Taniguchi W, Nakatsuka T, Miyazaki N, Yamada H, Takeda D, Fujita T, Kumamoto E, Yoshida M	In vivo patch-clamp analysis of dopaminergic antinociceptive actions on substantia gelatinosa neurons in the spinal cord.	Pain	152	95-105	2011
Nakao S, Minamide A, Kawakami M, Boden SD, Yoshida M	The influence of alendronate on spine fusion in an osteoporotic animal model.	Spine (Phila Pa 1976)	36	1446-1452	2011
Takiguchi N, Yoshida M, Taniguchi W, Hashizume H, Yamada H, Miyazaki N, Nishio N, Nakatsuka T	Distinct degree of radiculopathy at different levels of peripheral nerve injury.	Mol Pain	8	31	2012
Okada M, Minamide A, Yoshida M, Kawakami M, Enyo Y, Endo T	Observations in the diagnosis of cervical myelopathy in patients suffering from diabetes mellitus.	Spinal Cord	50	878-881	2012
Yamada H, Yoshida M, Hashizume H, Minamide A, Nakagawa Y, Kawai M, Iwasaki H, Tsutsui S	Efficacy of novel minimally invasive surgery using spinal microendoscope for treating extraforaminal stenosis at the lumbosacral junction.	J Spinal Disord Tech	25	268-276	2012
Enyo Y, Yamada H, Hoon Kim J, Yoshida M, Hutton WC	Microendoscopic Lateral Decompression for Lumbar Foraminal Stenosis: A Biomechanical Study.	J Spinal Disord Tech			in press
延與良夫、吉田宗人、山田宏、南出晃人、中川幸洋、河合将紀、岩崎博、遠藤徹、中尾慎一、吉村典子、岡敬之、村木重之、馬淵昭彦、中村耕三、川口浩	：腰椎における加齢変化の縦断的検討-山村地域住民における15年のコホート追跡結果より-	日脊会誌	19	383	2008
延與良夫、吉田宗人、吉村典子、村木重之、岡敬之、馬淵昭彦、中村耕三、川口浩	頚椎症における高位別有病率と頚部痛との関係 -Research on Osteoarthritis against Disability (ROAD)プロジェクト-	日整会誌	82	S163	2008
延與良夫、吉田宗人、山田宏、橋爪洋、南出晃人、中川幸洋、河合将紀、岩崎博、筒井俊二、石元優々、長田圭司、吉村典子、村木重之、岡敬之、中村耕三、川口浩	山村・漁村地域における頚部神経根症の疫学調査 -Research on Osteoarthritis Against Disability(ROAD) Project-	日脊会誌	20	49	2009
延與良夫、山田宏、中川幸洋、南出晃人、岩崎博、河合将紀、遠藤徹、中尾慎一、吉田宗人	山村地域のおける頚椎症性神経根症の疫学調査 有病率と頚椎症性変化との関係− ROADプロジェクト−	日整会誌	83	S85	2009

綿貫匡則、筒井俊二、延與良夫、山田宏、吉田宗人、吉村典子	山地域住民コホートを用いた腰椎変性側彎症新規発生例の前向き研究　単純レ線像からみた側彎進行の予後予測	中部整災雑誌	52:秋季学会号	118	2009
長田圭司、吉田宗人、山田宏、橋爪洋、南出晃人、中川幸洋、河合将紀、岩崎博、筒井俊二、延與良夫、遠藤徹、中尾慎一、木岡雅彦、石元優々、川上守、吉村典子	腰部脊柱管狭窄症患者に見られる深部感覚障害についての臨床的研究	日脊会誌	20	550	2009
長田圭司、吉田宗人、山田宏、橋爪洋、南出晃人、中川幸洋	腰部脊柱管狭窄症患者に見られる深部感覚障害についての臨床的研究（重傷度との相関）	中部整災雑誌	52巻春季学会号	92	2009
吉田宗人	腰部脊柱管狭窄症に対する黄色靱帯正中スプリット切除法	整形・災害外科	52	774-776	2009
吉田宗人，河合将紀，左海伸夫，野村和教，中尾慎一，貴志真也	腰椎疾患(椎間板ヘルニア)患者をいかに早期にスポーツ復帰させるか？腰部椎間板ヘルニアに対する内視鏡下手術　スポーツ選手の早期復帰への取り組み	日本整形外科スポーツ医学会雑誌	29	230	2009
山田宏、吉田宗人、南出晃人、中川幸洋、河合将紀、岩﨑博、遠藤徹、延與良夫、中尾慎一	いわゆるFar-out syndrome（腰仙椎移行部の椎間孔外狭窄）の臨床所見	臨床整形外科	44	593-598	2009
山田宏、吉田宗人、南出晃人、中川幸洋、河合将紀、岩﨑博、遠藤徹、安藤宗治、麻殖生和博、延與良夫、中尾慎一	腰仙椎移行部の椎間孔外狭窄症に対する後方侵入脊椎内視鏡手術の治療成績	臨床整形外科	44	1039-1047	2009
山田宏、吉田宗人、南出晃人、中川幸洋、河合将紀、岩﨑博	脊椎内視鏡を用いた腰椎椎間孔外狭窄症に対する低侵襲手術	中部整災誌	52	873-874	2009
南出晃人、吉田宗人、山田宏、中川幸洋、河合将紀、岩崎博	頸髄症患者に対する内視鏡下頸椎後方除圧術の現状と臨床成績	中部整災誌	52	1259-1260	2009
南出晃人、吉田宗人、山田宏、中川幸洋、河合将紀、岩崎博	頸髄症に対する内視鏡下後方除圧術の臨床成績	臨整外	44	1125-1131	2009

中川幸洋、吉田宗人、川上守、安藤宗治、山田宏、南出晃人、麻殖生和博、河合将紀、岩崎博、延與良夫、岡田基宏、遠藤徹、中尾慎一	腰椎後方内視鏡手術における閉鎖式ドレーン留置についての前向き調査	臨整外	44	1269-1274	2009
中川幸洋、吉田宗人、山田宏、橋爪洋、南出晃人、河合将紀	後方脊椎内視鏡手術における超音波骨メスの使用経験	脊椎脊髄手術手技	11（1）	40-43	2009
中川幸洋、吉田宗人、山田宏、橋爪洋、南出晃人、河合将紀	頚椎症性神経根症に対する内視鏡下椎間孔拡大術―短期成績の向上と低侵襲化のための工夫―	中部整災誌	52	493-494	2009
中川幸洋、吉田宗人、山田宏、橋爪洋、南出晃人、河合将紀	腰部脊柱管狭窄症に対する後方内視鏡下除圧術 - 単椎間除圧例と多椎間除圧例についての比較検討-	中部整災誌	52	877-878	2009
中川幸洋、吉田宗人、山田宏、橋爪洋、南出晃人、河合将紀、岩崎博、筒井俊二、遠藤徹、木岡雅彦	脊椎内視鏡手術後の術後せん妄発生について	日本脊髄障害医学会誌	22	110-111	2009
西秀人、橋爪洋、吉田宗人	リウマチ頚椎病変に発生した非骨傷性中心性頚髄不全損傷の1例	日本脊髄障害医学会誌	22	34-35	2009
岩﨑博、吉田宗人、山田宏、安藤宗治、遠藤徹、中尾慎一	特集：腰椎外側部神経障害の診断と治療　Far-out syndromeの診断法	整・災外	52	1081-1087	2009
岩﨑博、山田宏、吉田宗人	整形トピックス　腰椎椎間孔外狭窄病変に対する新しい電気生理学的診断法の試み	整形外科	60	130	2009
岩﨑博、山田宏、遠藤徹、南出晃人、中川幸洋、吉田宗人	肥満患者における脊椎内視鏡下手術の有用性	整形外科	60	251-253	2009
岩﨑博、吉田宗人、山田宏、延與良夫、南出晃人、中川幸洋	手術手技　私のくふう　腰椎椎間孔内狭窄に対する内視鏡下椎間孔拡大術	臨床整形外科	44	1107-1114	2009
岩﨑博、遠藤徹、中尾慎一、河合将紀、中川幸洋、南出晃人、山田宏、吉田宗人	電気生理学的手法を用いた腰椎椎間孔外狭窄病変の新しい診断法	脊髄機能診断学	30	125-128	2009
岩﨑博、山田宏、吉田宗人、南出晃人、中川幸洋、河合将紀	腰椎椎間孔内狭窄に対する内視鏡下後方除圧術の経験.	中部日本整形外科災害外科学会雑誌	52	577-578	2009

