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A Longitudinal Study of Disc Height Narrowing and Facet Joint Osteoarthritis at The Thoracic and Lumbar Spine, Evaluated by Computed Tomography: The Framingham Study

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Abstract

Background Context—Prevalence and progression of disc height narrowing (DHN) and facet joint osteoarthritis (FJOA) in the thoracic and lumbar regions in non-clinical populations are not well-established.

Purpose—Use computed tomography (CT) images to determine prevalence and progression of DHN and FJOA according to age, sex, and spinal region.

Study Design—Six-year longitudinal study

Sample—1,196 members of the Framingham Study (mean baseline age 61 ±9 years)

Outcome Measures—We compared prevalence and progression (new or worsening) of moderate-to-severe DHN and FJOA by age, sex, and spinal region.

Methods—A musculoskeletal radiologist evaluated DHN and FJOA from T4/T5 to L4/L5 on baseline and follow-up CT images using a semi-quantitative scale as: 0=normal, 1=mild, 2=moderate, and 3=severe.

Results—One-third or more of women and men ages 40–59 years at baseline had imaged-based evidence of prevalent DHN, more than half had prevalent FJOA, and DHN and FJOA prevalence increased ~2- to 4-fold in those age 60–69 and 70–89 years at baseline, respectively; $p<0.01$). Progression of DHN and FJOA occurred more frequently at the lumbar than thoracic spine and more in women than men (DHN: OR=1.42, CI=1.07, 1.88; FJOA: OR=1.70, CI=1.33, 2.17).

Conclusions—Prevalence and progression of moderate-to-severe DHN and FJOA are common in non-clinical populations of older adults. The high frequency of spinal degeneration observed on CTs in this community-based study may contribute to challenges in interpreting the clinical significance of imaging evidence of DHN and FJOA. Future studies investigating the association of CT based spinal degenerative features with pain and functional impairments in population-based samples are needed to help determine clinical significance of imaged based findings of DHN and FJOA.

Keywords

Aging spine; disc height; facet joint; longitudinal study

Introduction

Spinal degenerative conditions, including disc height narrowing (DHN) and facet joint osteoarthritis (FJOA), are considered to be common causes of back and neck pain in older adults and associated with significant morbidity and economic burden [1]. For instance, between 1996 and 2008, facet joint interventions increased 543% per 100,000 Medicare

beneficiaries in the U.S., resulting in a total expenditure of over \$511 million in 2006 [2]. Due to the aging of the population, the exponential rise in the cost of medical expenditures related to spinal conditions is expected to continue or accelerate [3]. Despite the clinical and public health importance, little is known about the frequency and progression of spinal degenerative disease in the general population. As a result, it can be difficult to determine the clinical significance of degenerative changes found on advanced imaging, including magnetic resonance imaging (MRI) and computed tomography (CT), which are increasingly used to evaluate back pain in older adults and inform decision-making regarding treatment.

As shown in recent systemic reviews [4, 5], few epidemiologic studies have evaluated frequency of both DHN and FJOA, particularly in non-clinical populations. One case-control study assessed DHN and FJOA and included subjects with high functional capacity, who were selected according to the presence or absence of back pain (N=320) [6]. In contrast, the Johnston County Osteoarthritis Project assessed DHN and FJOA in a cross-sectional study of a population-based cohort (N=840) [7]. However, both studies assessed spinal features with plain spine radiography, which can be less reliable and less sensitive in comparison with advanced imaging modalities, particularly for FJOA evaluation, due to obliquity of the joints [8]. In contrast, Kalichman et al. [9] used CT imaging to assess DHN and FJOA, however, this cross-sectional study had a small sample size (N=187). With few exceptions [10–12], longitudinal studies of DHN and FJOA in asymptomatic populations are lacking, and thus, incidence and progression of DHN and FJOA are not known.

Information on the frequency of degenerative changes in the spine in older adults could offer insights into etiopathogenesis and aid clinical decision making regarding the significance of imaging-based findings. Therefore, we conducted a 6-year longitudinal study to: (1) describe prevalence and progression of DHN and FJOA, evaluated by CT, in a community-based population of men and women, and (2) compare the frequency of DHN and FJOA by baseline age, sex, and spinal region.

