機能低下者は記憶愁訴を有する傾向が強かった。地域在住の65歳から84歳の高齢者511人を対象としたJonker[26]は，MMSEを用いて認知機能を測定し，記憶愁訴と認知機能低下の関連について検討した。その結果，年齢，性別，知能検査得点により値を調整してもなお両者間には有意な関連が認められ，認知機能低下者は記憶愁訴を有する傾向が強かった。地域在住の75歳から95歳の高齢者1,435人を対象としたPalmer[33]は，年齢および教育歴を考慮したうえでMMSE総得点により認知機能低下者を選別し，記憶愁訴と認知機能低下の関連について検討した。その結果，両者間には有意な関連が認められ，認知機能低下者は記憶愁訴を有する傾向が強かった。

上記先行研究では記憶愁訴と認知機能低下の関連について男女を込みにして検討しているため，これらと男女別に解析を行った本研究結果とを直接的に比較することは困難であるが，男性において記憶愁訴と認知機能低下の関連が認められたという結果は，上記先行研究結果に一致し，記憶愁訴が認知機能低下の有用かつ簡便な指標となる可能性が示された。縦断的調査結果を用いた先行研究は，記憶愁訴が数年後の認知機能低下の発生を予測することを見出している[12,24,33,34]。本研究においても数年後に追跡調査を行い，記憶愁訴の認知機能低下に対する予測的妥当性（predictive validity[35]）について明らかにすることが今後の課題となる。

しかしながら本研究では，女性において，記憶愁訴と認知機能低下の関連は認められなかった。これは，女性において，認知機能の主観的評価である記憶愁訴と，認知機能の客観的評価である認知機能低下（MMSE総得点が24点未満で定義）が一致しなかったことを意味する。その理由の一つとして以下が考えられる。女性は男性に比して，情緒的に不安定で，また自身の疾病をより重篤なものと判断する傾向が強い[36]。それゆえ女性では，客観的評価では認知機能が正常であるにも関わらず，主観的には認知機能が低下していると判断するといった，両指標間における不一致が生じやすかったことが考えられる。

本研究では，記憶愁訴とうつ傾向の関連は男女ともに見いだされなかった。先行研究と本研究間における結果の差異は，うつ傾向を測定する尺度に起因する可能性が考えられる。先行研究では，Center for Epidemiologic Studies-Depression Scale (CES-D)やGeneral Health Questionnaire (GHQ)等のように，うつ症状の程度を定量化可能な尺度を使用しているのに対し[12,21,24,25,27]，本研究では，大うつ病のスクリーニングに用いられる尺度を利用してうつ傾向の定義を行ったため，値のとり得る範囲が小さく，両者間の関連が認められにくかったと考えられる。うつ傾向は記憶愁訴と認知機能低下の間に介在する重要な交絡要因である[11]。それゆえ，記憶愁訴と認知機能低下の関連について詳細に検討する際には，うつ症状の程度を定量化可能な尺度を合わせて実施する必要があると考えられる。

V　結　　語

本研究は，地域在宅高齢者を対象として行った断面調査の結果を用いて，地域在宅高齢者が抱える記憶愁訴の実態を把握することを目的とした。

記憶愁訴の出現頻度は，「ときどきある」もしくは「しょっちゅうある」と回答した者が，男性では，26.8%，女性では，31.6%であった。

記憶愁訴の主症状について分類したところ，「人名を忘れる」が全体の約1/4，「物品をどこに置いたか（しまったか）忘れる」が約1/5，「物品をどこかに置き忘れてくる」が約15%を占めた。また，展望的記憶に関する愁訴が全体の約1/4を占めることが明らかになった。

記憶愁訴の関連要因の探索を行ったところ，男性では，健康度自己評価，認知機能低下において，女性では，聴覚機能障害，健康度自己評価において，それぞれ記憶愁訴との関連が認められた。このことから，記憶愁訴は，認知機能以外の要因からも影響を受け生起することが示唆された。また，男性において，記憶愁訴と認知機能低下の関連が認められたことから，男性では，記憶愁訴が認知機能低下の有用かつ簡便な指標として機能する可能性が示された。今後は数年後に追跡調査を行い，記憶愁訴の認知機能低下に対する予測的妥当性について明らかにすることが課題となる。

本研究における対象者は健診の受診者であり（健診受診率43.5%），一般的な地域在宅高齢者と比較すると健康状態が良いと考えられるため，知

見の一般化には注意を要する。こうした知見の限界があるものの，本研究は地域在宅高齢者における記憶愁訴の実態を明らかにした国内では数少ない研究のひとつである。

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MEMORY COMPLAINTS AMONG COMMUNITY-DWELLING ELDERLY IN JAPAN: COMPREHENSIVE HEALTH EXAMINATION FOR THE COMMUNITY ELDERLY FOR PREVENTION OF THE GERIATRIC SYNDROME AND A BED-RIDDEN STATE ("OTASHA-KENSHIN") PART III.

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Key words : memory complaints, community-dwelling elderly, cognitive decline, prospective memory

Purpose Previous studies have indicated that memory complaints may predict cognitive decline and dementia among the elderly. The present study was therefore conducted to clarify memory complaint characteristics among elderly dwelling in an urban community in Japan.

Method The participants analyzed in the present study were 453 men and 385 women aged 70 to 84 years living in an urban Japanese community. Data on problems related to memory complaints, cognitive decline (below 24 points on Mini-Mental State Examination), depression (measured by Mini-International Neuropsychiatric Interview), hearing and vision problems, I-ADL (measured by TMIG Index of Competence), self-rated health, age, sex, and years of education were collected at a comprehensive mass health examination for the elderly ("*Otasha-kenshin*").

Results and Discussion Twenty-seven percent of male respondents and 32% of female respondents reported having current trouble remembering things (reported as "frequently" or "sometimes").

We collected specific descriptions of the memory complaint difficulties the subjects were experiencing. A quarter of the responses indicated problems with forgetting persons' names, a fifth with forgetting where things had been left, 15% with leaving things behind, and a quarter with prospective memory failure.

The results of multivariate logistic regression analysis to explore correlates showed that in men self-rated health and cognitive decline, and in women hearing problems and self-rated health were significantly and independently related to the memory complaint. These findings suggest that in addition to cognitive decline, self-rated health and hearing problems may influence memory complaints, and that memory complaints in men may be a reliable, simple indicator of cognitive decline. We now need to carry out a longitudinal study to clarify predictive validity.

