりになり，食事が取れなくなって経管栄養をするようでは生きている価値がないという考えは間違っている．家族も医師も，患者が生きる努力をしているのを止める権利はない．超高齢だからといって，差別することな

く治療を行っていくことが大切だ．

生活習慣の改善

75歳未満の前期高齢者は元気である．多くの人が職についており，また積極的に社会参加をしている．喫煙や飲酒のコントロール，肥満防止，栄養改善，運動習慣などの生活習慣の改善は，寝たきりを防止して健康寿命を延ばしていくためには不可欠である．一方，75歳以上の後期高齢者，さらには80歳以上の超高齢者では加齢による身体機能の変化に対応し，10年先，20年先のことよりも現在の生活の質を考慮した生活習慣への介入が必要だ．

超高齢者では，健康の維持のためにはとくに食欲の低下による栄養不良，体重減少を予防していくことが必要であり，食事の制限や減塩などはどうしても必要な場合に限るべきであろう．喫煙は肺炎や気管支炎のリスクであり避けるべきである．高齢者では肝臓でのアルコール代謝機能が低下している場合が多く，過度の飲酒も好ましくない．

高齢者の心身の健康の維持のために運動習慣への積極的な介入が必要である．寝たきりにならない，介護予防の実施がとくに必要である．筋力トレーニング教室，転倒予防教室などへの超高齢者の参加を積極的に進めていくべきであろう．

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長寿科学総合研究の代表的な研究の紹介(2)

“老化とその要因に関する長期縦断的疫学研究”の概要について

老化とその要因に関する長期縦断的疫学研究は、日本人の老化および老年病に関する詳細な縦断的基礎データを収集蓄積し日本人の老化像を明らかにするとともに、老化および老年病に関する危険因子を解明して、高齢者の心身の健康を守り、老年病を予防する方法を見いだすことを目的としている。

調査の対象者は長寿医療センター周辺の住民であり、地方自治体の協力を得て地域住民から年齢・性別に層化した無作為抽出を行っている。平成12年４月に2267名の基礎集団（観察開始時年齢が40歳～79歳）が完成し、以後は２年ごとに検査を繰り返し実施しており、現在は第５次調査を実施中である。追跡中のドロップアウトは同じ人数の新たな補充を行い、定常状態として約2400人のダイナミックコホートとしている。

調査は長寿医療センター内に設けられた検査センターで年間を通して１日７名ずつに実施している。朝９時から夕方４時までの間、分刻みでスケジュールを組み、頭部ＭＲＩ検査や心臓および頸動脈超音波断層検査等の医学検査のみならず、詳細な生活調査、写真撮影を併用した栄養調査、運動機能調査、心理検査などを含む数千項目以上にも及ぶ調査・検査を行っている。

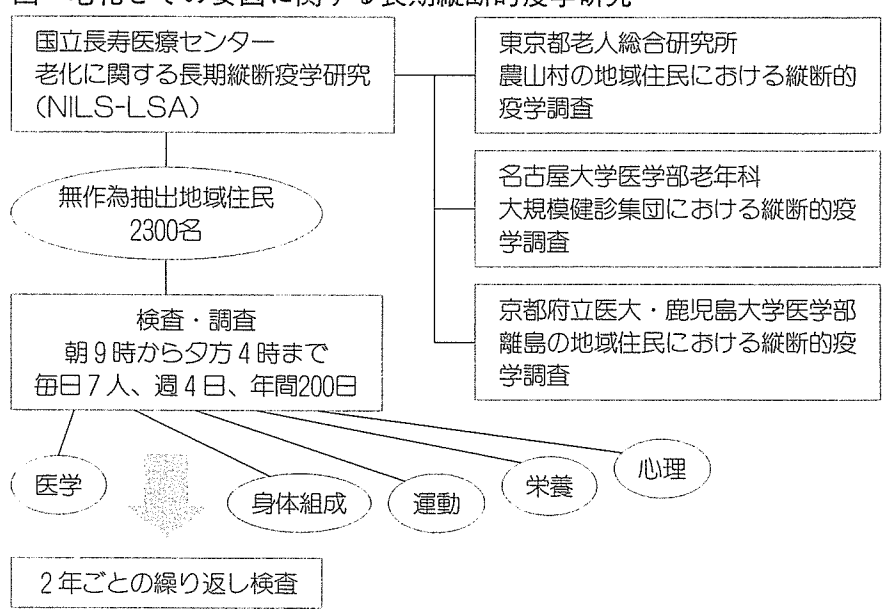
第１次調査から第４次調査までの結果をまとめインターネットにて英文で公開した（http://www.nils.go.jp/department/ep/index-j.html）。このように包括的かつ詳細な老化基礎データの公開は世界的にも他にほとんど例のないものである。

これらの蓄積されたデータを利用して、医学、栄養、心理、身体組成、運動の各分野での解析を行い、老化による変化、老年病に関連する因子等を検討している。研究成果として、歩行が特に高年期の抑うつ症状の低減に効果を持つこと、加齢による聴覚へ喫煙と騒音の相互作用があること、加齢により眼圧が下がること、コントラストを見分ける能力の加齢変化、中高年者のサプリメントの摂取率が50％以上あること等を明らかにしている。

これらを含め、NILS-LSA では研究開始以来、500以上の論文、学会発表による成果発表を行っている。

本研究では、さらに分担研究者の協力を得て、都市と農村や離島、地域・文化による老化の進行の比較研究、集団の質による差の縦断的検討、重要ではあるが特殊な診断技術や方法論を必要とする神経学的検査所見の縦断的研究などNILS-LSA だけでは実施が困難な研究も行い、日本人の老化について総合的な研究を目指している。

図　老化とその要因に関する長期縦断的疫学研究



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ORIGINAL ARTICLE

Risk factors for dietary variety decline among Japanese elderly in a rural community: a 8-year follow-up study from TMIG-LISA

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Objective: To examine the factors related to the decline of dietary variety among the rural community-dwelling Japanese elderly people and the implication on the planning of elderly people's nutritional improvement program in the future.
Design: A prospective cohort study during 8-year follow-up from 1992 to 2000.
Setting: This study was conducted in Nangai Village, a rural and mainly agricultural area of Akita Prefecture in the northern part of Honshu, one of four main islands in Japan.
Subjects: A total of 417 elderly people (160 men, 257 women) who completed interviews and food intake frequency surveys conducted in 1992, 1994, 1996, 1998, and 2000 were studied.
Methods: Dietary variety and variables potentially associated with dietary variety decline were identified from a face-to-face interview at the baseline and 8-year follow-up surveys. The dietary variety was measured using the dietary variety score (DVS), which covers the 10 main food groups in Japanese meals.
Results: During the 8-year follow-up, 36.2% of the subjects showed a decline in dietary variety. Health characteristics also change among the 8-year follow-up and these changes have an effect on the decline of dietary variety. Significant predictors for decline in dietary variety included loss of spouse, deterioration in self-perceived chewing ability, and decrease in intellectual activity score.
Conclusions: Loss of spouse, deterioration in chewing ability, and decline in intellectual activity may increase the risk of decline in dietary variety in community-dwelling Japanese elderly people.
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Keywords: longitudinal study; dietary variety decline; dietary variety score; community-dwelling elderly people; Japan

Introduction

Previous longitudinal studies have reported that intake of a variety of foods by the elderly is associated significantly with lower risks of chronic diseases and all-cause and cause-specific mortalities (Kant *et al.*, 1993, 1995; Michels and Wolk, 2002; Seymour *et al.*, 2003). The dietary variety is a straightforward tool for screening and identifying people at nutritional risk, as well as a tool for monitoring response to nutritional, medical, and environmental interventions (Bernstein *et al.*, 2002). In addition, dietary variety has previously been found to be associated with energy intake, quality of a meal and biochemical measures of nutritional status in community-dwelling elderly (Kant, 1996; Drewnowki *et al.*, 1997; Fung *et al.*, 2001; Marshall *et al.*, 2001).