Materials and Methods

Participants

Participants for the current study were members of the Framingham Heart Study Offspring and Third Generation Multi-Detector Computed Tomography (MDCT) Study [13]. Members of the Offspring and Third Generation Cohorts included second generation (plus spouses) and third generation offspring of the original cohort of the Framingham Heart Study established in 1948 [14]. CT scans of the chest and abdomen were acquired to assess coronary and aortic calcium at baseline in 2002 to 2005 and repeated at follow-up in 2008 to 2011 [13]. Exclusion criteria for the MDCT Study included pregnancy or baseline age less than 40 years for women, age less than 35 years for men, and weight greater than 320 pounds.

For the current study we included 1,195 members of the MDCT Study, who were at least 50 years old at the time of the baseline scans and who had both baseline and follow-up (mean, 6 years later) CT examinations evaluable for radiographic assessment [15]. Participants included 655 women and 540 men; 75% were second generation offspring or their spouses

and 25% were third generation offspring of the original cohort of the Framingham Heart Study. The timing of the baseline and follow-up MDCT examinations corresponded to Framingham Offspring Cohort examination cycles 7 and 8, respectively, and Third Generation Cohort cycles 1 and 2. Participants provided informed consent, and the study was approved by the institutional review boards of Hebrew SeniorLife Institute for Aging Research and Boston University Medical Center.

Computed Tomography Imaging Acquisition

An 8-section multidetector CT unit (Lightspeed Ultra/Plus, General Electric Medical Systems, Milwaukee, WI, USA) operating at tube voltage 120 kVp, tube current 320/400mA (< 220/>220 lb body weight), and gantry rotation of 500 ms was used for the baseline examination. Nominal in-plane pixel size was 0.68×0.68 mm, and slice thickness 2.5 mm. Effective radiation exposure was 1.0 to 1.25 mSv for 320 and 400 mA, respectively. Because the study was originally designed to assess the abdominal aorta and coronary arteries, the baseline CT consisted of two volumetric acquisitions: (1) a cardiac ECG-gated thoracic series, including contiguous slices from the carina of the trachea to the diaphragm (40 to 68 slices); and (2) an abdominal scan in which the L5/S1 junction was identified, and 60 contiguous CT slices (150 mm) were acquired above this point.

The follow-up CT was performed using a 64-section multidetector CT unit (Discovery VCT, General Electric Medical Systems, Milwaukee, WI, USA) operating at tube voltage 120 kVp, tube current 300/350 mA (< 220/>220 lbs body weight), and gantry rotation of 350 ms. The thoracic acquisition covered the entire chest from the base of the lungs to apices during a single inspirational breath hold, typically corresponding to T4 to L1 vertebral levels (slice thickness 0.625 mm, FOV 35cm). The abdominal scan was performed as follows: L5/S1 junction was identified, and 60 contiguous CT slices (150 mm) were acquired superior from this location (slice thickness 2.5 mm, FOV 35 cm).

Computed Tomography Assessments

CT imaging assessments were performed using a Myrian® platform (Version 1.12, Intrasure SA). One trained experienced reader (MJ) used standardized, validated methods together with an atlas to assess DHN and FJOA. The reader evaluated baseline and follow-up images side by side with full knowledge of chronology but was blinded to clinical information. DHN and FJOA were evaluated at each intervertebral level from T4/T5 to L4/L5. Scoring of DHN and FJOA was based on a 4-point semi-quantitative (SQ) scale as: 0=normal, 1=mild, 2=moderate, and 3=severe. Specific criteria for scoring DHN and FJOA are detailed below. To evaluate reliability, the reader assessed DHN and FJOA on two separate occasions for 30 individuals. Intraclass correlation coefficients (ICCs) for intra-reader reliability were 0.80 to 1.00 for DHN and 0.73 to 1.00 for FJOA.