岩﨑博、吉田宗人、山田宏、遠藤徹、橋爪洋、南出晃人	新しい電気生理学的評価法による腰椎椎間孔外狭窄の診断	中部日本整形外科災害外科学会雑誌	52	1233-1234	2009
高見正成、吉田宗人、山田宏、南出晃人、中川幸洋、安藤宗治	Posterior expansive cervico-thoracic laminoplastyで症状悪化を来した頚胸椎連続型後縦靭帯骨化例の検討	中部日本整形外科災害外科学会雑誌	52	131-132	2009
吉田宗人	内視鏡下腰椎椎間板ヘルニア摘出術	脊椎脊髄ジャーナル	22	1211-1215	2009
山田宏、吉田宗人、南出晃人、中川幸洋、河合将紀、岩崎博	いわゆるFar-out syndromeに対する脊椎内視鏡下後方除圧術	整形・災害外科	52	1089-1097	2009
山田宏、吉田宗人	透析性脊椎症手術例の周術期管理と合併症対策	脊椎脊髄ジャーナル	22	1049-1053	2009
南出晃人、吉田宗人	Failed back surgeryの原因と再手術手技 -腰椎椎間板ヘルニアの再手術の原因とrevision手技	脊椎脊髄ジャーナル	22	826-833	2009
中川幸洋、吉田宗人	脊椎内視鏡手術における背筋にやさしい工夫	整形外科最小侵襲ジャーナル	53	9-13	2009
野村和教、吉田宗人	腰椎椎間板ヘルニアに対する内視鏡下椎間板摘出術（MED法）	整形外科看護	14	1185-1192	2009
橋爪洋、吉田宗人	ロコモティブシンドロームの要因としての運動器疾患の診断と治療− 腰部脊柱管狭窄(症)	Modern Physician	30	525-529	2010
橋爪洋、吉田宗人	【内科医のための腰部脊柱管狭窄症の必須知識】プライマリ・ケア医として、知っておいて欲しいこと　5. 日常生活指導	Modern Physician	31	1076-1078	2011
石元優々、山田宏、橋爪洋、長田圭司、吉田宗人	【特集：腰部脊柱管狭窄症の問題点とその対策】疫学研究の問題点とその対策	整形・災害外科	54	1011-1014	2011
Yamada Y, Ando F, Shimokata H	Association of genetic variants of MAOA and SH2B1 with bone mineral density in community-dwelling Japanese women	Molecular Medicine Reports	1	269-274	2008
Wakao N, Harada A, Matsui Y, Takemura M, Shimokata H, Mizuno M, Ito M, Matsuyama Y, Ishiguro N	The effect of impact direction on the fracture load of osteoporotic proximal femurs.	Med Eng Phys	31	1134-1139	2009

Doyo W, Kozakai R, Kim H-Y, Ando F, Shimokata H	Spatio-temporal components of the three-dimensional gait analysis of community-dwelling middle-aged and elderly Japanese: age- and sex-related differences.	Geriat Gerontol Int	11	39-49	2011
Kuzuya M, Enoki H, Hasegawa J, Izawa S, Hirakawa Y, Shimokata H, Iguchi A	Impact of caregiver burden on adverse health outcomes in community-dwelling dependent older care recipients.	Am J Geriat Psych	19	382-391	2011
Sugiura M, Nakamura M, Ogawa K, Ikoma Y, Ando F, Shimokata H, Yano M	Dietary patterns of antioxidant vitamin and carotenoid intake associated with bone mineral density: findings from post-menopausal Japanese female subjects.	Osteoporosis Int	22	143-152	2011
Terabe Y, Harada A, Tokuda H, Okuizumi H, Nagaya M, Shimokata H	Vitamin D Deficiency in Elderly Women in Nursing Homes: Investigation with Consideration of Decreased Activation Function from the Kidneys.	J Am Geriatr Soc	60	251-255	2012
Kozakai R, Ando F, Kim HY, Rantanen T, Shimokata H	Regular exercise history as a predictor of exercise in community-dwelling older Japanese people.	J Phys Fitness Sports Med	1	1-8	2012
Matsui Y, Takemura M, Harada A, Ando F, Shimokata H	Divergent significance of bone mineral density changes in aging depending on sites and sex revealed through separate analyses of bone mineral content and area.	J Osteoporos	2012	1-6	2012
Hida T, Ishiguro N, Shimokata H, Sakai Y, Matsui Y, Takemura M, Terabe Y, Harada A	High prevalence of sarcopenia and reduced leg muscle mass in Japanese patients immediately after a hip fracture.	Geriat Geront Int	13	413-420	2013
下方浩史、安藤富士子	疾患ゲノム研究の現況：骨粗鬆症	CLINICAL CALCIUM	18	155-161	2008
安藤富士子、下方浩史	骨粗鬆症の危険因子：疫学研究の成果を生かして	Medicina	45	430-433	2008
松井康素、下方浩史	ビタミンAと骨	THE BONE	22	41-45	2008
下方浩史、安藤富士子	サプリメントの有効性の疫学研究	公衆衛生	73	25-30	2009

安藤富士子、西田裕紀子、下方浩史	認知機能の加齢変化－国立長寿医療センター研究所・老化に関する長期縦断疫学研究（NILS-LSA）より	アンチエイジング	6	16-22	2010
竹村真里枝、松井康素、原田教、安藤富士子、下方浩史	一般住民における動脈硬化と骨粗鬆症の関連	Osteoporosis Jpn	18	228-231	2010
下方浩史、安藤富士子	疾病予防のための理想的生活．生活習慣改善による疾病予防－エビデンスを求めて	成人病と生活習慣病	40	1026-1031	2010
下方浩史、安藤富士子	運動器疾患の長期縦断疫学研究．ロコモティブシンドロームと生活習慣病	Progress in Medicine	30	3021-3024	2010
下方浩史、安藤富士子	運動器疾患の長期縦断疫学研究．ロコモティブシンドローム　－運動器科学の新時代	医学のあゆみ	235	319-324	2011
金興烈、李成喆、森あさか、安藤富士子、下方浩史	歩行速度（無次元速度）の性差と年代差に関する考察	日本未病システム学会誌	16	254-257	2011
李成喆、金興烈、森あさか、安藤富士子、下方浩史	地域在住中高年者の下肢筋力と重心動揺の関連に関する横断的検討	日本未病システム学会誌	16	246-249	2011
安藤富士子、北村伊都子、金興烈、李成喆、下方浩史	潜在性慢性炎症と中高年者のサルコペニアに関する縦断的検討	日本未病システム学会誌	16	250-253	2011
下方浩史、安藤富士子	サルコペニアの疫学	Modern Physician	31	1283-1287	2011
下方浩史、安藤富士子	虚弱の危険因子、高齢者の虚弱－評価と対策－	Geriatric Medicine	49	303-306	2011
下方浩史、安藤富士子	運動器疾患の長期縦断疫学研究－運動器科学の新時代	医学のあゆみ	235	319-324	2011
下方浩史	高齢者の疾病－疫学、臨床的特徴	日本医事新報	4544	42-45	2011
下方浩史、安藤富士子	日常生活機能と骨格筋量、筋力との関連．サルコペニア－研究の現状と未来への展望	日本老年医学会雑誌	49	195-198	2012
下方浩史、安藤富士子	疫学研究からのサルコペニアとそのリスク－特に栄養との関連	日本老年医学会雑誌	49	721-725	2012
安藤富士子、今井具子、加藤友紀、大塚礼、松井康素、竹村真里枝、下方浩史	血清カロテノイドと2年後の骨粗鬆症／骨量減少発症リスクに及ぼす影響	日本未病システム学会雑誌	18	89-92	2012