On the other hand, food intake decreases with aging (Vellas *et al.*, 1997), and the reasons for the decline in food intake are multifactorial (Morley, 2001). When food intake decreases with aging, the possibility of a decline in dietary variety, which is evaluated based on food intake, is naturally

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high. Moreover, the characteristics of the subjects such as lifestyle and health status, which affects food intake may also change with aging. Therefore, clarifying the changes in dietary variety associated closely with elderly people's health status, the factor related to these changes, and the measures to be taken against such decline are important for comprehensive health maintenance of the elderly, their autonomy in the community, and prevention of bed confinement and dependence on long-term care.

Based on this background, we examined the factor related to the decline of dietary variety in the community-dwelling elderly people during an 8-year follow-up, with an aim to contribute to the planning of the elderly people's nutritional improvement program in the future.

Methods

Data source and study subjects

The data for this study were obtained from the Longitudinal Interdisciplinaly Study on Aging conducted by the Tokyo Metropolitan Institute of Gerontology (TMIG–LISA), which is a long-term project aiming to verify the predictors of longevity and outcome and to identify factors accelerating or retarding the aging process. The study was conducted in Nangai Village, a rural and mainly agricultural area of Akita Prefecture in the northern part of Honshu, one of four main islands in Japan. In 1992, 934 residents of the village (375 men, 559 women) aged 65 years and over were registered.

A baseline survey including face-to-face interview and medical examinations was carried out from June to August 1992, and a total of 738 people were interviewed, accounting for 79.0% of 934 residents. This cohort has been followed by interview and medical examinations on a yearly basis using methods similar to the baseline survey. The subjects analyzed in this study consisted of a total of 417 subjects (160 men, 257 women) who completed the interview surveys and food intake frequency surveys conducted in 1992, 1994, 1996, 1998, and 2000.

During the 8-year period, 381 people were lost to follow-up because of death, missing investigations in part, hospitalization, long-term absence, refusal to participate, and unknown cause. The disposition of subjects during the follow-up period is shown in Table 1. The follow-up survey of TMIG-LISA has been performed annually from July to August every year since the baseline survey in 1992 until the present. Details of the survey such as the investigation methods and contents have been described in our previous papers (Shibata *et al.*, 1997; Suzuki and Shibata, 2003). Investigations in the TMIG-LISA were approved by the Ethics Committee of our research institute and informed consent was obtained from the subjects for each follow-up.

Change in dietary variety

In TMIG-LISA, a food frequency questionnaire of 15 food groups commonly consumed in Japan has been performed every 2 years since the baseline survey in 1992 until the present (Kumagai *et al.*, 1999). However, in order to evaluate dietary variety in food groups that constitute the dishes, we excluded the daily foods eaten by almost all the Japanese elderly, and they included the traditionally eaten staples; rice eaten with miso soup and pickled vegetables, bread, and noodles, totaling five food groups. The rationale is that rice, bread, and noodles are eaten as staple food in Japan; and rice eaten with miso soup and salt pickled vegetables is a standard meal pattern for the elderly. We considered that more precise evaluation of dietary variety would be achieved by excluding these common daily foods.

The dietary variety was measured using the dietary variety score (DVS) (Kumagai *et al.*, 2003). DVS was assessed by a questionnaire of food frequency during 1 week, which covers the 10 main food groups in Japanese meals (meat, eggs, fish and shellfish, milk, dark-colored vegetables, soybean products, potatoes, fruits, seaweeds, and fats and oils). The response to each food group was either 'have eaten every day (a score of 1)', 'not eaten for 1 day or more (a score of 0)'. DVS was designated as the sum of the 10 food groups, such that a higher score (maximum of 10 points) would indicate a higher level of dietary variety. According to the surveys of Kumagai *et al.* (2003) based on a 5-year longitudinal study, higher dietary variety is associated with a reduced risk of a higher-level functional decline in community dwelling.

The change in dietary variety was classified into two group based on the change in DVS from 1992 to 2000. The change of DVS during the 8-year follow-up was summarized in quartiles and the cutoff point for change in dietary variety was defined as less than 25 percentile, which was equivalent to a score of -2 points. 'Decline' was thus defined as a change in DVS $\leqslant -2$ points, and 'nondecline' as a change in DVS > -2 points in this study.

Predictors of decline in dietary variety

The variables used for this analysis were: gender; age; education; DVS in 1992; and changes in spouse status, new

Table 1 Changes in number of study subjects during the follow-up period

	Men	*Women*	*Total*	*Participation rate (%)*
Study population	375	559	934	
Baseline survey	294	444	738	79.0
Follow-up survey				
All items completed	160	257	417	56.5
Death	84	77	161	
Missing investigation in part	24	45	69	
Hospitalization	21	43	64	
Long-term absence	1	9	10	
Refusal to participate	1	2	3	
Unknown	3	11	14	
Subjects available for analysis	160	257	417	

affected chronic disease, change in self-perceived chewing ability, change in higher-level functional capacity, and change in DVS during 8-year follow-up.

Change in status of the spouse during follow-up period was classified as 'no change' when there was no change from the baseline situation and 'loss of spouse' when the spouse passed away between 1992 and 2000. Newly affected chronic diseases such as stroke, heart disease, hypertension, and diabetes were classified as 'yes' and 'no'. When a diagnosis of the disease was made during the follow-up period, although there was no history of such disease at baseline, the case was classified as 'yes'. Chewing ability was assessed by self-reporting. Self-perceived chewing ability was rated as 'good' for subjects who answered 'can chew anything' or 'can chew most thing', and 'poor' for subjects who answered 'do not chew much' or 'taking blended food'. Change in self-perceived chewing ability was classified into four group. People rated as 'good' in chewing ability in both 1992 and 2000 surveys were assessed as 'maintenance of good chewing ability'. People rated as 'poor' in chewing ability in both 1992 and 2000 surveys were assessed as 'no change in poor chewing ability'. People whose self-perceived chewing ability worsened in the 2000 survey compared with 1992 were assessed as 'deterioration of chewing ability'. On the contrary, people whose self-perceived chewing ability became better were assessed as 'improvement of chewing ability'. The higher-level functional capacity of our subjects was measured using the TMIG-index of competence (Koyano *et al.*, 1988, 1991). This multidimensional 13-item index of competence comprises three subscales; 'instrumental self-maintenance (IADL)', 'intellectual activity', and 'social roles'. The response to each item was 'yes' (able to do) or 'no' (unable to do). Each item was scored 1 for 'yes' and 0 for 'no'. The total score was designated as the sum of scores for the 13 items, such that a higher score would indicate a higher level of competence. Three sublevels of competence were also calculated; a score of 0–5 for IADL, a score of 0–4 for intellectual activity, and a score of 0–4 for social roles. The TMIG Index of Competence has been widely accepted and used in Japan. Based on the difference of the score for three sublevels of competence, the changes in higher-level functional capacity were classified into 'increased', 'unchanged' and 'decreased'.