Disc Height Narrowing

DHN was scored using Videman's grading system based on a visual assessment of a reduction (narrowing) in disc height relative to the height of the disc immediately superior (reference disc): 0=normal (disc height greater than height of disc immediately superior), 1=mild (disc height equal to height of disc immediately superior), 2=moderate (disc height

less than height of disc immediately superior), 3=severe (vertebral endplates almost in contact) [12, 15–17].

Facet Joint Osteoarthritis

FJOA was graded bilaterally using a Framingham scale [15, 18–20] that was developed based on criteria used by Pathria [8] and Weishaupt [21]. We classified FJOA for each spinal level using the highest (SQ) severity score of the left and right sides. The Framingham Scale for FJOA considers severity of the following pathoanatomic changes: joint space narrowing, osteophytosis, articular process hypertrophy, sclerosis, subarticular erosion, subchondral cystic change, and presence of vacuum phenomenon [20].

Prevalence and Progression of Disc Height Narrowing and Facet Joint Osteoarthritis

We required moderate-to-severe scores, grades 2 to 3, to define DHN and FJOA, since nearly all participants had at least mild (grade 1 and greater) DHN (93%) and FJOA (99%) at baseline. Prevalence of moderate-to-severe DHN and FJOA was defined as any spinal level with grades 2 to 3 at baseline. Progression included new or worsening (herein referred to simply as progression) DHN and FJOA, defined as any spinal level that increased from grades 0 or 1 at baseline to grades 2 or 3 at follow-up, or from grade 2 at baseline to grade 3 at follow-up. For each individual, we determined the number (or count) of spinal levels with prevalent and progression to moderate-to-severe DHN and FJOA. We estimated prevalence and progression separately for the thoracic spine (T4/T5 to T12/L1) and the lumbar spine (L1/L2 to L4/L5).

Statistical Analysis

We used logistic regression to calculate odds ratios (ORs), 95% confidence intervals (CIs), and chi squared (X^2) tests for trend to evaluate associations between baseline age and prevalence and progression of DHN and FJOA for the lumbar and thoracic spine in women and men. We categorized baseline age as 40 to 59, 60 to 69, and 70 to 89 years, since grouping by equal decades of age did not permit adequate numbers for analyses; see Table 1. We used logistic regression to evaluate associations between sex (using men as the reference group) and baseline prevalence and progression of DHN and FJOA for the lumbar and thoracic spine, adjusted for baseline age. We calculated simple frequencies to characterize progression of DHN and FJOA by the number of levels affected and to describe the distribution across the spine.

Results

The study included 1,195 cohort members, 655 women and 540 men. Mean age at baseline was 61 years (Table 1), and ranged from 40 to 85 years. Mean BMI was 28 kg/m² in women and 29 kg/m² in men. Eight percent of women and 9% of men were current smokers. Mean ($\pm$ SD) follow-up time between CT scans was 6 ($\pm$ 1) years.

Prevalence of moderate-to-severe DHN was observed on baseline CTs in approximately one-third of individuals 40 to 59 years old, half of individuals 60 to 69 years old, and two-thirds of those 70 to 89 years old at baseline (Table 2). DHN prevalence was generally similar at

the thoracic and lumbar regions and increased with baseline age in both women and men (all tests for trend, $p < 0.01$).

Progression of DHN over six years also increased with age, ranging from 12 to 27% in women and men ages 40–59 years, 26 to 36% in those 60–69 years, and 29 to 43% among 70–89 year olds at baseline (all tests for trend, $p < 0.01$), however, DHN progression appeared to occur more frequently at the lumbar than thoracic spine (Table 3).

DHN progression at the thoracic spine was higher in women than men (OR=1.42; CI=1.07, 1.88) but not at the lumbar spine (OR=1.24; CI=0.97, 1.06); no sex differences were observed in DHN prevalence (Figure 1).

Prevalence of moderate-to-severe FJOA increased with baseline age in women and men (40–59 years: 44 to 71%, 60–69 years: 66 to 81%, and 70–89 years: 83 to 86%; all tests for trend, $p < 0.01$; Table 4). However, the association with age was stronger with FJOA at the lumbar region than the thoracic region. In men, for example, the OR for the oldest age group compared to the youngest age group was 8.59 (4.57, 16.13) for FJOA prevalence at the lumbar spine, versus an OR of 2.97 (1.65, 5.36) for FJOA prevalence at the thoracic spine. In women, the OR was 3.98 (2.32, 6.81) for FJOA prevalence at the lumbar spine versus an OR of 2.22 (1.27, 3.88) at the thoracic spine.