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Osteoporosis Japan

地域高齢者における転倒と転倒恐怖感についての研究

―要介護予防のための包括的健診（「お達者健診」）調査より

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金　憲経　古名丈人　杉浦美穂
吉田祐子

はじめに

高齢期の生活の質（QOL）あるいは日常生活動作能力（ADL）を低下させる大きな要因として，老年症候群があげられる。この老年症候群とは，老化が進行し身体および精神機能が低下した高齢者において，単純に疾患に帰すことのできない高齢者特有に発生するさまざまな障害を意味し，転倒(骨折)，失禁，痴呆，うつ状態，低栄養，生活機能低下，せん妄，寝たきりなどが含まれる[1]。

なかでも転倒は頻度も高く，加齢に伴って増加し，かつ骨折という重篤な外傷をもたらすとともに，生活空間の狭小化をもたらし，いわゆる閉じこもりや身体の虚弱化を促進させる「転倒症候群」を容易に発生する。これらの多くの問題を含む高齢期における転倒予防は重要かつ緊急の課題となっている[2]。

われわれは，地域在宅高齢者における老年症候群の代表的症状であり，かつ自助努力により相当の改善の見込まれる，1)転倒，2)失禁，3)低栄養，4)認知機能低下，および，5)生活機能(ADLおよび手段的ADL)低下などについて，それらの効果的スクリーニング方法の開発，および予防対策(介入)プログラムの確立を目指した包括的健診（以下「お達者健診」と称する）を都市部に居住する70歳以上の住民2000人以上を対象として実践してきた。本研究の目的は，そのなかで転倒の頻度や原因，転帰危険因子の分析および転倒恐怖感との関連性についての分析を行うことである。

1　研究方法

1) 対象者

調査対象者，すなわち「お達者健診」対象者は東京都板橋区在住の70歳以上の在宅高齢者である。対象者は板橋区の住民基本台帳から無作為に抽出された高齢者約900名，および同区内5ヵ所にある老人保健福祉施設を利用している在宅高齢者約900名である。「お達者健診」を受診する者と非受診の者では当然バイアスの存在が考えられる。この点については受診者と非受診者の特性の比較をすでに報告している[3]。

2) 方　法

「お達者健診」東京都板橋区内5ヵ所の高齢者向け保健・福祉施設を中心として，対象者を会場に招待し，医学的健康調査および面接聞き取

Study on Fall and Fear of Falling in the Community Elderly

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Key words : Fall, Fear of falling, Prevention of geriatric syndrome, Comprehensive health check-ups, Community elderly

東京都老人総合研究所疫学・福祉・政策研究グループ

表1　過去1年間の転倒経験者の性，年齢階級別内訳

	70～74歳	75～79歳	80＋歳	計
男性	51/404	63/345	30/178	144/927
(%)	(12.6)	(18.3)	(16.9)	(15.5)
女性	114/563	93/475	47/236	254/1274
(%)	(20.3)	(19.6)	(19.9)	(19.9)

り調査を実施した。「お達者健診」の実施にあたっては，受診者1人あたり1.5時間から2時間ですべての調査が終了するよう，会場内の安全と導線に配慮し会場設営を行った。

今回分析を行った転倒に関する特性あるいは要因については，以下の項目を中心として分析されている[3,4]。

①性および5歳階級による年齢階級

②身長，体重および体格指数 (kg/m^2)

③転倒について（過去1年間の転倒経験の有無，転倒回数，転倒の原因，転倒によるケガの状況，転倒恐怖感の有無，の5項目）

④外出頻度（1日1回以上，2～3日に1回程度，1週間に1回程度，ほとんど外出しない，の4者択一）

⑤老研式活動能力指標（手段的ADL5項目，知的能動性4項目，社会的役割4項目の合計13項目）

⑥失禁の有無

⑦飲酒および喫煙の状況

⑧認知機能（MMSE：30点満点による）

⑨身体運動機能（握力，膝伸展力，通常歩行速度，最大歩行速度，手伸ばし試験の5項目）

今回対象とした板橋区在住の70歳以上の高齢者は無作為抽出による対象者ではなく，先に報告したように，受診者としてのいくつかのバイアスは存在しているものの，本論文の研究テーマである「転倒経験」については受診者と非受診者間で有意な差を示していないことを明らかにしている[3]（転倒経験者割合は受診者19.2%対非受診者18.6%：$\chi^2 = 0.04$，$p = 0.838$）。

2　研究結果

1）転倒の発生率

各性および年齢階級別転倒者数（割合）は**表1**に示す。

転倒発生率について男女間では明らかな有意差を認めた（$\chi^2 = 7.02$，$p < 0.01$）。しかし，年齢階級別の発生率については，男性では加齢に伴う増加の弱い傾向が示されたが（$\chi^2 = 4.80$，$p = 0.09$），女性では全く有意差はなく，各年齢階級ともほぼ20%で安定した発生率を示していた。転倒の発生回数については男女とも1～10回までばらついているが，1回のみの者は男性95名（66.4%），女性171名（67.8%）であり，2回以上の複数回転倒者はそれぞれ48名，81名であった。

2）転倒の原因と受傷状況

転倒時の状況あるいは原因については，男女とも「つまずいた」が圧倒的に多く，それぞれ35.4%，40.6%を占めている。次いで「滑った」あるいは「段差に気付かなかった」が続いている。それぞれの原因の割合に男女差は認められなかった。

転倒による結果あるいは受傷状況については，男女で受傷状況が明らかに異なっており，女性では「打撲」（34.7%）や「擦り傷」（25.2%）が多いが，男性では「何もなかった」が49.3%とほぼ半数を占め，女性よりも有意に割合が大きかった（$\chi^2 = 26.5$，$p < 0.001$）。また「骨折」については男性4.9%，女性11.0%であり，有意な性差を認めた（$\chi^2 = 4.35$，$p = 0.04$）。また女性の中には大腿骨頸部骨折を受傷した者が2名（1.0%）含まれていた。

表2　多重ロジスティック回帰分析によるオッズ比（95%信頼区間）

要因	カテゴリー / 単位	男性	女性
転倒恐怖感	0＝あり，1＝なし	0.66 (0.51-0.87) ***	0.83 (0.68-1.00) *
外出頻度	0＝週1回以上，1＝週1回以下	1.01 (0.31-2.77)	0.81 (0.31-1.83)
失禁	0＝あり，1＝なし	1.47 (0.87-2.41)	1.14 (0.08-1.59)
視力	0＝普通，1＝困難	1.29 (0.57-2.62)	0.64 (0.25-1.39)
喫煙	0＝吸う，1＝吸わない	0.85 (0.54-1.28)	0.97 (0.51-1.97)
飲酒	0＝飲む，1＝飲まない	0.86 (0.67-1.10)	0.85 (0.72-0.99) *
MMSE	0＝23以下，1＝24以上	0.30 (0.07-0.90)	0.79 (0.36-1.58)
年齢	歳	1.24 (0.95-1.62)	0.83 (0.67-1.03)
手段的自立	5点満点	1.00 (0.71-1.43)	0.87 (0.64-1.20)
握力	kg	0.96 (0.93-0.99) **	0.96 (0.92-0.99) *
最大歩行速度	m/sec	1.01 (0.58-1.74)	0.69 (0.43-1.12)
体格指数	kg/m^2	1.07 (1.00-1.14) *	0.99 (0.94-1.03)

数値は小数点第3位で四捨五入　$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$
目的変数は「転倒経験」の有無（0＝なし，1＝あり）

3）転倒恐怖感

「転ぶことが怖い」と感ずる転倒恐怖感については男性で367名(39.7%)，女性で830名(65.2%)が感じており，女性で特に高く有意な性差を示していた（$\chi^2=149.9$, $p<0.001$）。さらに，これら転倒恐怖感を有する者の中で日常の生活動作を「手伝ってもらう」者はそれぞれ15名(4.1%)，52名(6.3%)であった。また「外出を控える」者はそれぞれ26名(7.1%)，86名(10.4%)となっていた。これらについては有意な性差は認められなかった。