松井康素、竹村真里枝、原田教、安藤富士子、下方浩史	地域在住中高齢者の膝関節変形と膝伸展筋力との関連	Osteoporosis Jpn			in press
下方浩史，安藤富士子	検査基準値の考え方－医学における正常と異常－	日本老年医学会雑誌			in press
幸篤武、安藤富士子、下方浩史	サルコペニア、虚弱の疫学－日本人データから	Bone Joint Nerve			in press
下方浩史，安藤富士子	健康長寿社会を築く長期縦断疫学研究	日本未病システム学会雑誌			in press
大塚礼、下方浩史、安藤富士子	高齢者の栄養に関する疫学研究	Geriatric Medicine			in press

Ⅲ. 研究成果の刊行物・別刷

XI 大規模臨床試験の概要・住民コホート研究の概要

LOCOMOスタディ

The longitudinal cohorts of motor system organ (LOCOMO) study

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Key words：コホート，要介護，運動器障害，発生率，有病率

はじめに

介護予防対策の推進により健康寿命を延伸し，膝痛・腰痛・骨折などの運動器障害による要介護高齢者を低減させるためには，運動器障害とその主要原因疾患(変形性膝関節症(KOA)，変形性腰椎症(LS)，骨粗鬆症(OP))に関する日本人の疫学エビデンスを構築し，危険因子を解明することが必須であるが，それらは皆無に近かった．

そこで厚生労働科学研究費補助金(長寿科学総合研究事業)により，平成20年度に‘膝痛・腰痛・骨折に関する高齢者介護予防のための地域代表性を有する大規模住民コホート追跡研究’班(主任研究者 吉村典子)が立ち上がることとなった．研究班では，膝痛，腰痛，ならびにその原因疾患であるKOA，LS，OPによる大腿骨頸部骨折，脊椎椎体骨折などの発生率，有病率の推移，予後などの疫学指標を確立し，危険因子を同定すること，更に日常生活活動度(ADL)，生活の質(QOL)や要介護度との関係を検証しエビデンスを解明することを主目的としている．

この目的を達成するために，研究班では，まず地域代表性をもち骨関節疾患を予防目的として運営されてきた全国の9コホート，すなわち，東京1，東京2，和歌山，広島，三重，新潟，秋田，群馬，愛知のうち，8コホートの情報を統合した大規模統合コホートの構築を行い，愛知コホートを検証コホートとし，この一連の研究を，the longitudinal cohorts of motor system organ(LOCOMO)スタディと名づけた．

本稿では，LOCOMOスタディの概要とそれによる成果について報告する[1)]．

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表1 大規模統合コホートの地域・性別参加者数

地域コホート	総数	男性	女性
東京①	1,350	465	885
和歌山(山村)	864	319	545
和歌山(漁村)	826	277	549
広島	2,613	794	1,819
三重	1,175	423	752
新潟	1,474	628	846
東京②	1,453	59	1,394
秋田	852	366	486
群馬	1,412	628	784
総計	12,019	3,959	8,060

1 LOCOMOスタディの構築

LOCOMOスタディは，我が国において骨関節疾患予防を目的として行われてきた代表的な8コホート，すなわち東京1，東京2，和歌山，広島，三重，新潟，秋田，群馬の情報統合データベースと，統合コホートで得られた結果の妥当性を検証するため検証コホート(愛知)からなる．検証コホートでは，大規模統合コホートと同様のベースライン項目の解析，および同内容の追跡調査を行い，大規模統合コホートの結果の妥当性を確認することとした．

LOCOMOスタディで，ベースラインデータ共通項目として統合しえた項目は以下のとおりである：

(1) ID，性別，アンケート実施年月日
(2) ベースライン時年齢
(3) 身長，体重，体格指数(body mass index (BMI)，kg/m^2)
(4) 飲酒，喫煙
(5) 膝痛，腰痛の有無
(6) 転倒の有無
(7) 骨折の既往
(8) 骨密度
(9) 閉経年齢
(10) 膝X線結果
(11) 腰椎X線結果
(12) 脊椎圧迫骨折(X線)結果

更にこれらの追跡を行い，要介護認定の有無および要介護認定の時期を特定し，要介護移行率を推定した．

2 LOCOMOスタディ参加者の背景要因

LOCOMOスタディ統合コホートを形成する8コホートにおいて，無記名化データの抽出，統合を行い，12,019人(男性3,959人，女性8,060人)からなる大規模統合コホートデータベースの構築に成功した．**表1**にそのコホート別参加者数を，**表2**に性・年齢別分布を示す．参加者数として最も多いのは70歳代(41.9%)であり，続いて60歳代(26.4%)，80歳代(17.6%)であった．

表3に統合対象者の特徴を示す．参加者の平均年齢は男性70.0歳，女性71.0歳となり，女性に高かった($p<0.001$)．また平均身長，平均体重はいずれも男性の方が高かったが，体格指数であるBMIは男性22.8kg/m^2，女性23.0kg/m^{2}となり，女性に有意に高かった($p<0.01$)．喫煙率，飲酒率はいずれも男性に高かった($p<0.001$)．

3 要介護移行率の推定と危険因子

LOCOMOスタディ統合コホート12,019人のデータベースから，要介護認定の有無および要介護認定の時期を特定できた5コホート6地

表2 大規模統合コホートの性・年齢別参加者数

年齢（歳）	総数（%）	男性（%）	女性（%）
−19	1(0.01)	1(0.03)	0(0.00)
20−29	35(0.3)	16(0.4)	19(0.2)
30−39	89(0.7)	32(0.8)	57(0.7)
40−49	483(4.0)	183(4.6)	300(3.7)
50−59	963(8.0)	320(8.1)	643(8.0)
60−69	3,170(26.4)	1,161(29.3)	2,009(24.9)
70−79	5,041(41.9)	1,573(39.7)	3,468(43.0)
80−89	2,111(17.6)	627(15.8)	1,484(18.4)
90−	126(1.1)	46(1.2)	80(1.0)
総計	12,019(100.0)	3,959(100.0)	8,060(100.0)

表3 大規模統合コホート参加者の身体特性

項目	男性	女性
年齢(歳)	70.0(10.6)	71.0(10.3)
身長(cm)	161.1(6.8)	148.5(6.4)
体重(kg)	59.3(9.5)	50.8(8.6)
BMI(kg/m^2)	22.8(3.0)	23.0(3.5)
喫煙[%]	34.0	4.8
飲酒[%]	52.4	21.1

平均値(標準偏差).

域(和歌山(山村，漁村)，秋田，群馬，三重，東京2)の65歳以上の地域住民4,987人(平均年齢76.3歳)を対象とした.

この対象者から，65歳以上の要介護移行率を推定すると，総数で4.52/100人年(男性4.05/100人年，女性4.76/100人年)であることがわかった．これを性・年代別に**図1**に示す.

この要介護移行率を平成22年度国勢調査による性・年齢別人口比率を用いて計算すると，年間141万人(男性49万人，女性92万人)が要介護に移行することがわかった.