Progression to moderate-to-severe FJOA appeared higher in the lumbar than thoracic spine in both women and men, however, there was no significant trend in FJOA progression with increasing baseline age in women (thoracic spine: $p = 0.67$, lumbar spine: $p = 0.40$) or men (thoracic spine: $p = 0.24$, lumbar spine, $p = 0.06$; Table 5). Further, prevalence and progression of FJOA at the lumbar spine were 56 to 70% higher in women than men, but no sex differences were seen with prevalence or progression of FJOA at the thoracic spine (Figure 1).

Progression to moderate-to-severe DHN and FJOA over six years occurred markedly more frequently in the lumbar spine than the thoracic spine (DHN: 11% to 12% for L1/L2 to L4/L5 versus 5% to 6% for T7/T8 to T11/T12; FJOA: 9% to 20% for L2/L3 to L4/L5 versus 5% for T5/T6); Figure 2. Within the lumbar region, 6-year progression of DHN was slightly lower in the upper segment (10% at L1/L2) than lower segment (11% to 12% at L2/L3 to L4/L5). Similarly, FJOA increased caudally: 9% at L2/L3, 15% at L3/L4, 20% at L4/L5. Within the thoracic region, 6-year progression of DHN and FJOA was greatest at the midthoracic spine, T8/T9, for DHN and T5/T6 for FJOA.

Discussion

This is the first longitudinal study to describe prevalence and progression of both DHN and FJOA, evaluated by CT, in a large community-based population of men and women. We found a high prevalence of moderate-to-severe DHN and FJOA that increased with baseline age, apparent on CT scans. Even among the youngest age group, 40 to 59 years, about one-third or more of women and men had imaged-based evidence of prevalent moderate-to-severe DHN, and more than half had prevalent FJOA. These estimates increased by two to three-fold for DHN and three to eight-fold for FJOA among individuals 70 to 89 years old at

baseline. Moreover, one-third of women and men age 60 years and older at baseline experienced progression (new or worsening) to moderate-to-severe DHN and FJOA over a period of six years.

Comparison of our findings with prior studies of DHN and FJOA is challenging due to differences in demographic characteristics of participants, imaging modalities and protocols, and diagnostic criteria [4]. Few studies evaluated women and men separately to allow direct comparison of sex differences [7], and only a small number of investigations were longitudinal [10–12]. Previous studies were largely based on evaluation of plain film radiographs [6, 7, 10, 11] which may not be as sensitive as CT imaging used in our study or MRI [12, 22], particularly for the evaluation of FJOA. Although semi-quantitative scoring of DHN and FJOA was used most frequently, the criteria and scale (for example, number of severity grades) differed across studies. Some investigations used radiographic based measurements other than semiquantitative scores, including morphometry or other approaches. Frequently, prior studies used definitions of mild (grade 1 and greater), and did not provide results for moderate-to-severe (grade 2 and greater), used in the present study.

With few exceptions [23, 24], prior work has focused on the lumbar spine, whereas, in our study, we included evaluation of both the thoracic and lumbar regions. Even though we provided results for the lumbar spine in order to compare findings to others, the lumbar levels evaluated are not always consistent across studies. Further, some definitions of DHN and FJOA required two or more levels, or two or more adjacent levels, to be affected, whereas others (including our study) did not have this requirement. Others used radiographic based measurements other than semiquantitative scores, including morphometry or other approaches.