4）転倒発生に関する要因の分析

「お達者健診」での転倒に関連すると思われる調査項目（要因）別に転倒経験の有無（回数別）との単変量による分析では，男女ともに有意に関連のあった要因は，「転倒恐怖感」，年齢，老研式活動能力指標(総得点，および手段的自立，社会的役割の二つの下位尺度)，握力，通常歩行速度，最大歩行速度の6項目であった。さらに男性では「外出頻度」，および老研式活動能力指標(知的能動性)の2項目が有意な関連性を示していた。

目的変数を転倒経験の有無とし，転倒経験と有意であった要因を説明変数の中心に，多重ロジスティック回帰分析を男女別に行った（表2）。その結果，転倒の発生と有意に関連のあった要因は，男性では「転倒恐怖感」，握力，および体格指数であり女性では「転倒恐怖感」，飲酒と握力が抽出された。したがって男女ともに共通であった関連要因は「転倒恐怖感」と握力という二つの項目が抽出された。

3　考　　察

わが国のような高齢社会における保健施策として疾病(特に生活習慣病)の予防と，寝たきりなどの介護を要する状態となることの予防(「介護予防」)を通じ，健康寿命の延伸を図ることが重点的な目標となる。

転倒の頻度に関するデータは国内でも数多くの報告がなされている。なかでも，調査方法や項目をほぼ標準化し，地域在宅高齢者を対象とした転倒の年間発生率の調査報告[5]によれば，沖縄の都市部データを除くと男性が16～20%，女性が14～23%となっていたが今回のデータもほぼ合致している。

転倒の有無に関連する要因の多重ロジスティック回帰分析モデルによる結果から，男女ともに「転倒あり」に有意な関連要因として面接質問項目からは「転倒恐怖感」のあること，身体機能測定データからは握力が低下していること

の2項目が共通に抽出された。

地域高齢者の転倒恐怖感について調べたTinettiら[6]は，43%が転倒恐怖感を有し，19%が活動に影響があると報告している。また，Howlandら[7]は55%（146/266）が転倒恐怖感をもっており，恐怖感を有する者の中の56%（82/146）が転倒恐怖感のために活動が制限されると指摘した。わが国でも，転倒外来受診者におけるわれわれの研究からは，85.4%（35/41）が転倒恐怖感を有することが報告された[8]。

さらに，われわれの行った介護保険制度下における後期高齢期の要支援者の生活機能の特徴の分析的研究[9]からは，男性では93.1%，女性では93.8%が転倒恐怖感を有し，そのなかで転倒が怖くて外出を控える者は男性66.7%，女性60.4%と非常な高率に上っていることが明らかにされている。以上，先行研究や本研究結果から，われわれは，地域高齢者には老年症候群の包括的予防と基本的生活機能を高める支援のための健診が必要であるとともに，転倒および転倒恐怖感の解消を目指す介入プログラムの提供が必須であると結論した。

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第6回日本骨粗鬆症学会奨励賞受賞演題

高齢者における骨密度と脈波速度の関連性についての前向き追跡研究－骨粗鬆症は動脈硬化の促進に関与するか－

鈴木隆雄・吉田英世・金　憲経

はじめに

骨粗鬆症および動脈硬化症はいずれも加齢に伴い発症する。両者の関連性についてはこれまでも臨床的な視点，あるいは疫学的な視点から検討されてきた[1~5]。

今日われわれは，70歳以上の地域在宅高齢者を対象として，現在東京都老人総合研究所が進めている，要介護状態をもたらす老年症候群，特に転倒・骨折，失禁，低栄養，生活機能低下，ウツ状態，認知機能低下（あるいはMCI）を，早期発見・早期対応を行うための介護予防包括的健診（「お達者健診」）を実施している[6,7]。この「お達者健診」においては，骨粗鬆症および動脈硬化症もまた，要介護状態の要因としてそれぞれの代表的パロメータである骨密度と脈波速度の測定が行われている。

本研究では，骨粗鬆症発症に関連する低骨密度と，動脈硬化の進行すなわち脈波速度の上昇について，2年間の追跡調査を実施し，骨粗鬆症と動脈硬化症との関連性について分析を行った。

1　対象と方法

調査対象者は東京都老人総合研究所の実施している長期縦断研究のなかで，東京都板橋区内在宅の70歳以上の高齢者約2,000名である。今回の報告では，それらのなかで2001年に同区内で実施された「お達者健診」受診者438名を対象とし，2003年に行われた追跡調査における再受診者287名（男性114名，女性173名）についての分析である。健診内容は老年症候群に含まれるさまざまな項目についてハイリスク高齢者のスクリーニングが主体となっているが，循環器疾患発症に関する（標準化された）調査項目が含まれている他，骨粗鬆症の進行あるいは大腿骨頸部骨折発生についても，前腕骨密度の測定（DTX-200）を行い，さらにColin社製form PWV/ABIを用いて左右の動脈速度；brachial-ankle Pulse Wave Velocity（baPWV;cm/sec）も測定されている。これら対象者の特性や測定項目の詳細についてはすでに報告されている[6]。

分析方法については，2001年（ベースライン）に測定された骨密度（BMD）は，年齢5歳階級ごとに3分位（低値，中値，高値）に分け，また，2年間の骨密度の変化（⊿BMD＝BMD（2003年）－BMD（2001年））も，3分位（減少，不変，増加）に区分した。一方，脈波速度に関しては，2003年の脈波速度（PWV）および，脈波速度の変化（⊿baPWV＝baPWV（2003年）－baPWV（2001年））を動脈硬化の進展の結果とした。なお，統計学的検定には，一元配置分散分析を用いた。

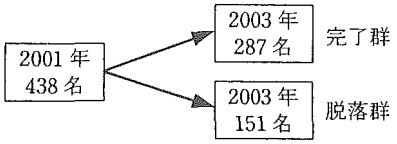
A Prospective Study on the Association of Low Bone Mineral Density and Increased Pulse Wave Velocity among the Community Elderly in Japan－Dose Osteoporosis Accelerate Atherosclerosis?

Takao Suzuki: Tokyo Metropolitan Institute of Gerontology

Key Words: Bone mineral density, Pulse wave velocity, Atherosclerosis

東京都老人総合研究所

表1 追跡期間中の脱落群と追跡完了群の比較



	男性			女性		
	完了群 167	脱落群 53（31.7%）	p 値	完了群 271	脱落群 98（36.2%）	p 値
平均年数	74.9	75.6	NS	74.6	75.8	$p<0.05$
BMI	23.4	23.1	NS	22.9	22.9	NS
PWV Lba	1876	1901	NS	1908	1945	NS
PWV Rba	1835	1853	NS	1819	1855	NS
BMD	0.466	0.439	NS	0.297	0.281	NS