Statistical analysis

We compared the baseline characteristics between participants and non-participants in the follow-up study using χ^2-test, and *t*-test. The χ^2-test, *t*-test, and paired *t*-test were used to compare the changes in demographic and health characteristics between the decline group and the nondecline group in DVS during the 8-year follow-up period. To investigate the relationship between changes in demographic/health characteristics and change in DVS during the 8-year follow-up, multiple logistic regression analysis was performed after controlling gender, age, scores of three sublevels of TMIG-index of competence in 1992, and DVS in 1992. All data were analyzed with the SAS software for Windows version 8.0 and the level of significance was set at 5%.

Results

Table 2 compares the baseline characteristics between participants and non-participants in the follow-up study. Compared to non-participants ($n=321$), participants ($n=417$) in the follow-up study were younger in mean age, were higher in educational level, had lower prevalence of a history of heart disease and diabetes, and had higher scores in the higher-level functional capacity (instrumental self-maintenance, intellectual activity, and social role) at baseline. The mean DVS was 6.3 (2.4) points in participants and 6.0 (2.4) in nonparticipants out of a full score of 10, with no significant difference.

Table 3 shows the relation between the changes in demographic/health characteristic and change in dietary variety during the 8-year follow-up period. During the follow-up period, 36.3% showed a decline in dietary variety as assessed by the DVS. Significant differences between subjects with and without dietary variety decline were found in three variables: change in spouse survival status, change in self-perceived chewing ability, and change in intellectual activity score during the 8-year follow-up period. Subjects with dietary variety decline had a significantly higher frequency of loss of spouse by death ($P=0.027$), deterioration in self-perceived chewing ability ($P=0.001$), and decrease in intellectual activity ($P=0.030$) compared to nondecline group. The scores of intellectual activity ($P=0.004$) and DVS ($P<0.001$) were decreased significantly in subjects with dietary variety decline than in those with no decline during the 8-year follow-up period.

Table 4 summarizes the results of analyses by multivariate logistic regression models adjusted for gender, age, scores of the higher-level functional capacity (instrumental self-maintenance, intellectual activity, and social roles) in 1992, and DVS in 1992 to identify the predictors for dietary variety decline during 8 years. Changes in spouse survival status, self-perceived chewing ability and intellectual activity were identified as predictors for decline of dietary variety with the following results: (1) loss of spouse (odds ratio = 2.78, $P=0.008$), (2) deterioration in self-perceived chewing ability (odds ratio = 3.31, $P=0.009$), and (3) decrease in intellectual activity score (odds ratio = 2.02, $P=0.020$).

Discussion

Clarifying the factors of decline in dietary variety closely related to elderly people' health status and considering countermeasures are important to promote autonomy of the elderly and prevent them from living in a bed-confined state.

Table 2 Comparisons of baseline characteristics (1992) between participants and non-participants in the follow-up study

Variable	*Participants (n = 417) % or mean (s.d.)*	*Non-participants (n = 321) % or mean (s.d.)*	*P-value*[a]
Demographic variables			
Gender (men)	38.4	41.7	0.353
Age groups (years)	70.4 (4.5)	73.7 (6.2)	<0.001
65–69	51.6	29.3	<0.001
70–74	29.7	30.5	
75–79	13.4	19.3	
80+	5.3	20.9	
Spouse surviving (yes)	62.4	53.9	0.021
Education (<7years)	90.9	92.8	0.341
History of chronic disease			
Stroke	4.1	6.2	0.233
Heart disease	17.5	27.1	0.002
Hypertension	41.5	43.3	0.621
Diabetes	5.3	9.7	0.030
Self-perceived chewing ability			
Can chew anything	51.3	43.6	0.107
Can chew most thing	39.1	43.3	
Do not chew much	9.6	13.1	
Taking blended food	0.0	0.0	
Lifestyle-related variables			
Alcohol drinking status (current drinker)	38.4	38.9	0.874
Smoking status (current smoker)	14.6	18.4	0.180
Exercise habit (present)	17.3	16.8	0.517
Higher-level functional capacity[b] *(score)*			
Instrumental self-maintenance	4.8 (0.6)	4.3 (1.3)	<0.001
Intellectual activity	3.2 (1.1)	2.8 (1.3)	<0.001
Social role	3.7 (0.7)	3.3 (1.1)	<0.001
DVS[c] (score)	6.3 (2.4)	6.0 (2.4)	0.196

[a]*P*-values are based on χ^2-test or Fisher's test, except continuous data where *P*-values are derived from *t*-test.
[b]Higher-level functional capacity was measured using the TMIG-index of competence. This multidimensional 13-item index of competence comprises three subscales; 'instrumental self-maintenance (IADL)', 'intellectual activity', and 'social roles'.
[c]Dietary variety score.

However, knowledge of how dietary patterns change with age is limited because most dietary data are cross-sectional, in which people in one age group are compared with different people in another age group (Drewnowki and Shultz, 2001). Furthermore, previous studies that investigated the dietary intake by follow-up survey (Drewnowki and Shultz, 2001; Wakimoto and Block, 2001), generally emphasized health outcomes such as morbidity and mortality rather than age-associated changes in dietary habits. In addition, although dietary variety and its related factor change with aging, prospective data examining the relation between the change in dietary variety and changes in related factors are sparse. The significance of the present study is

Table 3 Relation between changes in demographic/health characteristics and change in dietary variety during 8-year follow-up, 1992–2000

	Decline (n = 151) % or mean (s.d.)	*Nondecline (n = 266) % or mean (s.d.)*	*P-value*[a]
Gender			0.824
Men	39.1	38.0	
Women	60.9	62.0	
Age (years)			0.200
65–69	53.6	50.4	
70–74	26.6	31.6	
75–79	11.9	14.2	
80+	7.9	3.8	
Change in spouse status			0.027
Loss of spouse	17.2	9.8	
No change	82.8	90.2	
Education			0.932
<7 years	90.7	91.0	
⩾7 years	9.3	9.0	
Newly affected chronic disease			
Stroke			0.107
Yes	9.9	94.7	
No	90.1	5.3	
Heart disease			0.316
Yes	17.9	22.6	
No	82.1	77.4	
Hypertension			0.479
Yes	26.5	23.3	
No	73.5	76.7	
Diabetes			0.955
Yes	6.6	6.8	
No	93.4	93.2	
Change in self-perceived chewing ability			0.001
Improvement	4.6	14.3	
Maintenance of good chewing ability	25.2	24.4	
No change in poor chewing ability	36.4	38.7	
Deterioration	33.8	22.6	
Change in alcohol drinking status			0.143
Habitual drinker	60.3	58.3	
Quitted	27.2	27.8	
New drinker	4.6	1.5	
Nondrinker	7.9	12.4	
Change in smoking status			0.307
Habitual smoker	11.9	10.2	
Quitted	2.0	5.6	
New smoker	1.3	0.8	
Nonsmoker	84.8	83.4	
Change in exercise habit			0.733
Habitually exercising	9.3	9.4	
Quitted	6.0	9.0	
Newly exercising	6.6	6.0	
Nonexercising	78.1	75.6	