次に，要介護移行の危険因子をCoxの比例ハザードモデルを用いて推定した．目的変数を要介護移行とし，性，年齢，体格，地域を説明変数としてモデルに入れて検討したところ，年齢が高いほど要介護移行へのリスクは高く(+1歳，hazard ratio 1.13，95%信頼区間1.11−1.15，$p<0.001$)，地域差が存在することがわかった(vs 東京2，和歌山山村0.49，0.34−0.7，$p<0.001$; 和歌山漁村0.46，0.29−0.74，$p=0.002$; 秋田，群馬，三重は東京2と有意な地域差なし)．性差，体格については有意な差異は認められなかった.

おわりに

膝痛・腰痛・骨折は高齢者のADLやQOLを著しく低下させ，ひいては要介護状態に陥る原因となるため，LOCOMOスタディではこれら運動器疾患の予防による高齢者の要介護予防を最終目的としている.

厚生労働省研究班では，初年度，2年目の2年間で高齢者要介護予防のための地域代表性を有する住民コホートの共通のデータを統合し，大規模コホートデータベースを構築することができた．このデータベース構築には，全国8地域の住民コホートが参加しており，まさに全国規模の調査結果といってよい．更に参加者総数約12,000人，検証コホートを含めると14,500人

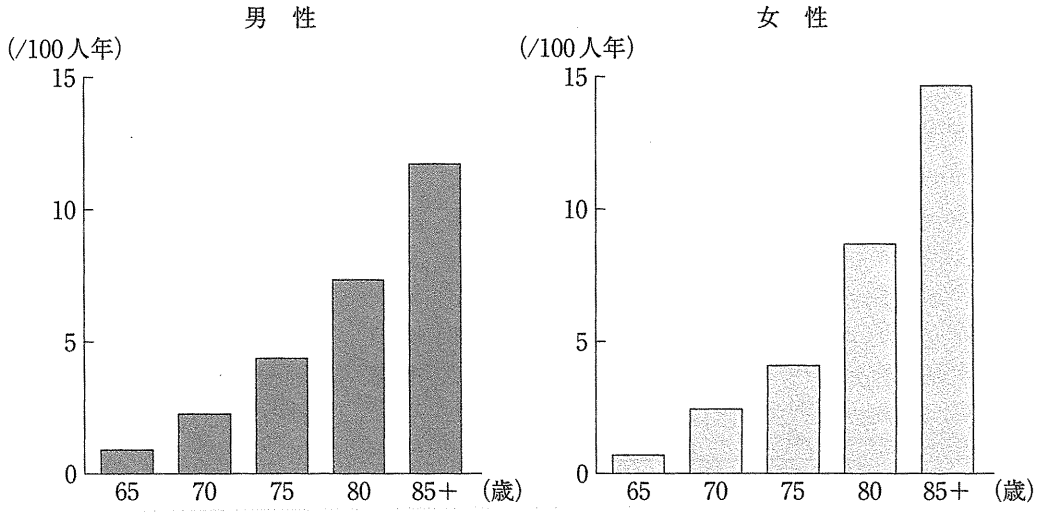

図1 要介護移行率

の男女が参加している本コホートは世界的にみても類をみない規模である．今回はLOCOMOスタディの成果の一つとして，既に要介護情報などの取得に成功した和歌山県(山村，漁村)，秋田県，群馬県，三重県，東京2在住の65歳以上の住民から推定した要介護移行率と年齢，地域差の影響について紹介した．今後，ベースライン結果と追跡調査の結果をリンクし，オールジャパンデータでの膝痛，腰痛，骨折の発生率やそれに影響を及ぼす要因，また要介護移行率の更なる危険因子の解明を行い，要介護状態の一次，二次，三次予防に質の高いエビデンスを供給し，地域在住高齢者のADL，QOLの向上に寄与できるように努力したい．

文 献

1) 吉村典子：厚生労働科学研究費補助金(長寿科学総合研究事業)平成23年度総括報告書．

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ORIGINAL ARTICLE

Association between height loss and bone loss, cumulative incidence of vertebral fractures and future quality of life: the Miyama study

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Abstract
Introduction The study aimed to clarify associations between height loss, bone loss and the quality of life (QOL) score among general inhabitants of Miyama, a rural Japanese community. This population-based epidemiological study was conducted in Miyama, a village located in a mountain area in Wakayama Prefecture, Japan.

Methods A list of all inhabitants comprising 1,543 inhabitants (716 men, 827 women) born in this village between 1910–1949 was compiled. From the above whole cohort, a subcohort to measure bone mineral density (BMD) was recruited, consisting of 400 participants, divided into four groups of 50 men and 50 women each, and stratified into age decades by decade of birth-year (1910–1919, 1920–1929, 1930–1939 or 1940–1949). BMD measurement, physical measurements of height (cm) and body weight (kg) were taken, and body mass index (BMI; kg/m^2) were calculated. BMD and anthropometric measurements were repeated on the same participants at 3, 7 and 10 years after baseline measurement (1993, 1997 and 2000).

Results and discussion Among 299 of 400 participants, changes in height over 10 years for men in their 40s, 50s, 60s and 70s were −0.7 cm, −0.5 cm, −1.2 cm and −1.5 cm, respectively, compared with −0.7 cm, −1.4 cm, −2.1 cm and −3.7 cm in women, respectively. No significant relationships between change in height and rate of change in BMD at the lumbar spine and femoral neck after adjustment for age in men (lumbar spine, β=0.058, standard error of the mean (SE)=0.031, P=0.501, R^2= 0.038; femoral neck, β=0.100, SE=0.038, P=0.228, R^2= 0.121) were identified. By contrast, among women, a significant positive association was identified between height change and change rate of BMD at the lumbar spine after adjusting for age (β=0.221, SE=0.039, P=0.012, R^2= 0.069), while no significant relationship was found between height change and change rate at the femoral neck (β=0.107, SE=0.039, P=0.229, R^2=0.048). No significant relationship was noted between vertebral fractures (VFx) and height at baseline in men and women (men: odds ratio (OR) 0.93, 95% confidence interval (CI) 0.81–1.05, P=0.24; women: OR 0.97, 95% CI 0.87–1.08, P=0.58) or between VFx and height loss

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(men: OR 1.31, 95% CI 1.00–1.71, P=0.051; women: OR 1.20, 95% CI 0.94–1.53, P=0.14). In both men and women, no significant relationship was identified between utility of the EuroQol EQ5D questionnaire and height at baseline (men: β=−0.148, SE=0.003, P=0.202, R^2=0.076; women: β=0.127, SE=0.004, P=0.235, R^2=0.048), and height change (men: β=−0.078, SE=0.008, P=0.452, R^2=0.065; women: β=0.053, SE=0.010, P=0.608, R^2=0.038).

Keywords Bone mineral density · Cohort study · Height loss · Osteoporosis · Quality of life · Vertebral fractures

Introduction

Osteoporotic fracture is one of the leading reasons for the elderly becoming bedridden in Japan [1, 2]. Among fractures associated with osteoporosis, hip fracture results in confinement to bed and markedly impaired quality of life (QOL) in aged individuals. The number of patients with femoral neck fracture has almost doubled over the past 15 years from 1987 to 2002 [3, 4]. Prevention of osteoporosis and osteoporotic fracture is, therefore, an urgent issue for maintaining QOL in the elderly and containing the medical costs of their care.

For the prevention of osteoporosis, the importance of risk assessment must be emphasized. As a risk factor of osteoporosis and osteoporotic fractures, anthropometric measurements no doubt have an important role to play. Particularly among anthropometric measures, light weight [5–8], weight loss [9, 10], and low body mass index (BMI) [11–13] suggest a risk of osteoporosis and osteoporotic fractures. However, data are scarcer on relationships between height loss and subsequent rate of changes in bone mineral density (BMD) or osteoporotic fractures. In addition, few reports have assessed relationships between height loss and subsequent loss of QOL.

To clarify associations between height or height loss and bone loss, osteoporotic fractures focused on vertebral fractures and QOL scores among general inhabitants, the present study was performed as a postal survey on the cohort established in Miyama, a rural Japanese community.