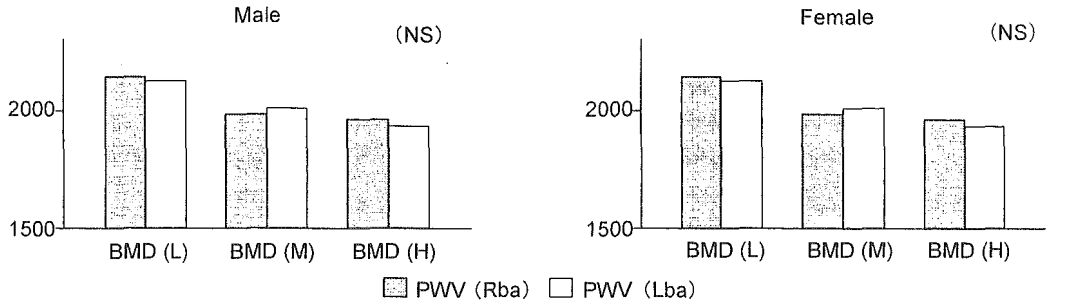


図1 ベースライン時のBMDのPWVに及ぼす影響

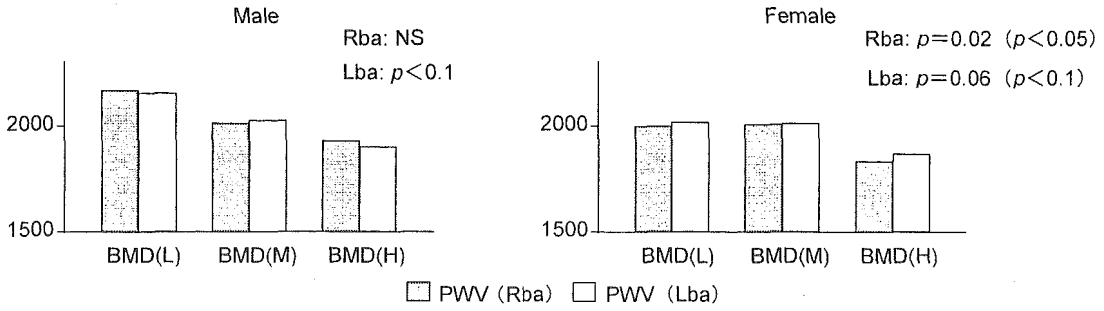


図2 追跡期間中⊿BMDのPWVに及ぼす影響

2 結　　果

①2001年から2003年の2年間における追跡期間中の脱落群と追跡完了群との間での初回調査時の主な測定変数(年齢，BMI，PWV，BMD)についての比較で，女性における年齢のみが有意($p<0.05$)であったが，男女ともに，BMI，PWV，BMDとも有意差は検出されなかった（表1）。

②初回調査時（2001年）の骨密度（BMD）と追跡時（2003年）の脈波速度（PWV）との関連性については，男女ともBMDを三分位としてみると，最も低い者（第1三分位）で最もPWVは高く，最も高いBMDでPWVは最も低かった。しかし，3群に有意差は認められなかった(図1)。

③初回調査時BMDと追跡期間（2年間）にお

けるPWVの変化（⊿PWV）との関連性においても男女とも②と同様である。すなわち，最低位のBMDで⊿PWVは最大であり，逆に最高位BMDは⊿PWVは最小となっていた。

④追跡期間中の骨密度の変化（⊿BMD）と追跡時のPWVとの関連性については⊿BMDを三分位にしてみると，最低位の⊿BMDでPWVは最高位となり逆に⊿BMDの最高位でPWVは最低位となり，その関連性は男女とも有意あるいは有意傾向を認めた（図2）。

⑤追跡期間中の⊿BMDの⊿PWVに及ぼす影響についても三分位でみてみると，男女ともに，最低位⊿BMDで最高位⊿PWVであり，最高位⊿BMDで最低位⊿PWVとなった。すなわち骨密度の減少が大きいほど，PWVの変化は小さいことが示された。

3　考察と結論

骨粗鬆症は生活習慣病，特にインスリン抵抗性に基因する疾病とほぼ同様の危険因子を有し，いずれも運動と栄養という生活習慣の変容により相当な予防効果を有していることは明らかである[8]。またいずれの疾患も検診での早期発見と早期治療が有効であり，予防戦略にも共通性を有している。最近骨粗鬆症の進展と動脈硬化の進展，あるいは動脈硬化に基づく循環器死亡との関連性が報告されるようになってきた。

今回対象とした70歳以上の比較的健康と判断される地域在宅高齢者についても，前腕骨密度と動脈伝導速度との横断的データに基づく関連性については以前報告したように骨密度低下と動脈硬化の進展が，他の要因を調整しても男性では弱い関連性が認められている。今回の縦断的データからの分析においては，

1）脱落群と完了群の間には男女ともにBMD，PWVに差はない

2）初回調査時のBMDが低い者ほど，2年後のPWVは高い

3）初回調査時のBMDが低い者ほど，2年後の⊿PWVは大きい

4）追跡期間中の⊿BMD減少が大きいほど，2年後のPWVは有意に高い

5）追跡期間中の⊿BMD減少が大きいほど，2年間の⊿PWVは大きい

という点が明らかとなり，要約すれば，初回調査において骨密度の低い者ほど，2年後の動脈硬化は進行しており，また追跡期間中の骨密度の減少の大きい者ほど，やはり動脈硬化は進行していたことが明らかとなった。

国内外においても低骨密度あるいは骨粗鬆症は動脈硬化の進展に寄与する，あるいは心血管系死亡イベントに関与するとの報告がなされており，今回の調査結果もこれらの先行研究を支持するものとなった。

以上のことから，骨密度の低下・減少は動脈硬化の進展に及ぼす影響の大きいことが示され，動脈硬化の予防の視点においても骨粗鬆症の予防の重要性が示された。

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Randomized controlled trial of exercise intervention for the prevention of falls in community-dwelling elderly Japanese women

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Abstract Falls are common in elderly people. Possible consequences include serious injuries and the post-fall syndrome, with functional decline and limitation of physical activity. The present randomized controlled study sought to clarify the benefits of a combined long-term and home-based fall prevention program for elderly Japanese women. The subjects were individuals aged over 73 years, living at home in a western suburb of Tokyo, who had attended a comprehensive geriatric health check. Persons with a marked decline in the basic activities of daily living (ADL), hemiplegia, or those missing baseline data were excluded. Fifty-two subjects who expressed a wish to participate in the trial were randomized, 28 to an exercise-intervention group and 24 to a control group. Baseline data for age, handgrip force, walking speed, total serum cholesterol, serum albumin, basic ADL, visual and auditory impairments, self-rated health, and experience of falls did not differ significantly between the two groups. Beginning from June 2000, the intervention group attended a 6-month program of fall-prevention exercise classes aimed at improving leg strength, balance, and walking ability; this was supplemented by a home-based exercise program that focused on leg strength. The control group received only a pamphlet and advice on fall prevention.

The average rate of attendance at exercise class was 75.3% (range, 64% to 86%). Participants showed significant improvements in tandem walk and functional reach after the intervention program, with enhanced self confidence. At the 8-month follow-up, the proportion of women with falls was 13.6% (3/22) in the intervention group and 40.9% (9/22) in the control group. At 20 months, the proportion remained unchanged, at 13.6% in the intervention group, but had increased to 54.5% (12/22) in the control group, which showed a statistically significant difference between the two groups (Fisher's exact test; $P = 0.0097$). The total number of falls during the 20-month follow-up period was 6 in the intervention group and 17 in the control group. We conclude that a moderate exercise intervention program plus a home-based program significantly decreases the incidence of falls in both the short and the long term, contributing to improved health and quality of life in the elderly.