Prevalence of moderate-to-severe (lumbar spine) DHN, ranging from 20% to 55%, has been reported for populations in the US [7], Netherlands [25, 26], Sweden [27], UK [28, 29], Japan [11], and Hong Kong [30]. Our 34 to 69% prevalence is in the upper distribution within this range, but consistent with the more sensitive CT imaging used in this study. Kalichman et al. [9] and Suri et al. [31] reported a higher moderate-to-severe DHN, 64% to 67%, in a subset of cohort members of the Framingham MDCT Study, the source population for the current study. The difference between our estimates is likely due to the small number of individuals in these subsets (N=187 [9]; N=362 [31]), versus our large sample (N=1,195). In addition, these prior studies were cross-sectional, whereas our study design was longitudinal and therefore restricted to cohort members who had both baseline and follow up CT examinations.

The Chingford Study reported 68% prevalence of DHN in a population-based cohort of women (mean age 54 years) in the UK [10]. However, the Chingford Study used a definition of grade 1 (mild) DHN, ascertained by plain radiography, in contrast to our threshold of grade 2 (moderate), evaluated by CT. The Wakayama Spine Study found notably high prevalence of DHN, greater than 90%, in a community-based study of 975 older adults in Japan with mean age 66 years [23]. However, the Wakayama Spine Study used the Pfirrmann classification system for MRI which includes evaluation of additional features (such as signal intensity) than disk height narrowing [32].

The prevalence of moderate-to-severe DHN was similar in women and men in our study. Similarly, the prevalence of moderate-to-severe DHN for the lumbar spine did not differ between women and men in the Johnston County Study [7], European Vertebral Osteoporosis Study (EVOS) [28] or Wakayama Spine Study [23], whereas the Rotterdam Study [25] and the Osteoporotic Fractures in Men (MrOS) and Women (MsOS) Studies in Hong Kong [30] found higher prevalence in women than men. We did find that women had higher 6-year progression of DHN than men for the thoracic, but not the lumbar spine. A 10-year longitudinal study in 197 village inhabitants in Japan found women were 2.5 times more likely than men to have greater progression in a lumbar spine disc height index measured from plain radiography [11].

In our study, frequency of progression of lumbar spine DHN in women was slightly higher (~5.5%/year) than the Chingford Study (~3%/year), consistent with differences in baseline age (Framingham, age 61; Chingford, age 54) and imaging modalities (CT versus radiography). In contrast, we observed ~4.7%/year progression of lumbar spine DHN in men, whereas Videman et al. [12] reported ~9%/year progression in 58 monozygotic twin males, despite the 12-year younger baseline age of the twin study. On the other hand, DHN was assessed by MRI in the twin study which may be more sensitive than CT in evaluation of progression.

In order to evaluate FJOA, advanced imaging techniques are required to assess the 3-dimensional orientation of the facet joints. However, CT and MRI studies have mostly included patient volunteers recruited from clinical and trauma settings or younger aged adults (20 to 50 years) [33–39]. The advanced imaging studies that have evaluated prevalence of FJOA in non-clinical samples of older adults are limited to small sub-samples of participants in the current study [19, 31] and the Wakayama Spine Study [23]. No studies have reported incidence or progression of FJOA.

Our estimates of prevalence of moderate-to-severe lumbar spine FJOA are consistent with findings of 67% prevalence reported in the small, cross-sectional studies in the Framingham cohort conducted by Suri [31] and Kalichman [19]. In contrast, FJOA prevalence was somewhat lower, 57%, in the Johnston County Osteoarthritis Project, despite their use of a less severe definition of mild FJOA (although based on conventional radiograph evaluation) [7]. Although Jentzsch et al. [34] used CT evaluation of FJOA, the sample was comprised of trauma patients so that prevalence was predictably higher (75%) than in our study.

Women had higher prevalence of moderate-to-severe lumbar spine FJOA than men in our study, consistent with some [7, 19] but not all [34] previous reports. Higher prevalence in women is also observed for osteoarthritis in other joints, such as the knee [40], as well as higher frequency of women receiving treatment with facet joint steroid injections [2].

Progression of moderate-to-severe DHN and FJOA occurred markedly more frequently in the lumbar spine than the thoracic spine. This has been hypothesized to result from vulnerability of the lumbar segment to torsional forces [41]. In addition, our study shows cephalo-caudal increase in FJOA within the lumbar spine with highest frequency at L4/L5, consistent with previous cross-sectional [18, 35], case-control [36], and cadaveric studies

[42]. Cross-sectional studies previously showed cephalo-caudal increase of DHN in the lumbar spine [23, 43, 44].