Methods

Establishment of baseline cohort

This population-based epidemiological study was initiated in 1990 in Miyama, a mountain village in Wakayama Prefecture, Japan. As the Miyama cohort has been profiled in detail elsewhere [14, 15], subject characteristics are summarized here briefly. A list of all inhabitants born in this village between 1910–1949, and therefore aged 40 to 79 years, was compiled from the register of residents as of the end of 1989. A cohort of 1,543 inhabitants (716 men, 827 women) was identified, all of whom completed a self-administered questionnaire covering daily activities, such as dietary habits, smoking habits, alcohol consumption and physical exercise (125 items) (the whole cohort).

From the above whole cohort, a BMD cohort was recruited, consisting of 400 participants, divided into four groups of 50 men and 50 women each, and stratified into age decades by decade of birth-year (1910–1919, 1920–1929, 1930–1939, 1940–1949). An interviewer administered a second questionnaire to these 400 participants, covering items of past medical history, family history, calcium intake, dietary habits, physical exercise, occupational activities and sun exposure, in addition to reproductive variables for women.

BMD and anthropometric measurements

The baseline measurement of BMD was made in 1990. Dual energy X-ray absorptiometry (DXA:Lunar DPX, Madison, WI, USA) was used for the measurement of BMD, providing antero-posterior images at lumbar vertebrae L2–4 and the proximal femur (femoral neck, Ward's triangle, trochanter, and total hip). In addition to BMD, physical measurements of height and body weight were taken, and BMI (kg/m^2) was calculated. Height and weight at each visit were all measured by the same well-trained public health nurse (TT).

BMD measurements were repeated on the same participants at 3, 7 and 10 years after baseline measurement (1993, 1997 and 2000). Rates of change in BMD and height change were calculated over the 10-year period, classified by sex and age stratum. BMD measurements at all visits were performed by the same well-trained medical doctor (NY).

To control for precision of DXA, the equipment was checked every examination in 1990, 1993, 1997 and 2000 using the same phantom, and BMD of the phantom was regulated to 1.270 ±0.025 g/cm^2 (2%) during examinations. In addition, to control for observer variability, all participants were examined by the same medical doctor. Intra-observer variability of DXA (Lunar DPX) in vitro and in vivo had been measured for a prior study [16], using the same doctor, and CV% for L2–4 in vitro was determined as 0.35%, while CV% for L2–4, proximal femur, Ward's triangle and trochanter, examined in vivo in five male volunteers, were 0.61–0.90%, 1.02–2.57%, 1.97–5.45% and 1.77–4.17%, respectively.

Radiography

Radiographic examination of the spine was performed on all participants in 1990. Anteroposterior and lateral images

of thoracolumbar vertebrae Th5-L5 were used for diagnosis (Initial X-ray survey). Radiographic examination was again performed on subjects who provided consent after 10 years. Lateral images of thoracolumbar vertebrae Th5-L5 were again used for diagnosis (2nd X-ray survey). Lateral spinal radiographs were examined for the presence of one or more vertebral fractures (VFx) between Th5–L5, using the criteria determined by the Japan Bone and Mineral Society (Fig. 1) [17]. According to these criteria, measurement of anterior, middle and posterior heights on lateral radiography of the thoracic and lumbar spine is required, to determine ratios defining the anterior wedge, biconcave and compound dimensions of the vertebral bodies. Diagnosis of VFx on all radiographs was performed by the same experienced orthopedic doctor (HK). In the present study, cumulative incidence over 10 years was detected by dividing the number of incident cases by the number of participants in the follow-up study, and cases with previous VFx were excluded from both numerators and denominators. In this analysis, cumulative incidence of cases with first VFx was detected.

QOL postal survey

The QOL questionnaire postal survey was performed in 2002. To select QOL items, the Euro Qol EQ5D questionnaire [18] translated into Japanese was used, comprising the following two parts: a 5-dimensional health state classification; and a visual analogue scale (VAS) called the "thermometer" [19]. The 5-dimensional healthcare classification included questions on the status of morbidity, self-care, usual activities, pain/discomfort and anxiety/depression. Participants were asked to indicate current health status by ticking the most appropriate of three statements about each of five QOL dimensions. Each statement represents an increasing degree of severity. These results were coded and converted to a score of utility using the tables of values. The VAS "thermometer" represents a self-rated scale of current health-related QOL. The endpoint of 100 at the top indicates the best imaginable health state, and 0 at the bottom indicates the worst imaginable health state at that time.

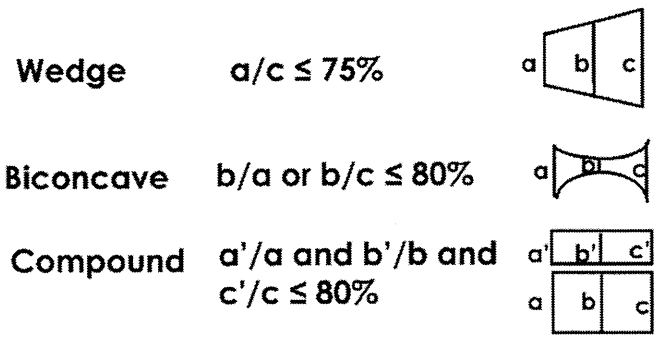

Fig. 1 Diagnostic criteria of vertebral fractures

Statistical analysis

Statistical analyses were performed using SPSS statistical software (SPSS, USA) and STATA software (STATA, USA). Differences were tested for significance using ANOVA for comparison among multiple groups and Scheffe's LSD test for pairs of groups. Significant items were selected, and multiple regression analysis was performed with adjustment of suitable variables.

Results

Eligible participants

From the whole cohort of 1,543 inhabitants (716 men, 827 women), 50 men and 50 women in each decade age group between 40–79 years (a total of 400 participants) were recruited for baseline bone densitometry in 1990 (baseline BMD cohort).

To evaluate the representativeness of subjects in the baseline BMD cohort compared to the whole cohort, the prevalence of 125 items of the self-administered questionnaire, results of physical measurements and blood examination were compared between members of the BMD and whole cohorts [14]. As a result, prevalence of lifestyle factors such as smoking and drinking were identical among BMD and whole cohorts. In addition, no significant differences existed in frequency distribution of the following items favorable to the maintenance of good health among BMD and whole cohorts: sleeping 7–8 h/day; exercise and sports >1 h/day; walking >30 min/day; eating regularly; reduction of salt intake compared with age 30; less stress; less anger. Regarding medical examinations, no significant differences in blood pressure classified by age and sex were seen between cohorts. Moreover, no abnormal values in serum calcium or phosphorus were observed. In view of these findings, subjects in the BMD study were considered to have been selected adequately from the whole cohort.

A total of 299 of 400 participants (137 men, 162 women; 74.8%) completed the follow-up survey after 10 years. Loss of 101 participants was due to following: death, n=55 (37 men, 18 women); moved away from Miyama, n=16 (8 men, 8 women); illness, n=13 (4 men, 9 women); busy, n=8 (8 men); refused to participate further, n=5 (5 men); and away from the area at the time of follow-up, n=4 (1 man, 3 women). Analysis was performed on the 299 subjects who had participated in all surveys performed in 1990, 1993, 1997 and 2000.

A comparison of physical characteristics between completers and non-completers has been described elsewhere [20], and is briefly summarized here. Height, weight and

BMI classified by age-strata and sex were identical between completers and non-completers, while mean age of female completers in their 70s was significantly younger than that of female non-completers (completers, 71.7 years (standard deviation (SD), 1.8 years) vs. non-completers 75.1 years (SD; 2.8 years); $p<0.001$).

Table 1 shows the characteristics including anthropometric factors and BMDs at the time of baseline measurement for participants who completed the 10-year follow-up (Table 1). Mean height and weight of the remaining participants were smaller according to age, while BMI did not differ significantly for both men and women in all age groups except men in their 70s.