Key words exercise intervention · geriatric exercise · home-based exercise · fractures

Introductions

A combination of osteoporosis and falls underlies most fractures in the elderly. In particular, falls account for 90% of the growing problem of femoral neck fractures [1]. Other forms of trauma such as bruises and sprains also have a high incidence, and a fear of falling (the "post-fall syndrome") leads to a marked decline in the activities of daily living (ADL) [2]. Falls are thus an important factor when considering quality of life (QOL) in the elderly. Predisposing risk factors include a gait deficit [3–12], visual impairment [13,14], the use of sedatives [4–15], and a history of falls [6–22]. In a long-term, longitudinal study of community-dwelling elderly people in Japan, "a history of a fall in the previous year" and "decreased free walking speed" were independent strong predictors of future falls [23]. Irrespective of age, maintaining muscle strength, balance, and walking ability seem to be important first steps in preventing falls.

An elderly person's gait is characterized by a decreased height of the swing phase and a decreased stride length [24], both changes probably increasing the individual's susceptibility to falls. Therefore, in addition to correcting visual acuity and eliminating adverse drug reactions, active correction of physical weakness, especially walking ability, should be a highly effective intervention both at individual and societal levels [25]. A recent review of 16 studies ranked the major risk factors for falls in the elderly, in descending order, as (1) muscle weakness, (2) a history of falls, (3) gait deficit, and (4)

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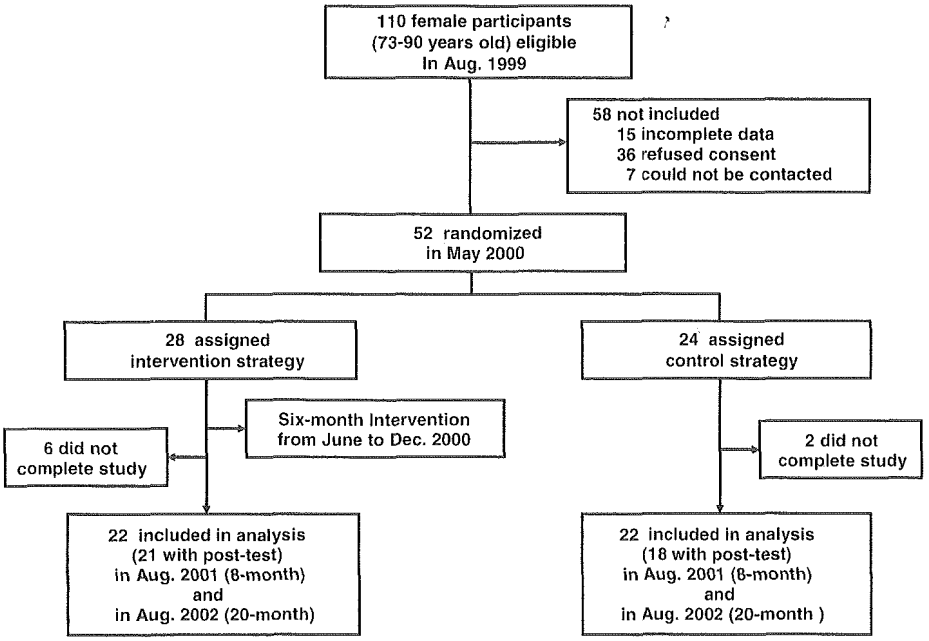

Fig. 1. Trial pofile

balance deficit [26]. The importance of addressing these risk factors as a practical preventive strategy has become widely recognized in Japan and elsewhere.

We therefore conducted a randomized controlled trial to examine the effectiveness of an intervention that aimed to improve overall physical function as a means of preventing falls. The two major goals of the intervention were (1) to improve muscle strength of the lower extremities and, thus, walking ability, and (2) to reduce the incidence of future falls through improvement of these physical attributes.

Subjects and methods

Subject sample

Subjects (Fig. 1) were selected from participants in the Tokyo Metropolitan Institute of Gerontology Longitudinal Interdisciplinary Study on Aging (TMIG-LISA), which was launched in 1991 [27,28]. In August 1999, 110 women, aged 73 to 90 years, living in Koganei City, a western suburb of Tokyo, attended a comprehensive geriatric health examination at the last survey in TMIG-LISA. Fifteen individuals were excluded for the following reasons: muscle strength could not be determined in 5 subjects, 5 had poor mobility due to hemiplegia, 2 had poorly controlled blood pressure, and 3 had communication difficulties due to impaired hearing.

In May 2000, a pamphlet containing information on "Fall Prevention Exercise Classes" was mailed to the remaining 95 subjects. Responses were obtained from 88 individuals; 52 agreed to join the exercise classes and 36 declined to participate. After obtaining informed consent, we allocated the 52 respondents randomly to an intervention group (n = 28) or a control group (n = 24). We expected the number of dropouts to be greater in the intervention group than that in the control group. Baseline data (August 1999) for age, handgrip force, walking speed, physical performance test scores, degree of dependence in basic ADL (moving, eating, personal toilet, dressing, bathing), and history of falls did not differ significantly between the two groups (Table 1).

The intervention group attended an exercise-centerd fall-prevention program, and also undertook a home-based exercise program aimed at enhancing muscle strength, balance, and walking ability. The control group received only a pamphlet and advice on the prevention of falls. Participants provided written informed consent to participate in this study, which the Institutional Review Board and Ethics Committee of the TMIG approved (Accepted, no. 12, June 8th, 1998).

Variables measured

Interview

An interview assessed the individual's history of fractures and falls over the previous year, basic ADL, instrumental ADL, and subjective changes in physical strength.

Measurements of physical function

Based on the items reported as effective in screening for falls in the elderly [3,29,30], and considering their

Table 1. Comparison of physical performance parameters (mean ± SD values) and questionnaire variables (%) at baseline survey in 1999 between control and intervention groups

Variables	Control group (n = 24)	Intervention group (n = 28)	P value*
Age[a]	78.45 ± 4.42	77.68 ± 3.41	0.477
NWS[b]	1.19 ± 0.24	1.19 ± 0.28	0.995
MWS[c]	1.73 ± 0.35	1.72 ± 0.34	0.869
GS[d]	21.38 ± 6.12	21.21 ± 4.36	0.913
STO[e]	23.83 ± 21.02	26.46 ± 22.00	0.663
STC[f]	4.33 ± 2.1	5.18 ± 4.47	0.378
TW[g]	8.79 ± 2.67	8.39 ± 3.51	0.651
FR[h]	27.81 ± 3.73	28.49 ± 4.49	0.562
KEP[i]	48.01 ± 13.49	49.90 ± 14.93	0.408
Fall[j]	16.7%	14.3%	0.556
ADL[k]	94.4%	100.0%	0.462

* Control group vs intervention group by t-test (a–i), and Fisher's exact test (j, k)
[a] Average age (years)
[b] Normal walking speed (m/s)
[c] Maximum walking speed (m/s)
[d] Grip strength (kg)
[e] Stork stand time with eyes open (s)
[f] Stork stand time with eyes closed (s)
[g] Tandem walking (steps)
[h] Functional reach (cm)
[i] Knee extension power (Nm)
[j] Fall experience within 1 year preceding baseline (%)
[k] Independence of basic ADL (%)

validity, reliability, and objectivity, the following items were selected to estimate muscle strength, balance, and walking ability.

Anthropometry
Height and body mass were measured, and the percentage of body fat was estimated by an impedance method (body fat analyzer, TBF-305; Tanita Tokyo, Japan).