Table 3 *Continued*

	Decline (n = 151) % or mean (s.d.)	*Nondecline (n = 266) % or mean (s.d.)*	P-*value*[a]
Change in higher-level fuctional capacity			
Instrumental self-maintenance			0.373
Decrease	24.5	19.2	
No change	70.9	77.0	
Increase	4.6	3.8	
Change in score, 1992–2000	−0.6 (1.5)[b]	−0.4 (1.1)[b]	0.078
Intellectual activity			0.030
Decrease	38.4	26.3	
No change	43.7	49.6	
Increase	17.9	24.1	
Change in score, 1992–2000	−0.4 (1.3)[b]	−0.1 (1.1)	0.004
Social role			0.474
Decrease	31.1	28.9	
No change	57.6	62.8	
Increase	11.3	8.3	
Change in score, 1992–2000	−0.5 (1.3)[b]	−0.4 (1.0)[b]	0.145
Change in dietary variety score, 1992–2000	−3.2 (1.4)[b]	1.0 (1.7)[b]	<0.001
Total	36.3	63.7	

[a]*P*-values are based on χ^2-test or Fisher's test, except continuous data where *P*-values are derived from *t*-test.
[b]$P<0.001$ measured by paired *t*-test (from 1992 to 2000).

Table 4 Predictors of dietary variety decline during 8-year follow-up, 1992–2000

Risk factor	*Odds ratio*[a]	*95% CI*[b]	P-*value*
Change in spouse survival status (→ loss of spouse)	2.78	1.30, 5.95	0.008
Change in self-perceived chewing ability			
Improvement (reference group)			
Maintenance of good chewing ability	2.31	0.98, 5.48	0.057
No change in poor chewing ability	2.41	0.52, 11.09	0.260
Deterioration	3.31	1.36, 8.08	0.009
Change in instrumental self-maintenance			
No change (reference group)			
Decrease	1.27	0.61, 2.66	0.525
Increase	2.51	0.50, 12.63	0.264
Change in intellectual activity			
No change (reference group)			
Decrease	2.02	1.12, 3.65	0.020
Increase	0.59	0.27, 1.29	0.185
Change in social role			
No change (reference group)			
Decrease	1.38	0.72, 2.64	0.328
Increase	1.21	0.42, 3.51	0.720

[a]Odds ratio adjusted for gender; age, and instrumental self-maintenance score, intellectual activity score, social role score and dietary variety score in 1992.
[b]CI, confidence interval.

that we examined the change in dietary variety and the factors relevant to this change by conducting longitudinal surveys for duration of 8-years on the same group of elderly subjects.

Before interpreting the results and establishing a final conclusion, some limitations of our study must be considered. First, among 738 people examined in 1992, 321 people (43.5%) were excluded from the analysis for identifying risk factors of dietary variety decline, because of missing data due to death, partial nonparticipation in investigation items, hospitalization and other reasons. The population that was excluded from analyses was older and weaker than the population analyzed using logistic regression. Therefore, the selection bias would have weakened the predictive value of each predictor for dietary variety decline in this study, suggesting that the actual predictive value might be even higher. Second, TMIG-LISA consists of three major disciplines: medical, psychological, and social sciences (Suzuki and Shibata, 2003). Food frequency has been contained as a part of the medical history questionnaire. In this study, since a nutrient intake survey was not conducted, we cannot specify what kind of changes had happened in terms of the composition of nutritional values including protein, vitamin and energy. However a decline in DVS may suggest that the nutritive value might have deteriorated and changed into an unbalanced diet.

In this study, 'decline in dietary variety' defined as a decrease by two or more points on the DVS from 1992 to 2000 was observed in 36.3% of the subjects. In addition, the demographic and health characteristics as well as DVS also changed with aging during the follow-up period and these changes affect the decline in dietary variety. In a multivariate logistic regression analysis to identify the predictors of dietary variety decline during the 8-year period, changes in spouse survival status, self-perceived chewing ability and intellectual activity during follow-up were identified as significant factors.

Having identified the change of spouse survival status as a related factor, we suggest that teaching dietary management is necessary for those elderly people who have lost the spouse. Since dietary management and cooking are prescribed by gender role, the influence of spouse status on the change in dietary variety may be particularly strong for men. In terms of the influence of spouse survival status on health status, Erlangsen *et al.* (2004) have also reported that being widowed offers more obstacles for the oldest old men than it does for women.

Deterioration in chewing ability is one of the most important consequences of oral diseases and disorders (Locker, 2002). A large number of studies have clearly demonstrated that self-perceived chewing ability is very important for the maintenance of good dietary habits in the elderly (Sheiham *et al.*, 1999; Osterberg *et al.*, 2002; Bartali *et al.*, 2003). Furthermore, Gordon *et al.* (1985) suggest that the presence of self-perceived chewing problems often is an indicator of altered food selection patterns in these older

individuals, and that this may be a more reliable indicator than the quality of the dentition itself. However, we could know through this longitudinal study that chewing ability deteriorated with aging. People who are aware of weakened chewing ability tend to only take food that is easy to bite. As a result, the dietary variety worsens significantly (odds ratio = 3.31, $P = 0.009$). Fortunately, chewing ability is improved by suitable dental treatments such as dentures and implants (Bergendal and Magnusson, 2000; Bakke *et al.*, 2002). After that, however, dietary quality may be lowered in subjects with self-perceived ill-fitting dentures (Marshall *et al.*, 2002; Sahyoun and Krall, 2003). Furthermore, Allen and McMillan (2002) suggest that tailored dietary advice in addition to appropriate prosthetic rehabilitation may be required for these patients, and that further research is warranted.

Intellectual activity as well as self-perceived chewing ability also changed with aging during the follow-up period. The results obtained are similar to those reported in other group of Japanese urban community (Fujiwara *et al.*, 2003). Change in intellectual activity is another significant factor of decline in dietary variety. The odds ratio for dietary variety decline becomes higher accompanying a decrease in intellectual activity score during the 8-year follow-up. This signifies that loss of a lifestyle with interest for health-related information through the mass media including newspaper, book, magazine, and television leads to a decline in intellectual activity and increases the risk of decline in dietary variety. Kumagai *et al.* (2003) pointed out that higher dietary variety is associated with a reduced risk of high-level functional capacity decline in community dwelling elderly. Moreover, according to the surveys of Fujiwara *et al.* (2003) and Ishizaki *et al.* (2000) based on an elderly people living in a Japanese community, maintenance of a high-level intellectual activity is strongly associated with sustaining independence in IADL. Therefore, it is also important for elderly people to maintain a lifestyle that improves intellectual activity.