Height loss and bone loss

Table 2 shows mean change of height, weight, BMI and change rate of BMDs over 10 years by age and gender (Table 2). Height and weight of men and women decreased in all age strata, and these decreases were greatest in subjects in their seventies. BMI in the 50s, 60s and 70s were decreased over 10 years in both genders, but no significant differences were seen among age-strata. BMDs at the lumbar spine and femoral neck decreased except for BMD at the lumbar spine in men.

To clarify associations between height, height change and changes in BMD, multiple regression analysis was performed. Rate of change of BMD (%/year) was used as an objective factor and height at baseline (cm) or change of height (cm/10 years) were used as explanatory factors. Analysis was performed after adjustment for age and female menstrual status at baseline (0, regular; 1, irregular; 2, menopause). In both men and women, no significant relationship was identified between bone loss and height at baseline (lumbar spine: men, $\beta=-0.046$, standard error of the mean (SE)=0.011, P=0.653, $R^2=0.036$; women, $\beta=-0.042$, SE=0.014, P=0.652, $R^2=0.032$; femoral neck: men, $\beta=0.143$, SE=0.014, P=0.149, $R^2=0.125$; women: $\beta=0.078$, SE=0.014, P=0.397, $R^2=0.043$).

Regarding the association between height loss and bone loss over 10 years, no significant relationship was identified between height change and rate of change of BMD at the lumbar spine and femoral neck after adjusting for age in men (lumbar spine: $\beta=0.058$, SE=0.031, P=0.501, $R^2=0.038$; femoral neck: $\beta=0.100$, SE=0.038, P=0.228, $R^2=0.121$). In contrast, among women, significant positive associations were noted between height change and change rate of BMD at the lumbar spine after adjusting for age ($\beta=0.221$, SE=0.039, P=0.012, $R^2=0.069$), while no significant relationship was noted between height change and change rate at the femoral neck ($\beta=0.107$, SE=0.039, P=0.229, $R^2=0.048$).

Height loss and vertebral fractures

As reported elsewhere [21], 32 men and 35 women had suffered from previous VFx at the initial survey. Cumulative incidences of first VFx at follow-up for subjects in their 40s, 50s, 60s and 70s were thus 2.9%, 2.8%, 8.6% and 21.1% in male completers, respectively, and 2.1%, 7.0%, 18.9% and 31.3% in female completers, respectively. Cumulative incidence of first VFx among participants during follow-up increased with age in both men and women, and was higher in women than in men in all age-strata except the 40s.

Table 3 shows differences in height at baseline and height loss between the incident group and non-fracture group. Both height and height loss over the 10 years were

Table 1 Characteristics at the baseline measurement of participants completed 10-year follow-up

				Anthropometric factors			Bone mineral density (g/cm^2)	
Birth cohort	Age strata	N	Age (years)	Height(cm)	Weight(kg)	BMI (kg/m^2)	L2-4	Femoral neck
Men								
1940–1949	40–49	36	44.1 (3.1)	166.5 (5.9)	64.4 (8.9)	23.1 (2.3)	1.19 (0.17)	0.98 (0.16)
1930–1939	50–59	41	53.9 (2.6)	162.0 (5.7)[a]	60.2 (8.0)	22.9 (2.4)	1.15 (0.20)	0.90 (0.18)
1920–1929	60–69	38	63.2 (2.8)	159.4 (5.4)[a]	56.1 (7.5)[a]	22.0 (2.4)	1.03 (0.19)[a]	0.82 (0.12)[ab]
1910–1919	70–79	22	73.2 (2.7)	155.3 (6.5)[ab]	50.0 (8.4)[ab]	20.6 (2.6)[ab]	1.03 (0.20)[a]	0.79 (0.11)[ab]
Women								
1940–1949	40–49	49	44.7 (3.1)	152.5 (4.7)	53.3 (8.4)	22.9 (2.8)	1.18 (0.16)	0.88 (0.12)
1930–1939	50–59	46	54.8 (2.6)	149.6 (5.3)	50.3 (7.4)	22.4 (2.8)	0.99 (0.18)[a]	0.75 (0.12)[a]
1920–1929	60–69	40	64.4 (2.8)	147.4 (5.1)[a]	47.4 (6.8)[a]	21.8 (3.0)	0.86 (0.20)[ab]	0.69 (0.11)[ab]
1910–1919	70–79	27	71.7 (1.8)	143.1 (5.5)[ab]	45.4 (7.7)[a]	22.1 (3.0)	0.79 (0.16)[ab]	0.65 (0.09)[ab]

Mean (SD)
a: Significantly different from values of the birth cohort group born in 1940–1949
b: Significantly different from values of the birth cohort group born in 1930–1939

Table 2 Changes in height, weight, BMI and change rate in bone mineral densities over 10 years by age and gender

Age at initial survey	Change rate of anthropometric factors			Change rate of bone mineral density	
Age strata (years)	Height (cm)	Weight (kg)	BMI (kg/m^2)	L2–4 (%/year)	Femoral neck (%/year)
Men					
40–49	−0.73 (2.21)	−0.21 (5.09)	0.17 (2.20)	0.17 (0.69)	−0.26 (0.86)
50–59	−0.54 (2.09)	−0.83 (3.69)	−0.18 (1.38)	0.55 (0.58)	−0.13 (0.84)
60–69	−1.19 (2.41)	−3.01 (4.80)	−0.86 (1.84)	0.01 (0.89)[b]	−0.75 (0.97)[b]
70–79	−1.54 (1.72)	−3.05 (3.88)	−0.84 (1.65)	−0.16 (0.68)[b]	−1.17 (1.09)[ab]
Women					
40–49	−0.69 (1.21)	−0.33 (3.22)	0.06 (1.39)	−0.87 (0.71)	−0.53 (0.70)
50–59	−1.37 (1.18)	−1.74 (3.64)	−0.35 (1.69)	−0.83 (0.75)	−0.53 (0.71)
60–69	−2.06 (2.08)[a]	−2.44 (3.55)[a]	−0.58 (1.69)	−0.48 (0.71)	−0.50 (0.87)
70–79	−3.65 (2.83)[abc]	−3.09 (3.48)[a]	−0.42 (1.76)	−0.48 (1.48)	−1.16 (1.32)[abc]

Mean (SD)
a: Significantly different from values of the age-group in their 40s
b: Significantly different from values of the age-group in their 50s
c: Significantly different from values of the age-group in their 60s

also greater in the group with VFx than without VFx. To clarify associations between height or height change and incidence of VFx after excluding the effects of age, logistic regression analysis was performed. We utilized new VFx over 10 years (1: yes; 0: no) as an objective factor and height at baseline (cm) or change of height (cm/10 years) as explanatory factors. Analysis was performed after adjusting for age and female menstrual status at baseline (0: regular; 1: irregular; 2: menopause). After logistic regression analysis, no significant relationship was identified between VFx and height at baseline in men and women (men: odds ratio (OR) 0.93, 95% confidence interval (CI) 0.81–1.05, P=0.24; women: OR 0.97, 95% CI 0.87–1.08, P=0.58). Furthermore, a non-significant relationship was seen between cumulative incidence of VFx and height loss in men and women (men: OR 1.31, 95% CI 1.00–1.71, P=0.051; women: OR 1.20, 95% CI 0.94–1.53, P=0.14).

Table 3 Comparison of height (cm) at baseline and height loss between the group with new vertebral fractures and the no fracture group

		VFx* over 10 years		
		No (n=116)	Yes (n=9)	P (Yes vs. No)
Men	Height (cm)	161.8 (6.49)	156.4 (7.76)	0.014
	Height loss (cm/10 years)	0.87 (2.08)	2.59 (2.23)	0.019
		No (n=128)	Yes (n=16)	
Women	Height (cm)	149.7 (5.75)	145.9 (6.43)	0.015
	Height loss (cm/10 years)	1.33 (1.78)	2.88 (2.26)	0.002

*VFx: vertebral fractures

Height loss and QOL

Among the 299 subjects who participated in the latest follow-up survey in 2000, 212 answered the QOL questionnaire distributed in 2002 (94 men, 118 women; 70.9%).