Handgrip force
The peak handgrip force of each hand was determined to 5 kN, using a hand-held Smedley-type dynamometer.

Stork stand (eyes open)
While standing on a square (0.4 × 0.4 m), the subject either foot while watching a point set at eye level 1 m away, and tried to maintain this posture. A stopwatch measured the duration in seconds up to a maximum of 1 min, the longer of two attempts being recorded.

Stork stand (eyes closed)
The test was repeated, but with the eyes closed. The time was recorded up to a maximum of 30 s, the better of two attempts being noted.

Walking speed
A flat walking path of 11 m was marked with tapes at the 3-m and 8-m points. 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 line. The participants first took the test by walking at normal speed, and then by walking as fast as possible. Walking tests at both normal and maximum speeds were repeated and the faster speed was recorded in each walking test.

Tandem walking
A 2.5-m tape was affixed to a flat floor. The subject was instructed "to walk step-over-step" (walk with the tip of one foot touching the heel of the other foot). Note was taken of whether the subject could complete the 2.5-m walk; if successful, the number of steps and the time taken were also recorded.

Knee muscle power
The knee extension power (N) was measured in the dominant leg, using a hand-held dynamometer. The subject was asked to sit on a chair with the knee bent at a right angle. The dynamometer was placed at the ankle joint. The muscle strength was measured as the peak force during isometric extension when the subjects were asked to extend the knee by their maximum leg power. The test was carried out two times and the higher of two measurements made on the dominant leg was recorded.

Functional reach

The subject stood sideways against a wall in a natural position, and stretched both arms 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 subject 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 [31,32].

Intervention program

The intervention program comprised ten 1-h exercise sessions held at the community center once every 2 weeks for 6 months. Because this amount of exercise was insufficient to maintain and develop muscle strength, it was supplemented by an individual exercise program which subjects could practice at home. Participation was noted on a "Falls Prevention Exercise Record Card", which was brought to each of the formal exercise classes for confirmation. The following exercises were used.

Basic exercises

Before training, subjects participated in 10 to 15 min of warmup and stretching exercises, consisting of finger joining and pushing, bending the fingers backward, shoulder rotation, waist rotation, upward stretching, and lateral bending of the arms, forward bending, and other similar exercises.

Muscle strengthening of legs, waist, and abdomen

The muscle strengthening routine consisted of bending and flexing the ankles, raising the heels, bending the knees, raising one leg while lying on the back, raising both legs and bending backwards and forwards (while lying on the back), raising the upper part of the body while lying on the stomach, raising both knees (while lying on the stomach), and other similar items.

Balance and gait training

Gait training consisted of standing on one leg, shifting weight laterally from one foot to the other foot, and anterior-posterior weight shifting, performed in a position similar to a fencing position [33]. It also included side stepping on alternate legs and tandem walking. A wall or chair was used to provide a safe support when needed.

Resistance exercise

Moderate resistance training included two kinds of exercise, i.e., using a dumbbell (0.5-kg to 1.5-kg weights) and a rubber band (light-to-medium-resistance band). The dumbbell exercise was performed in a standing and/or chair-sitting position, with pushing up and down or pulling up and down at a resistance that permitted four to eight repetitions.

Exercises using the rubber band (Thera-Band, Sakai, Tokyo) included horizontal stretching of both arms with the band in front, up-and-down stretching with the band above the head, and sideways, striding exercise, and others.

Tai Chi exercise

In China, one of the most popular forms of Tai Chi is the Yang style. A 24-form simplified Tai Chi, based on Yang's system, was developed in 1965 by a group of Tai Chi experts. The subjects performed three to five basic forms, i.e., hand-holding and departing, one-hand pushing, empty step, backward-step, and clouding [34,35]. The duration of exercise was increased progressively to 30 min in the last three sessions.

Home exercise

Subjects were instructed to undertake home exercise with two to three sets of the 15 exercises which they had learned in the last session. They were also advised to do the home exercises at least three times a week for about 30 min per day. Subjects were asked to record the exercise times and number of sets performed on a "Fall Prevention Exercise Record Card".

Post-intervention measurements and follow-up

An interview and blinded physical function assessments were conducted at the end of the 6-month intervention. During the first 8 months of follow-up, the home-based exercise program was mailed monthly to each subject, and the "Fall Prevention Exercise Record Card" was returned by the participant. The number of falls was assessed by interviews conducted 8 and 20 months after the intervention.

Data analysis

As shown in Fig. 1, a total of 8 subjects dropped out (6 in the intervention group and 2 in the control group) during the entire follow-up period, and they could not be assessed at the end of the 6-month intervention or traced for falling events during the 20-month follow-up period. One of 22 subjects in the intervention group and 4 of 22 subjects in the control group failed to undergo physical function assessment at the end of the 6-month intervention (post-intervention measurements), but could be traced only for falling events during the 20-month follow-up period. Thus, among the 52 participants enrolled in this study, 44 (22 from the intervention group and 22 from the control group) responded twice to the outcome survey at 8 and 20 months after the

6-month intervention, and the information about falling events could be traced during the 20-month follow-up period.

Data were analyzed on an intention-to-treat basis. Means and SDs were calculated for each variable, and differences between the intervention and control groups were tested by *t*-tests. In samples with unequal variance, a *t*-test with Welch's correction was used. Repeated measures two-way analysis of variance (ANOVA) was performed on outcome variables. Significant interactions were examined (Scheffe's post-hoc analysis) to determine if effects were greater in the exercise or control group. A χ^2 test assessed the frequency of pre- and post-intervention events for the intervention and control groups. The proportions of women with falls during the follow-up period, for the intervention and the control groups, were also compared by χ^2 tests, except when cell sample sizes in the contingency table were small, in which case Fisher's exact test was used. All subjects who provided follow-up data at any time point were included in the analysis.

Results

Among 110 elderly female community living residents, 52 (47.3%) were recruited to participate in the study and were assigned to either an exercise group or a control group. As shown in Table 1, there were no sigsnificant differences between the two groups at baseline.

Of the 52 participants, 8 (6 in the intervention group and 2 in the control group) dropped out during the 6-month intervention period. Among the 6 dropouts (24.1%) in the intervention group, 4 complained of lumbago ($n = 2$) or knee pain ($n = 2$) and withdrew at an early stage of exercise intervention, and the remaining 2 dropped out later because of relocation or hospitalization due to worsening of hypertension. Table 2 compares the physical performance and baseline questionnaire data between the subjects in the intervention and control groups who completed the trial (without the dropouts in each group). There were no variables showing significant differences between the two groups, including fall experience within 1 year preceding the baseline survey, which had been confirmed to be a very strong predictor for future falls in our previous community-based cohort study [23].