Some investigators have suggested that since elderly people have a higher interest in health-related information than other age groups, there is a high potential that their behaviors can be modified to maintain their health status and autonomy (U.S. Department of health and human services, 1998). In particular, Fujiwara *et al.* (2003) reported that the intellectual activity of the elderly can be potentially modified toward a healthy direction through a correct lifestyle. Consequently, to prevent the decline of dietary variety, it is necessary to prepare a plan that improves intellectual activity in addition to the implementation of a nutritional improvement program. For example, even in the case of deteriorated chewing ability due to aging, methods of maintaining dietary variety with underlying efforts to improve intellectual activity will bring out much greater effect. This may take the form of appropriate support in buying food and choosing cooking methods appropriate to the chewing ability.

In summary, we found that DVS decreased with aging in the community-dwelling elderly during an 8-year follow-up. Self-perceived chewing ability and intellectual activity also changed during the 8-year follow-up and these changes had an effect on the decline of dietary variety. In planning future nutritional improvement programs based on the maintenance or improvement of dietary variety, the spouse status and self-perceived chewing ability should be taken into consideration, and measures to create an environment conducive to improving intellectual activity are required.

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Association Between Change in Bone Mineral Density and Decline in Usual Walking Speed in Elderly Community-Dwelling Japanese Women During 2 Years of Follow-Up

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OBJECTIVES: To investigate the association between change in bone mineral density (BMD) and change in usual walking speed in elderly community-living Japanese women during 2 years of follow-up.

DESIGN: Longitudinal cohort study.

SETTING: Community-based.

PARTCIPANTS: A total of 182 women aged 70 to 84 who completed a baseline survey and a follow-up survey 2 years later.

MEASUREMENTS: An interview, anthropometric measurements, blood analysis, and physical performance tests were performed at baseline and at follow-up 2 years later. BMD was evaluated using dual-energy X-ray absorptiometry measured at the forearm. Annual percentage changes in BMD and usual walking speed during the 2-year follow-up period were calculated; annual percentage changes in BMD were summarized in quartiles. The association between annual bone loss rate and decline in usual walking speed was analyzed using multiple linear regression adjusted for changes in muscle strength, balance capability, and other potential confounders.

RESULTS: Change in BMD was significantly related to change in usual walking speed during the 2-year follow-up. After multivariate adjustment, usual walking speed declined significantly more in elderly women whose BMD decreased (−3.5% change in walking speed in the first quartile of percentage change in BMD and −3.1% in the second quartile) than in women whose BMD increased (+1.5% in fourth quartile).

CONCLUSION: Elderly women whose BMD decreased had a significantly greater decline in usual walking speed than women whose BMD increased, even after multivariate adjustment of potential confounders. J Am Geriatr Soc 55:240–244, 2007.

Key words: bone mineral density; decline in usual walking speed; Japanese community elderly women

The maintenance of physical performance in later life may improve quality of life for older adults.[1,2] To assess the physical performance of elderly community-dwelling people, muscle strength, balance capability, and walking speed are routinely measured.[3,4] Of these physical performance measures, walking speed has been reported to be an indicator of general morbidity and a good indicator of functional capacity.[3–5]

Alternatively, walking ability decreases with aging, and ambulatory difficulties are common in older people. Moreover, decrease in walking speed predisposes elderly people to deterioration in quality of life, aggravation of disability, and need for care.[6] The reasons for the decline in walking speed are multifactorial. In particular, muscle strength and balance capability have been found to be positively associated with walking speed.[6–8]

Several studies have shown that women with lower bone mineral density (BMD) have significantly lower muscle strength[9–11] and slower walking speed.[9,12] Improvement in grip strength during 10-year follow-up wass significantly associated with lower bone loss,[11] although the association between changes in BMD and walking speed with aging remains undefined, because most past reports were cross-sectional studies.

The aim of the present study was to investigate the association between change in BMD and change in usual walking speed adjusted for changes in muscle strength and balance capability in Japanese community-dwelling elderly women during a 2-year follow-up.

SUBJECTS AND METHODS

Data Source and Study Subjects

The data for this study were obtained from the mass health examinations for community-dwelling people ("Otasha-

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kenshin" in Japanese) aged 70 and older living in Itabashi-ku, Tokyo. "Otasha-kenshin," literally meaning "health examinations for successful aging," are comprehensive health examinations for community-dwelling older adults aimed at preventing geriatric syndromes including falls and fractures, incontinence, oral health and function, mild cognitive impairment, depression, and undernutrition. Details of the survey, such as the investigation methods and contents, have been described previously.[13,14]

The baseline survey for the present study was conducted in December 2002. Of 2,000 persons aged 70 to 84 randomly sampled from the resident registration records of Itabashi-ku in metropolitan Tokyo, 847 (456 men and 391 women) participated in the baseline survey. Of the 391 women, 205 (52.4%) also participated in the follow-up survey conducted in November 2004 and completed the interview, anthropometric measurements, blood analysis, and physical performance tests. Twenty-three people who participated in other intervention programs conducted at the Tokyo Metropolitan Institute of Gerontology for promoting independence were excluded. Thus the research subjects analyzed in this study consisted of 182 elderly women who participated in the baseline and follow-up surveys and had not participated in other intervention programs during the 2-year period. The ethics committee of the Tokyo Metropolitan Institute of Gerontology approved the study, and informed consent was obtained from all subjects.

Assessment of BMD

BMD was evaluated using dual-energy X-ray absorptiometry (DTX-200, Osteometer Medi-Tech, Hawthorne, CA) measured at the forearm. Specially trained personnel performed the measurements. The Osteometer DTX-200 can set region of interest automatically 24 mm proximal to the position where the radius and ulna are 8 mm apart. Baseline and follow-up examinations were conducted using densitometers of the same make and model. Annual percentage changes in BMD during the 2-year follow-up period were calculated using the following formula

$$100 \times (\text{BMD in 2004} - \text{BMD in 2002}) / (\text{BMD in 2002} \times \text{length of follow-up in years})$$

and summarized in quartiles of percentage change as follow: first (− 12.57 to − 4.18), second (− 4.17 to − 1.78), third (− 1.77–0.72), and fourth (0.73–18.81).

Assessment of Physical Performance

Physical performance was assessed according to handgrip strength, functional reach, and walking speeds (usual and maximal). These assessments are routinely conducted as part of the Otasha-kenshin program, as described previously.[3,4]

Handgrip strength was measured using Smedley's Hand Dynamometer (Yagami, Tokyo, Japan). For functional reach, the subject stood sideways against a wall in a natural position and stretched both arms forward to the height of the shoulders. The positions of the fingertips were taken as the zero point. Then one arm was lowered. With the body tilted forward as far as possible, the subjects continued to stretch the arm parallel to the ground. The greatest distance of forward reach was measured. Three measurements were made, and the mean value was recorded.[15] To test walking speed, participants walked along a straight 11-m walkway on a flat floor. A stopwatch measured the time taken to walk 5 m, from the time when the foot touched the ground after the 3-m line to when the foot touched the ground after the 8-m mark. The participant first took the test by walking at usual speed and then by walking as fast as possible. Walking tests at usual and maximum speeds were repeated, and the faster speed was recorded in each walking test.