Figures 2 and 3 show mean values for utility in EQ5D health states and VAS scores classified by age and gender. Mean utility for EQ5D in men in their 40s (n=30), 50s (n=33), 60s (n=25) and 70s (n=6) were 0.95, 0.87, 0.88 and 0.83, respectively, compared to 0.90, 0.85, 0.81 and 0.77 in women in their 40s (n=42), 50s (n=32), 60s (n=31) and 70s (n=13). VAS values in men were 76.6, 75.1, 72.4 and 63.8, respectively, compared to 77.6, 73.9, 67.6 and 71.7, respectively, in women. Utility of EQ5D decreased according to age in both men and women, while mean VAS scores were lowest for women in their 60s.

We utilized multiple regression analysis using utility of EQ5D health states or VAS scores as an objective factor and height at baseline (cm) or change of height (cm/10 years) as explanatory factors to clarify associations between height and QOL. Analysis was performed after adjusting for age and female menstrual status at baseline

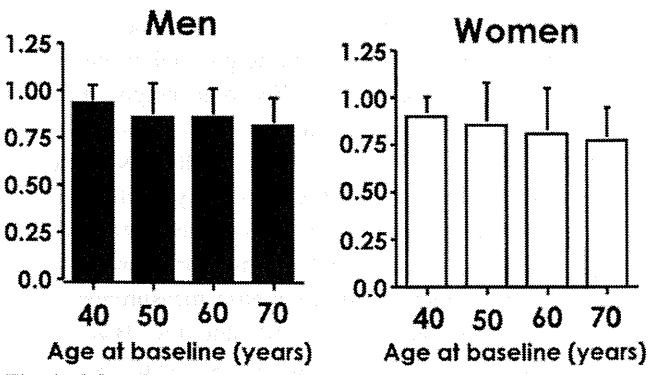

Fig. 2 QOL score classified by age and gender

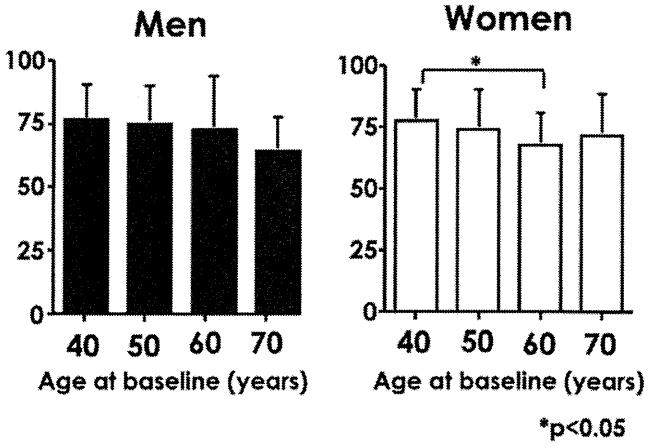

Fig. 3 VAS scores classified by age and gender

(0: regular; 1: irregular; 2: menopause). In both men and women, no significant relationship was identified between utility of EQ5D and height at baseline (men: $\beta=-0.148$, SE=0.003, P=0.202, $R^2=0.076$; women: $\beta=0.127$, SE=0.004, P=0.235 $R^2=0.048$), and height change (men: $\beta=-0.078$, SE=0.008, P=0.452, $R^2=0.065$; women: $\beta=0.053$, SE=0.010, P=0.608, $R^2=0.038$). Regarding VAS scores, height at baseline among men and women was not significantly associated VAS scores (men: $\beta=-0.148$; SE=0.003, P=0.202, $R^2=0.076$; women: $\beta=0.066$, SE=0.255, P=0.532, $R^2=0.092$). In addition, no significant associations were identified between utility of VAS scores and height change (men: $\beta a=-0.148$, SE=0.003, P=0.202, $R^2=0.076$; women: $\beta=0.142$, SE=0.698, P=0.160, $R^2=0.105$).

Discussion

The present study clarified associations between height, height change and bone loss and cumulative incidence of VFx. Furthermore, we assessed the usefulness of height and height change as predictors of future QOL. As a result, we identified significant positive associations between height change and change rate of BMD at the lumbar spine in women after adjusting for age and menstrual status, while no significant relationships were found between height or height change at the femoral neck in either men or women. Regarding associations between height, height change and cumulative incidence of first VFx, both height and height loss over the 10 years were also greater in the group with VFx than in the group without VFx, but the association was less significant in logistic regression analysis after adjusting for age. No significant relationships existed between height, height change and future QOL in men or women.

Particularly among anthropometric measurements, light weight [5–8], weight loss [9, 10] and low BMI [11–13] could suggest a risk of osteoporosis and osteoporotic fractures. Conversely, few investigations have reported that height and height loss are associated with low BMD or bone loss. We have already reported that tall height is associated with greater bone loss over 3 years [22]. Twiss et al. [23] reported that actual height loss is associated with risk factors of osteoporosis, while Thornton et al. [24] evaluated relationship between height change and bone mineral density among 168 healthy women at 50- to 65-years-old, and reported no significant relationships between height change and BMD. Kantor [25] reviewed cross-sectional data from 2,108 women referred for a bone density scan and reported that a height loss of ≥2 inches offers a highly significant predictor of osteoporosis at the hip [25]. As mentioned, investigations into associations between height and bone loss have yielded controversial results, and no data from follow-up studies over periods as long as 10 years have been available. The present study clarified that greater height loss was associated with greater bone loss at the lumbar spine in women. This means that height loss might offer a predictor for greater bone loss, thus indicating a potential high-risk group for future osteoporosis in women. Conversely, the present study failed to identify any significant association between height loss and bone loss at the lumbar spine in men, which is artificial due to the difficulties in measuring BMD at the lumbar spine in men. As observed in the BMD cohort, 35.1% of men and 13.3% of women were diagnosed with osteophytosis more than grade 3 according to Nathan's classification [26, 27]. Such osteophytes might lead to overestimation of BMD in men.

Regarding the relationship between height loss and osteoporotic fractures, Meyer et al. [11] compared mean height among participants of population-based cohort studies established in different countries in Europe, and found that participants in Oslo were taller than those in other European countries. They noted that the taller height of community-dwelling inhabitants might contribute to the higher incidence of hip fracture in Finland, although this suggestion was based on ecological data. Fujiwara et al. [28] suggested that the presence of more than one column of VFx will lead to a decrease of about 2 cm in height. The present study found both height and height loss over the 10 years were also greater in the group with VFx than in the group without VFx, but failed to identify any statistically significant association between height loss and VFx. This might be because the sample size of the BMD cohort was insufficient to detect a significant association. However, height loss (cm/10 years) tended to increase the OR of VFx in both men and women. Loss of height may represent an important clinical sign of vertebral deformation and/or fracture in postmenopausal women and elderly men. Relationships between BMD at the femoral neck and hip fracture were not able to be analyzed because of the low numbers of new hip fractures in subjects. A larger

epidemiological study would be needed to clarify associations between height loss and future osteoporotic fractures.

Regarding relationships between QOL, height and height loss, Martin et al. [29] found that height loss and kyphosis in women are significantly associated with increased physical difficulty in activities of daily life. In addition, some reports have described the influence of osteoporotic VFx on QOL [30–32]. These investigations have shown that patients with higher grades of vertebral deformities displayed low QOL, suggesting that the results of VFx such as height loss are related to QOL, but the direct influence of height loss on QOL remains unclear. The present study could not find any significant association between height loss and QOL, so we concluded that QOL in patients with osteoporosis is impaired by postural deformities, particularly by whole kyphosis, and that spinal mobility exerts a strong effect on QOL in these patients.