Two persons (8.3%) in the control group dropped out because they did not wish to participate in the post-intervention measurements or to keep in contact during the follow-up period. It was impossible to trace all dropouts for the information about falling events. After the post-intervention measurements, there were no more

Table 2. Comparison of physical performance parameters (means ± SD) and questionnaire variables (%) at baseline survey in 1999 between subjects in the control and intervention groups who completed the trial

Variables	Control group ($n = 22$)	Intervention group ($n = 22$)	*P* value*
Age[a]	78.64 ± 4.39	77.31 ± 3.40	0.272
NWS[b]	1.18 ± 0.25	1.24 ± 0.23	0.365
MWS[c]	1.72 ± 0.35	1.80 ± 0.25	0.408
GS[d]	20.82 ± 5.65	21.82 ± 4.63	0.524
STO[e]	25.09 ± 21.33	29.59 ± 22.77	0.502
STC[f]	4.23 ± 2.07	5.73 ± 4.70	0.181
TW[g]	9.00 ± 2.62	9.23 ± 2.60	0.774
FR[h]	28.02 ± 3.80	29.04 ± 4.25	0.404
KEP[i]	47.11 ± 13.45	52.62 ± 15.42	0.214
Fall[j]	18.2	18.2	1.000
ADL[k]	95.5	100.0	1.000

* Subjects who completed trial *vs* dropouts in the intervention group, by *t*-test (a–i), and Fisher's exact test (j, k)
[a] Average age (years)
[b] Normal walking speed (m/s)
[c] Maximum walking speed (m/s)
[d] Grip strength (kg)
[e] Stork stand time with eyes open (s)
[f] Stork stand time with eyes closed (s)
[g] Tandem walking (steps)
[h] Functional reach (cm)
[i] Knee extension power (Nm)
[j] Fall experience within 1 year preceding baseline (%)
[k] Independence of basic ADL (%)

dropouts in either the intervention group or the control group. Thus, the two groups did not differ in the follow-up rate (Fisher's exact test; $P = 0.262$) or in reasons for dropout. Table 3 compares the physical performance and baseline questionnaire data between the subjects who completed the trial ($n = 22$) and dropouts ($n = 6$) in the intervention group. There were two variables (i.e. normal walking speed and knee extention power) showing significant difference between the two groups.

Attendance rate

Individual rates of attendance at the fall prevention exercise classes ranged from 64% to 86%, with a mean of 75.3%. Fifteen subjects (53.6%) attended all ten sessions. Six subjects who attended none to three times were regarded as failing to master the exercise program; the reasons were refusal to participate after randomization because of lumbago ($n = 2$), knee pain ($n = 2$), relocation ($n = 1$), and hospitalization ($n = 1$). Among the 22 subjects who completed the intervention, 21 subjects (95.5%) participated in more than seven sessions.

Interview survey

Change in physical fitness

When subjects were questioned about perceived changes in physical fitness, 28.6% of the intervention group (6 subjects) responded "improved", 57.1% (12 subjects) reported "no change", and 14.3% (3 subjects) responded "worsened". No subject in the control group responded "improved"; most (61.1%; 11 subjects) indicated "no change", but 38.9% (7 subjects) responded that their condition had "worsened".

Basic activities of daily living (BADL)

Before the intervention, 100% of the intervention group and 94.4% (17 subjects) of the control group were independent in BADL. After the intervention, 85.7% (18 subjects) in the intervention group were still independent, but 14.3% (3 subjects) were impaired, as compared to 88.9% (16 subjects) and 11.1% (2 subjects), respectively, in the control group.

Subjective changes in physical strength and confidence in fall prevention

Some 66.7% of exercise-class participants perceived that walking had stabilized, and 55.6% perceived that their leg muscles had become stronger during the program. Moreover, 61.1% were confident that they were able to prevent falling by themselves.

Physical function measurements

Comparison between intervention and control groups

Before the intervention, there were no statistically significant differences in muscle strength, balance, or walking ability between the intervention and control groups. After the intervention, there were significant differences in tandem walking (intervention group versus control group, 10.7 ± 0.86 versus 7.3 ± 3.46 steps) and functional reach (33.5 ± 4.7 versus 28.0 ± 4.6 cm). Knee extension power, though significantly increased after intervention in the intervention group, showed no significant difference in the comparison of the two groups.

Comparison of measurement changes between the intervention and control group

In comparison of measurements before and after the intervention, the intervention group developed significant gains in tandem walking (pre-intervention versus post-intervention: 9.24 ± 2.66 versus 10.67 ± 0.86 steps), functional reach (29.27 ± 4.22 versus 33.52 ± 4.70 cm), and knee extension power (52.12 ± 15.62 versus 56.81 ± 11.71 Nm; Fig. 2). The control group, in contrast, developed a significant decrease in handgrip force (pre-intervention versus post-intervention: 22.17 ± 5.57 versus 20.22 ± 4.21 kg), with no significant changes in any of the other variables.

Proportion of women with falls in each group, and numbers of falls during follow-up

Before the intervention, 16.7% (4 of 24 subjects) in the control group and 14.3% (4 of 28 subjects) in the intervention group had experienced falls (no significant difference). At the 8-month follow-up, the proportion of women with falls in the control group had increased to 40.9% (9 of 22 subjects), but had decreased to 13.6% (3 of 22 subjects) in the intervention group (Fisher's exact test, $P = 0.0883$). At the 20-month follow-up, the proportion of women with falls in the control group had increased to 54.5% (12 of 22 subjects), but remained unchanged, at 13.6% (3 of 22 subjects), in the intervention group (Fisher's exact test, $P = 0.0097$; Fig. 3). The number of falls sustained during the 20-month follow-up period was 6 in the intervention group and 17 in the control group. No subject in either group sustained a fracture.

Discussion

A Japanese national survey showed that the annual frequency of falls was greater than 20% in subjects aged over 65 years; approximately 10% of these falls resulted

Table 3. Comparison of physical performance parameters (means ± SD) and questionnaire variables (%) at baseline survey in 1999 between subjects who completed the trial and dropouts in the intervention group

Variables	Completed trial (n = 22)	Dropouts (n = 6)	P Value*
Age[a]	77.31 ± 3.40	79.00 ± 3.41	0.293
NWS[b]	1.24 ± 0.23	0.99 ± 0.36	0.047
MWS[c]	1.80 ± 0.25	1.41 ± 0.44	0.089
GS[d]	21.82 ± 4.63	19.00 ± 2.28	0.164
STO[e]	29.59 ± 22.77	15.00 ± 15.34	0.153
STC[f]	5.73 ± 4.70	3.17 ± 2.99	0.220
TW[g]	9.23 ± 2.60	5.33 ± 4.89	0.111
FR[h]	29.04 ± 4.25	26.04 ± 5.18	0.182
KEP[i]	52.62 ± 15.42	39.95 ± 7.33	0.011
Fall[j]	18.2	0.0	0.357
ADL[k]	100.0	100.0	—

*Subjects who completed the trial *vs* dropouts in the intervention group by t-test (a–i), and Fisher's exact test (j, k)
[a]Average age (years)s
[b]Normal walking speed (m/s)
[c]Maximum walking speed (m/s)
[d]Grip strength (kg)
[e]Stork stand time with eyes open (s)
[f]Stork stand time with eyes closed (s)
[g]Tandem walking (steps)
[h]Functional reach (cm)
[i]Knee extension power (Nm)
[j]Fall experience within 1 year preceding baseline (%)
[k]Independence of basic ADL (%)

in fractures [36]. Over 80% of femoral neck fractures in the elderly are caused by falls, and these usually require long-term hospitalization. Proposed methods of preventing fractures include increasing bone mineral density, preventing falls, and using appliances. Bone mineral density may be increased by either pharmacotherapy or exercise. However, most reports suggest that, in practice, it is difficult to use exercise for fracture prevention [37]. On the other hand, many studies agree that by strengthening the muscles and improving balance, exercise training can prevent falls that often cause fractures.