The change in physical performance was expressed as the change in value from 2002 to 2004 for each parameter. Annual percentage change in usual walking speed during the 2-year follow-up period was calculated by the formula

$$100 \times (\text{usual walking speed in 2004} - \text{usual walking speed in 2002}) / (\text{usual walking speed in 2002} \times \text{length of follow-up in years})$$

Assessment of Other Variables

An interview was conducted to assess the age, education level, subjective health status, regular exercise habits, chronic disease history, and higher-level functional capacity. Regular exercise per week was based on the following activities: walking outdoors, running, exercise, and sports. Chronic disease conditions were self-reported and included hypertension, stroke, heart attack, and diabetes mellitus. The higher-level functional capacity was measured using the Tokyo Metropolitan Institute of Gerontology Index of Competence.[16] This multidimensional 13-item index of competence comprises three subscales: instrumental activities of daily living, intellectual activity, and social roles. Blood samples were collected under a nonfasting state, in a sitting position. The analyses were performed centrally in one laboratory (Special Reference Laboratories, Inc., Tokyo, Japan). Serum albumin level was measured using a standard kit using the BCG method. Body mass index (BMI, kg/m^2) was calculated as weight (in kg) divided by the square of height (in m).

Statistical Analysis

All data were analyzed using SPSS software for Windows version 13.0 (SPSS Inc., Chicago, IL), and the level of significance was set at 5%. Population characteristics at baseline and at 2-year follow-up are expressed as frequency or mean ± standard deviation). Paired t tests were used to evaluate the changes in physical performance during the 2-year follow-up period. Simple correlation was used to test the association between changes in BMD and physical performance. Comparison of annual change in usual walking speed according to annual BMD change in quartile was conducted using analysis of covariance (ANCOVA). Trend analysis was conducted using linear regression and entering the quartiles of performance as ordinal variables.[9] The model was adjusted for age; subjective health status; regular exercise; BMI; serum albumin concentration; handgrip strength; functional reach; usual walking speed in 2002; and changes in BMI, serum albumin concentration, handgrip strength, and functional reach from 2002 to 2004.

Table 1. Characteristics of the Study Subjects (n = 182) in Baseline and Follow-Up Surveys

Characteristic	Value	*P*-value*
Age, mean ± SD	75.9 ± 3.6	
Education level ≥ high school, %	62.6	
Good subjective health status, %	80.2	
Regular exercise every day, %	42.3	
Chronic disease history, %		
Hypertension	50.5	
Stroke	5.5	
Heart attack	8.8	
Diabetes mellitus	4.9	
Higher-level functional capacity score, mean ± SD		
2002	12.2 ± 1.2	
2004	11.8 ± 1.4	<.001
Change 2004–2002	−0.48 ± 1.32	
Body mass index, kg/m², mean ± SD		
2002	22.8 ± 3.2	
2004	22.6 ± 3.2	.005
Change 2004–2002	−0.26 ± 1.23	
Bone mineral density, g/cm², mean ± SD		
2002	0.296 ± 0.068	
2004	0.286 ± 0.067	<.001
Change 2004–2002	−0.010 ± 0.023	
Serum albumin, g/dL, mean ± SD		
2002	4.25 ± 0.20	
2004	4.34 ± 0.20	<.001
Change 2004–2002	0.09 ± 0.16	
Handgrip strength, kg, mean ± SD		
2002	18.1 ± 4.4	
2004	17.4 ± 4.3	.001
Change 2004–2002	−0.74 ± 2.94	
Functional reach, cm, mean ± SD		
2002	32.0 ± 5.3	
2004	32.3 ± 5.3	.65
Change 2004–2002	0.16 ± 4.73	
Usual walking speed, m/sec, mean ± SD		
2002	1.15 ± 0.25	
2004	1.10 ± 0.26	.001
Change 2004–2002	−0.04 ± 0.18	
Maximal walking speed, m/sec, mean ± SD		
2002	1.61 ± 0.34	
2004	1.62 ± 0.39	.495
Change 2004–2002	0.01 ± 0.25	

* According to paired *t*-test.
SD = standard deviation.

Table 2. Correlations Between Changes in Bone Mineral Density (BMD) and Physical Performance During the 2-Year Follow-Up

Change in Physical Performance	Change in BMD (g/cm2) Correlation Coefficient	*P*-value*
Handgrip strength, kg	−0.036	.63
Functional reach, cm	0.062	.41
Usual walking speed, m/sec	0.212	.004
Maximal walking speed, m/sec	0.129	.08

* According to Pearson correlation analysis.

RESULTS

Participants in the follow-up study were younger and had significantly better subjective health, higher scores in higher-level functional capacity, and higher scores in physical performance (functional reach, usual walking speed, and maximal walking speed) (data not shown) than nonparticipants.

The baseline characteristics and changes in BMD and physical performance during the 2-year follow-up period of the 182 study participants are shown in Table 1. The mean age in 2002 was 75.9 ± 3.6 (range 70–84). The frequency of good self-rated health was 80.2%, and the mean higher-level functional capacity score was 12.2 ± 1.2 out of a full score of 13. During the follow-up period, higher-level functional capacity ($P<.001$), BMI ($P=.005$), BMD ($P<.001$), handgrip strength ($P=.001$), and usual walking speed ($P=.001$) decreased significantly. Alternatively, serum albumin concentration increased significantly ($P<.001$). There were no significant changes in functional reach and maximal walking speed during the 2-year follow-up period.

Table 2 shows the correlation between the change in BMD and change in physical performance during the 2-year follow-up period. Change in BMD was significantly related only to change in usual walking speed (correlation coefficient = 0.212, $P=.004$). There was no significant relationship between changes in BMD, handgrip strength, functional reach, and maximal walking speed.

Figure 1 compares the change in usual walking speed according to the change in BMD presented in quartiles. Mean annual BMD change rate was −1.57 ± 4.12% (range −12.57–18.81), and mean annual usual walking speed change rate was −1.54 ± 8.58% (range −23.84–47.78). A significant association was observed between mean annual change in usual walking speed and annual BMD change presented in quartiles ($P=.03$, according to ANCOVA). Elderly women whose BMD decreased (−3.5% in the first quartile and −3.1% in the second quartile) over the 2-year follow-up showed significantly ($P=.01$) greater decline in usual walking speed than women whose BMD increased (1.5% in the fourth quartile). More-rapid annual bone loss was associated with greater decline in usual walking speed ($P=.005$, according to trend test). This result was adjusted for age; subjective health status; regular exercise; BMI; serum albumin concentration; handgrip strength; functional reach; usual walking speed in 2002; and changes in BMI, serum albumin concentration, handgrip strength, and functional reach from 2002 to 2004.