Conclusions

The present study identified significant positive associations between height change and change rate of BMD at the lumbar spine in women, while no significant relationships were found between height, height change, cumulative incidence of VFx and future QOL.

In conclusion, changes in measured height might offer a cost-saving indicator of bone loss. Measurement of height should be considered as one potential component in determining risk of comprehensive osteoporosis, but further consideration is required before utilizing this approach as a predictor of future osteoporotic fracture and QOL.

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References

1. Hosoda Y, Fujiwara S (1992) The epidemiology of osteoporosis in Japan. J Epidemiol 2(suppl):205–213
2. Hashimoto T, Sakata K, Yoshimura N (1997) Epidemiology of osteoporosis in Japan. Osteoporos Int 7(suppl):99–102
3. Orimo H, Hashimoto T, Sakata K, Yoshimura N, Seino Y, Emi M, Hada A, Suzuki T, Hosoi T, Miyao M, Research Group for Risk Factors for Prevention of Osteoporosis, Longevity Science General Research Project, Ministry of Health and Welfare, (Director Orimo H) (1999) Results of the 3rd nation-wide survey of femoral neck fracture. Estimation of the number of new patients in 1997 and changes during the past 10-year period. Nihon Iji Shinpo (Japan Medical Journal) 3916:46–49 (in Japanese)
4. Yosihmura N, Suzuki T, Hosoi T, Orimo H (2005) Epidemiology of hip fracture in Japan: incidence and risk factors. J Bone Miner Metab 23:78–80
5. Wardlaw GM (1996) Putting body weight and osteoporosis into perspective. Am J Clin Nutr 63 (3 Suppl):433–436
6. Yoshimura N, Hashimoto T, Morioka S, Sakata K, Kasamatsu T, Cooper C (1998) Determinants of bone loss in a rural Japanese community. The Taiji Study. Osteoporos Int 8:604–610
7. Dennison E, Eastell R, Fall CH, Kellingray S, Wood PJ, Cooper C.(1999) Determinants of bone loss in elderly men and women: a prospective population-based study. Osteoporos Int 10:384–391
8. Wildner M, Peters A, Raghuvanshi VS, Hohnloser J, Siebert U (2003) Superiority of age and weight as variables in predicting osteoporosis in postmenopausal white women. Osteoporos Int 14:950–956
9. Nguyen TV, Sambrook PN, Eisman JA. (1998) Bone loss, physical activity, and weight change in elderly women: the Dubbo Osteoporosis Epidemiology Study. J Bone Miner Res 13:1458–1467
10. Tsunenari T, Yamada S, Kawakatsu M, Negishi H, Tsutsumi M (1995) Menopause-related changes in bone mineral density in Japanese women. A longitudinal study. Calcif Tissue Int 56:5–10
11. Meyer HE, Falch JA, O'Neill T, Tverdal A, Varlow J (1995) Height and body mass index in Oslo, Norway, compared to other regions of Europe: do they explain differences in the incidence of hip fracture? European Vertebral Osteoporosis Study Group. Bone 17:347–350
12. Nguyen TV, Center JR, Eisman JA (2000) Osteoporosis in elderly men and women: effects of dietary calcium, physical activity, and body mass index. J Bone Miner Res 15:322–331
13. Korpelainen R, Korpelainen J, Heikkinen J, Vaananen K, Keinanen-Kiukaanniemi S (2006) Lifelong risk factors for osteoporosis and fractures in elderly women with low body mass index-A population-based study. Bone 39:385–391
14. Kasamatsu T, Morioka S, Hashimoto T, Kinoshita H, Yamada H, Tamaki T (1991) Epidemiological study on bone mineral density of inhabitants in Miyama Village, Wakayama Prefecture (Part 1). Background of study population and sampling method. J Bone Miner Metabol 9(suppl):50–55
15. Kinoshita H, Danjoh S, Yamada H et al (1991) Epidemiological study on the bone mineral density of inhabitants in Miyama Village, Wakayama Prefecture (part II) Bone mineral density of the spine and proximal femur. J Bone Miner Metab 9(suppl):56–60
16. Yoshimura N, Kakimoto T, Nishioka M, Kishi T, Iwasaki H, Niwa T, Morioka S, Sakata T, Hashimoto T (1997) Evaluation of reproducibility of bone mineral density measured by dual energy X-ray absorptiometry (Lunar DPX-L). J Wakayama Medical Society 48:461–466
17. Yoshimura N, Kinoshita H, Danjoh S, Yamada H, Tamaki T, Morioka S, Kasamatsu T, Hashimoto T, Inoue T (1995) Prevalence of vertebral fractures in a rural Japanese population. J Epidemiology 5:171–175
18. EuroQol Group (1990) EuroQol: A new facility for the measurement of health-related quality of life. Health Policy 16:199–208
19. Ikeda S, Ikegami N (on behalf of the Japanese EuroQol Tariff Project) (1999) Health status in Japanese population, Results from Japanese EuroQol Study. Iryou-to-Kagaku 9:83–92 (in Japanese)
20. Yoshimura N, Kinoshita H, Danjoh S, Takijiri T, Morioka S, Kasamatsu T, Sakata K, Hashimoto T (2002) Bone loss at the lumbar spine and the proximal femur in a rural Japanese community, 1990–2000: The Miyama study. Osteoporos Int 13:803–808
21. Yoshimura N, Kinoshita H, Oka H, Muraki S, Mabuchi A, Kawaguchi H, Nakamura K (2006) Cumulative incidence and changes in prevalence of vertebral fractures in a rural Japanese

community: a 10-year follow-up of the Miyama Cohort. Archives Osteoporosis, DOI 10.1007/s11657-006-0007-0
22. Yoshimura N (1996) Incidence of fast bone losers and factors affecting changes in bone mineral density - A cohort study in a rural Japanese community-. J Bone Miner Metab 14:171–177
23. Twiss JJ, Dillon AL, Konfrst JM, Stauffer J, Paulman A (2002) The relationship of actual height loss with health-seeking behaviors and risk factors in perimenopausal and menopausal women. J Am Acad Nurse Pract 14:131–137
24. Thornton MJ, Sedlak CA, Doheny MO (2004) Height change and bone mineral density: revisited. Orthop Nurs 23:315–320
25. Kantor SM, Ossa KS, Hoshaw-Woodard SL, Lemeshow S (2004) Height loss and osteoporosis of the hip. J Clin Densitom 7:65–70
26. Nathan H (1962) Osteophytes of the vertebral column, an anatomical study of their development according to age, race, and sex with considerations as to their etiology and significance. J Bone and Joint Surg 44:243
27. Yoshimura N, Saika A, Oka H (2006) The study on the causality between osteoporosis and osteoarthritis. Osteoporos Jpn 14:691–695 (in Japanese)
28. Fujiwara S (2006) Clinical sign-height loss and vertebral deformity. Nippon Rinsho 64:1610–1614 (in Japanese)
29. Martin AR, Sornay-Rendu E, Chandler JM, Duboeuf F, Girman CJ, Delmas PD (2002) The impact of osteoporosis on quality-of-life: the OFELY cohort. Bone 31:32–36
30. Fechtenbaum J, Cropet C, Kolta S, Horlait S, Orcel P, Roux C (2005) The severity of vertebral fractures and health-related quality of life in osteoporotic postmenopausal women. Osteoporos Int 16:2175–2179
31. Miyakoshi N, Itoi E, Kobayashi M, Kodama H (2003) Impact of postural deformities and spinal mobility on quality of life in postmenopausal osteoporosis. Osteoporos Int 14:1007–1012
32. Tanaka K, Yoshizawa M, Yoh K (2005) Improvement of QOL in osteoporotic patients by calcitonin treatment. Clin Calcium 15:174–178 (in Japanese)