Walking ability is particularly important in preventing falls. Our recent 5-year follow-up study [23] showed that the incidence of falls was 26.3% in the group with a slow normal walking speed (0.96 m/s), compared with 11.4% in the group with a fast normal walking speed (1.28 m/s). Furthermore, a 1-m/s increase in walking speed lowered the risk ratio to 0.2 (95% confidence interval; 0.08 to 0.52) after adjusting for other variables. According to The Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT) study [38,39], muscle training and environmental modification were the most effective methods of preventing falls in the elderly. Gardner et al. [40] reviewed 11 randomized controlled trials based on a total of 4933 subjects aged over 60 years. Five of these trials found that exercise significantly reduced the incidence of falls or the risk of falling. Close et al. [41] conducted a randomized controlled trial on subjects aged over 55 years who were attending an emergency department because of falls, providing not only medical evaluation but also evaluation and interventions from the occupational therapy viewpoint. They achieved not only a reduced incidence of falls but also a reduction in the percentage of hospital admissions, indicating the effectiveness of practical approaches. Rubenstein et al. [42], in a randomized controlled trial, reported that, even for fall-prone elderly men with chronic impairments, a group exercise program (three times per week × 12 weeks) could significantly improve isokinetic strength, endurance, and gait, which resulted in a significant reduction of fall rates in the intervention group.

The types and intensities of exercise used in our study were chosen so that they could be implemented by the subjects themselves, at home. Home-based exercise is already known to be effective in preventing falls [43,44]. As a first outcome of our trial, we noted several perceived changes in functions. Over 50% of subjects in the intervention group perceived increased muscle power in their legs and approximately 70% also perceived greater stability when walking. Over 60% became

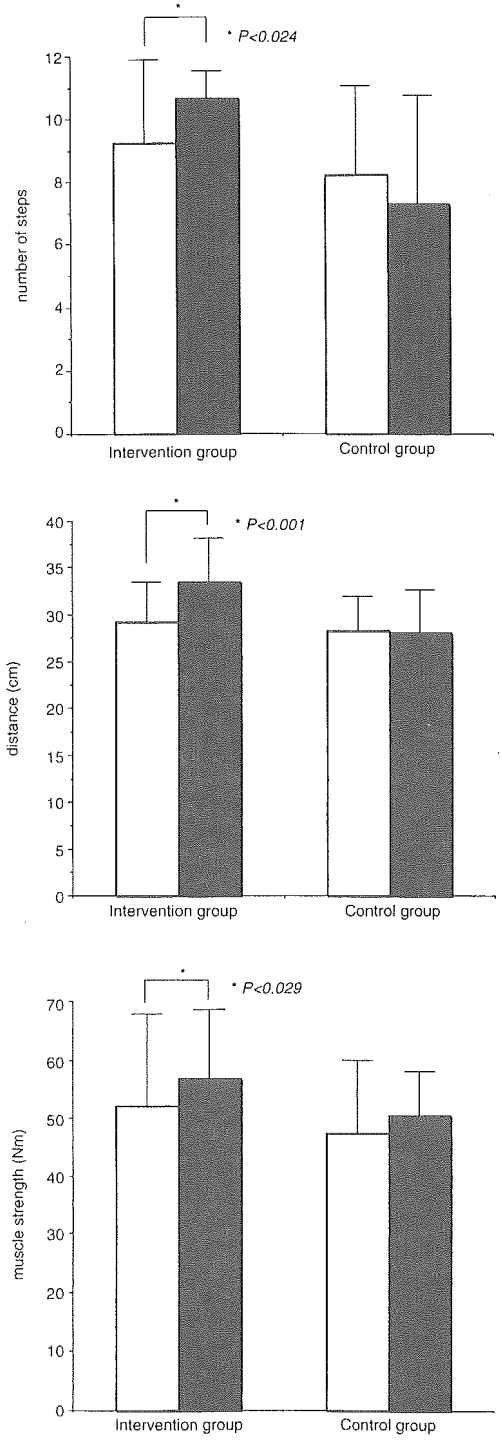

Fig. 2. Comparisons of physical performance parameters (number of steps in tandem walking, distance of functional reach, and muscle strength in knee extension power) in between intervention and control groups after 6-month intervention (paired *t*-test was used separately for both groups). *White bars*, pre-test; *black bars*, post-test

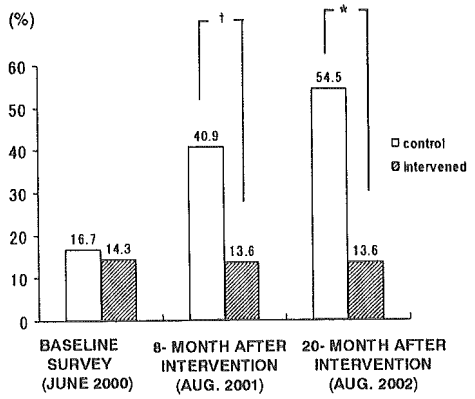

Fig. 3. Changes in proportions of women with falls (%), 8 and 20 months after intervention, in control (*white bars*) and intervention (*black bars*) groups. Fisher's exact test, $^{\dagger}P < 0.1$; $^{*}P < 0.05$

confident that they themselves could prevent falls, indicating an important psychological benefit from the program.

A second outcome was a significant improvement in dynamic balance and muscle strength in the lower extremities. Deficits in skeletal muscle strength, balance, and gait, being major causes of frailty and risk factors for falls, are equivalently and potentially reversible by exercise training. Binder et al. [45], in a randomized controlled trial, showed that intensive exercise training could improve those physical functions even in frail and impaired community elderly. In our study, it appears that an exercise class even once every 2 weeks is very effective in enhancing physical function in ambulatory individuals aged over 73 years, provided that it is supplemented by a home-based exercise program.

A third outcome was a significant reduction in the incidence of falls in the intervention group. This may translate into a smaller number of fractures, with resulting decreases in medical expenditure. In the control group, the cumulative incidence of falls was more than 50% over the 20-month follow-up period, a figure consistent with previous reports on the incidence of falls among elderly Japanese [13,36]. The beneficial effect of the intervention apparently continued not only over the short term (8-month follow-up) but also over the longer term (20-month follow-up).

In our study, there were some methodological weakness. First, the number of subjects was not sufficiently large, so that the incidence of falls during the follow-up period may have been influenced by chance. Second, the dropout rate of more than 20% in the intervention group may have produced a type-I error, as already reported by McMurdo et al. [46]. The high dropout rate in our randomized controlled trial may have reduced the statistical power to detect a significant effect of the

interventions for fall prevention among the elderly. In spite of these limitations, this first randomized controlled intervention study for prevention of falls among the community elderly in Japan suggests beneficial effects of long-tem moderate exercise to improve physical activity and to reduce the incidence of falls. A large-scale study is needed to confirm the present results and to evaluate the most effective exercises for the prevention of falls.

The general conclusion to be drawn from this study is that the incorporation of exercises in daily life is important in maintaining an appropriate level of physical function in the elderly. Integrating exercises in daily life can strengthen muscles in the legs, waist and abdomen, improve balance, and increase the individual's self-confidence.

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