DISCUSSION

The present 2-year longitudinal follow-up study evaluated the association between changes in BMD and physical per-

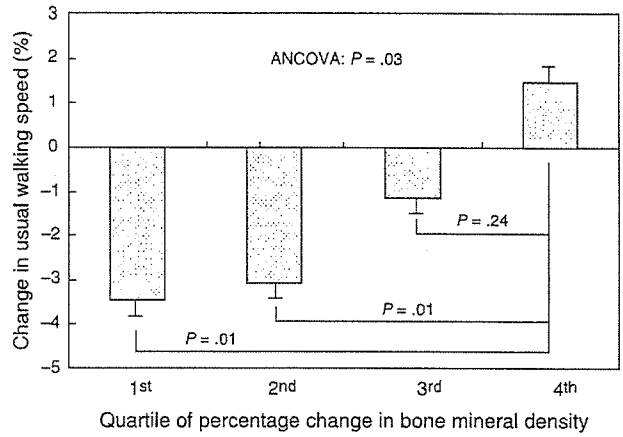

Figure 1. Associations between change in bone mineral density (expressed in quartiles) and change in usual walking speed during the 2-year follow-up. First quartile: −12.57 to −4.18; second quartile: −4.17 to −1.78; third quartile: −1.77–0.72; fourth quartile: 0.73–18.81. Annual percentage change = 100 × (data from 2004–data from 2002)/(data of 2002 × 2 (length of follow-up in years)). ANCOVA = analysis of covariance.

formance in a population-based random sample of 182 Japanese women aged 70 and older. It found that elderly women with more-rapid bone loss had a greater decline in usual walking speed.

To promote independence and to maintain quality of life in older people, the maintenance of physical performance, including muscle strength, balance capacity, and walking speed, is important.[1–4] Of these measures of physical performance, walking speed, especially usual walking speed, is the most sensitive predictor of functional dependence in older people.[3] Walking speed decreases with aging, is influenced by multiple factors, and should be modified through a lifestyle that strengthens muscles of the lower extremities.[4,17,18] For example, exercise and nutritional interventional interventions in relatively healthy community-dwelling elderly people have been shown to improve walking speed.[17,18]

BMD decreases with age, decreasing 1% per year after menopause in women,[19] although adequate dietary protein,[20] calcium and dairy,[21,22] and vitamin C intake;[23] weight maintenance;[21,23] higher BMI;[21] maintenance of daily physical activity;[21,22] supplementation;[24] and hormone replacement therapy[25] may contribute to healthy bones and prevent decline in bone mass.

Cross-sectional studies have reported that BMD in elderly people is significantly associated with physical performance.[9,10,12] Elderly women with lower BMD had significantly lower grip strength and knee extension power and poorer balance. These results suggest a strong role of maintaining muscular strength in the prevention of bone loss in healthy and functionally independent women. In the absence of neurological and degenerative disorders, poor physical performance in elderly people is likely to result from reduced physical activity, and a consequence of the reduced mechanical loading would be reduced bone mass and density.[9]

In the present study, elderly women with more-rapid bone loss during 2 years of follow-up had a greater risk of decline in usual walking speed than those with greater BMD. Because the directionality of the association between the change in mineral density and usual walking speed cannot be ascertained from this study design, the result does not imply that modification or improvement of BMD would have any effect upon walking speed. Intervention trials are needed to assess the effect of treatment of osteoporosis on walking speed and the effect of interventions targeting gait speed on bone density.

This study has some limitations. First, the characteristics of the subjects must be considered. Although the subjects analyzed were selected randomly from the population of an urban district, they were relatively healthy elderly persons who were able to travel from their homes to the health examination center at baseline and 2 years later. As a result, the present results may not be applicable to frail older people or those with multiple comorbidities who have low physical functional capacity. Second, BMD has been measured at virtually all available measurement sites (spine, proximal femur, forearm, whole body, calcaneus, and tibia) in other reports.[26] In the present study, only forearm BMD was used as indicator of bone loss. Therefore, the findings may not be directly comparable with those in other groups. To generalize this result, a more-comprehensive approach, including measuring bone mass at various sites in a large sample of elderly people and evaluating the associations between bone loss at different sites and changes in physical performance, is necessary. Forearm BMD measurement was chosen, because it is a quick, easy, and accurate method to evaluate the bone health of older people.[27] In addition, forearm BMD may be useful to assess osteoporosis in postmenopausal women because forearm BMD is significantly associated with BMD of the lumbar spine and hip.[28] Third, this study did not control for the type and dose of drugs that affect bone turnover, such as calcium, estrogens, vitamin D, and calcitonin, all of which may affect BMD. Finally, this study focused on the association between change in BMD and change in walking speed during the 2-year follow-up period and did not provide information on the cause-and-effect relationship. However, the relationship between the two parameters that were used in this study is expected to form a basis for further study. The number of elderly people with low bone mass and walking ability is going to increase in the future. Therefore, there will be an increasing need for strategies to strengthen these two parameters.

In conclusion, elderly women with more-rapid bone loss had greater decline in usual walking speed, even after multivariate adjustment including changes in muscle strength, balance capability, and other potential confounders. Further studies are needed to investigate the cause-and-effect relationship between BMD and walking speed.

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地域在住高齢者における運動習慣の定着に関連する要因

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■原著論文■

地域在住高齢者における運動習慣の定着に関連する要因

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抄録

地域に在住する高齢者の運動の開始および運動の継続に関連する要因について検討した．分析対象は，ベースライン調査および2年後の追跡調査に参加した65歳以上の高齢者1,029人（平均年齢72.0±5.9歳，男性436人，女性593人）とした．ベースライン調査で運動習慣ありと運動習慣なしに分類し，それぞれ別に分析を行った．多重ロジスティック回帰分析の結果，運動の開始には，男女で高齢者のグループ活動に参加していること，女性で歩行速度が速いことが関連した．一方，運動の継続には，男女共にグループ活動に参加していること，男性で肥満がないこと，痛みがないこと，外来通院をしていること，主観的健康感が高いこと，女性で肥満があること，趣味があることが関連した．高齢者における運動の開始や継続には，心身の健康維持や社会活動性が影響することが示された．

Key words：運動の開始，運動の継続，グループ活動，身体的健康，地域高齢者

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Ⅰ．緒　言

高齢期における運動は加齢に伴う体力の低下を抑制し[1,2]，精神的健康度の維持[3,4]，QOLの維持[5]に寄与する．さらに，運動は活動余命の延伸[6,7]，糖尿病の改善[8]，骨量の維持[9]，心疾患の予防や心疾患による死亡率の低下[10]，総死亡率の低下[11-14]に関連する．このように高齢期における運動は身体機能の改善だけではなく，健康の維持に有益な効果を及ぼし，健康的な加齢を導くとされている．

健康日本21[15]では，高齢期の身体機能の低下を予防するため，運動実施者の増加を目標として掲げている．1997年の国民栄養調査[16]によると，70歳以上の高齢者における運動の実施状況の割合は，男性36.2％，女性24.9％であったが，2002年の国民栄養調査[17]では，男性39.1％，女性32.6％であり，高齢者の運動実施率は増加していることが報告されている．

しかし一方で，高齢者における運動の定着は難しいことも示されている．高齢者を対象とした縦断調査によると，調査期間中，運動継続者は全体の41％，運動を中止した者は22％，期間を通して運動習慣のない者は25％であることが報告されている[18]．また，高齢者を対象に実施された運動介入研究によると，介入開始後3か月で20％が，最終的には36％が脱落すること[19]，また，運動介入期間中43％が脱落すること[20]が報告されており，高齢者の運動をいかにして長期にわたり継続させるかが問題である．

疫学調査による高齢者の運動の開始・継続の関連要因の検討では，性，年齢などの社会人口学的

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要因[18,21]，やけが[22]などの身体的要因，抑うつ傾向[18]などの精神的要因，運動ができる環境があるかどうか[21]などの環境的要因，活動的な友人や知人の存在といった社会交流などが関連要因としてあげられている．本研究ではこれらの先行研究を踏まえ，地域在住の高齢者を対象に，高齢者における運動の開始および運動の継続と，身体的要因，精神的要因，社会活動性との関連について縦断的に検討することを目的とした．

Ⅱ．対象と方法

1．対　象

対象は1998年に秋田県南外村（南外村総人口4,889人，65歳人口割合26.8％）に在住する65歳以上の高齢者を対象に実施した健診受診者であった．調査対象である秋田県南外村は県中央の山間にある農村であり，農業を主な産業としている．

本研究の対象は1998年の6月1日時点で特別養護老人ホーム入所者を除く65歳以上の村内に在住する高齢者1,290人（男性530人，女性760人）である．健診は村内の公民館および福祉施設で実施し，参加者は健診参加用の送迎バス，自家用車，自転車，徒歩，家族の送迎等を利用し参加できる程度に自立した高齢者であった．

本研究では1998年をベースライン調査とし，同様の調査方法を用いた追跡調査を2年後の2000年に実施した．ベースライン調査には，男性530人中480人（参加率90.6％），女性760人中663人（参加率83.3％）の計1,143人が参加した（表1）．このうち追跡調査に参加したのは，男性439人（追跡調査参加率91.5％），女性599人（同90.3％）の計1,038人であった．ベースライン調査参加者の追跡期間中の死亡数は，2000年までに男性25人，女性23人の計48人が確認された．ベースライン調査および追跡調査に参加した1,038人のうち，運動の実施状況の回答に欠損値のない1,029人（男性436人，女性593人）を解析対象とした．

本研究は，東京都老人総合研究所の長期プロジェクト研究「中年からの老化予防総合的長期追跡研究」の一環として行った．このプロジェクトは，地域の高齢者を悉皆かつ縦断的な方法で調査することにより，真の老化過程を観察し，その要因を見極め，高齢期の障害の予防およびQOLの向上のための手立てや施策の確立を目的としている．調査項目は，一般の医学健診項目に加え，社会的調査項目，心理的調査項目，身体的調査項目など多岐にわたる．調査方法ならびにその詳細についてはさきに報告されている[23]．

表1　ベースライン調査の参加人数と追跡調査時の転帰状況

		男性		女性		全体	
		人	(%)	人	(%)	人	(%)
1998年	調査対象者数	530		760		1,290	
	参加者数	480	(90.6)	663	(83.3)	1,143	(88.6)
2000年	参加	439	(91.5)	599	(90.3)	1,038	(90.8)
	拒否	0	(0.0)	1	(0.2)	1	(0.1)
	入院・入所	13	(2.7)	23	(3.5)	36	(3.1)
	長期不在	2	(0.4)	13	(2.0)	15	(1.3)
	死亡	25	(5.2)	23	(3.5)	48	(4.2)
	その他	1	(0.2)	1	(0.2)	2	(0.2)
	短期不在・留守	0	(0.0)	2	(0.3)	2	(0.2)
	不明	0	(0.0)	1	(0.2)	1	(0.1)
解析対象*		436	(90.8)	593	(89.4)	1,029	(90.0)

*解析対象者は追跡調査に参加した者のうち，運動の実施状況の回答に欠損のない者とした．また，解析対象の割合は1998年の調査参加者を元に算出した．

また，本研究は当研究所の倫理委員会の審査を経て実施され，対象者には研究の主旨と個人情報の厳守について十分な説明を行い，調査協力の同意を得た．

2．分析項目

本研究の分析項目は，性，年齢，Body Mass Index（kg/m^2；以下，BMI），通常歩行速度[24]，痛みの有無，外来通院の有無，主観的健康感，抑うつ度（15項目短縮版 Geriatric Depression Scale；以下，GDS）[25]，老研式活動能力指標[26]，老人クラブなどの高齢者のグループ活動への参加状況，趣味の有無とした．

通常歩行速度は，あらかじめ3mと8m地点に印をつけた11mの歩行路上で直線歩行を行い，3m地点を越えてはじめに足が接地してから8mを越えて接地するまでの時間を測定した．対象者への通常歩行の教示は「いつも歩いている速さで歩いて下さい」とした．

痛みについては，「普段，体のどこかに痛いところがありますか」という設問に対し，「ある」「ない」を選択肢とした．ここでは，頭痛，胸痛，腹痛などを除く筋骨格系の痛みについて聞き取りを実施した．外来通院については「あなたは，この1か月間に「医者・歯医者」や「はり・きゅう・あんま」などに通いましたか」という設問に対し，「通った」「通っていない」を選択肢とした．主観的健康感については「ふだん，ご自分で健康だと思われますか」という設問に対し，「非常に健康」「まあ健康なほう」「あまり健康ではない」「健康でない」を選択肢とした．グループ活動については，「老人のグループ活動にどの程度参加していますか」という設問に対し，「いつも」「ときどき」「たまに」「まったく参加していない」を選択肢とした．

なお，分析にあたり，各項目を以下のように2値に再分類した．主観的健康感については，「非常に健康」「まあ健康な方」を「健康」とした．高齢者のグループ活動への参加状況は，「いつも」「ときどき」「たまに」を「する」にした．趣味は，「ときどきする」「よくする」を「する」とした．抑うつ度については，カットオフポイントを5/6点におき，6点以上を「抑うつ傾向あり」とした[27]．

定期的な運動の実施については，聞き取り調査項目の「運動やスポーツを定期的にしていますか」の問いに対し，「している」「していない」のうちいずれか1つを選択させた．定期的な運動を「している」と回答した場合，その内容について「ゲートボール」「ジョギング」「テニス」「ゴルフ」「ハイキング」「ダンス」「水泳」「武道」「その他（自由回答）」から複数回答させた．また，頻度については，「週に何日行っていますか」の問いに対し「毎日」「5～6回」「週に2～4回」「1日以下」のいずれかを回答させた．本研究では運動やスポーツについては本人が運動と認識している身体活動とした．分析には運動の種目や頻度にかかわらず，上述の「運動やスポーツを定期的にしていますか」の問いに対し「している」と回答した場合を「運動習慣あり」「していない」と回答した場合を「運動習慣なし」とした．

運動実施状況の変化については，ベースライン調査時および追跡調査時の運動の実施状況で分類した（図1）．すなわち，ベースライン調査時に「運動習慣あり」のうち，追跡調査時に運動を実施していた場合を「運動継続」，運動を実施していない場合を「運動中止」とした．また，ベースライン調査時に「運動習慣なし」のうち，追跡調査時に運動を実施していた場合を「運動開始」，追跡調査時に運動を実施していない場合を「運動非実施」とした．

3．統計解析

運動の実施状況別の各変数の比較は，連続量については年齢を調整した共分散分析，離散量については年齢を調整したMantel-haenszel testを用いた．

ベースライン調査時から追跡調査時における運動の開始と運動の継続の関連要因を探索するた