Although few data are available on the thoracic spine, our findings of increased progression in the mid-thoracic spine are consistent with cross-sectional MRI studies that focused on thoracic disease [23, 45]. Girard et al conducted a longitudinal study of 40 patients (followed between 1 month and 3 years) and found the highest progression of DHN in the mid- and lower thoracic segments [46]. In Finnish twin men (N=519), Niemelainen and co-workers reported highest prevalence of DHN in the mid-thoracic spine and highest prevalence of anterior disc bulging in the lowest thoracic levels [24]. This might be related to greater load carried by the mid and lower thoracic spine.

Our study has several strengths. We used standardized, validated methods with high reliability to evaluate DHN and FJOA using advanced CT imaging. The longitudinal design allowed for evaluation of progression of DHN and FJOA. The large, population-based cohort provided results that could be generalized to the larger population of older adults and allowed comparisons between men and women. However, participants in the Framingham Study were predominately Caucasian. Thus, our findings may not be generalizable since frequency and risk factors for DSN and FJOA can vary across race and ethnic groups [7].

To our knowledge, this is the first longitudinal study in a non-clinical population of older adults to provide information on both DHN and FJOA for the thoracic spine as well as the lumbar spine, which lays the basis for a greater understanding of the interrelationship between thoracic and lumbar degenerative features. Finally, we did not have information on back pain in our study and were unable to compare frequency of spinal degeneration features detected by imaging versus defined by clinical evaluation. Systemic reviews show that epidemiologic studies evaluating the association between back pain and FJOA or DHN in older adults have been conflicting [4, 5, 47, 48]. Taken together with the current study, these results may suggest a cautious interpretation of image-based evidence of DHN and FJOA may be warranted given the high prevalence and progression of these degenerative findings in older adults.

Our study describes the prevalence, progression, and distribution of both DHN and FJOA in the thoracic and lumbar spine in women and men. Our results appear to be in line with clinical impressions of high frequencies of these degenerative conditions in older adults, particularly for the lumbar spine, and greater burden of FJOA in women than men. Further work is needed to determine the temporal sequence and etiology of these changes, and importantly, the impact on clinical outcomes.

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Fig. 1.

Age-adjusted odds ratios (98% confidence intervals) for the association between sex (men, reference group) and prevalence and progression of disc height narrowing (DHN) and facet joint osteoarthritis (FJOA) at the thoracic and lumbar spine

Fig. 2.
Progression of disc height narrowing (DHN) and facet joint osteoarthritis (FJOA) according to spinal level (T=thoracic and L=lumbar).

Table 1

Baseline characteristics of participants, Framingham Study, 2002–2005

	Men N=540	Women N=655	Total N=1,195
Baseline characteristic	Mean (SD) or Percent (n)		
Age (years)	61 (9)	61 (8)	61 (9)
Age group (%)			
40–49	5% (27)	4% (25)	4% (52)
50–59	44% (240)	46% (304)	46% (544)
60–69	32% (170)	32% (206)	32% (376)
70–79	18% (96)	17% (111)	17% (207)
80–89	1% (7)	1% (9)	1% (16)
BMI (kg/m ²)	29 (4)	28 (5)	28 (5)
Current smokers (%)	9% (48)	8% (52)	8% (100)

Table 2

Association between age and baseline prevalence of moderate-to-severe disc height narrowing (DHN) at the thoracic and lumbar spine in men and women, The Framingham Study. Prevalence of moderate-to-severe DHN is defined as grades 2 to 3 at baseline.

	Men N=540								Women N=655							
	Thoracic Spine				Lumbar Spine				Thoracic Spine				Lumbar Spine			
	n/N	%	OR	95% CI	n/N	%	OR	95% CI	n/N	%	OR	95% CI	n/N	%	OR	95% CI
Age (years)																
40–59	105/267	39	1.00	--	92/267	34	1.00	--	134/329	41	1.00	--	122/329	37	1.00	--
60–69	95/170	56	1.95	(1.32, 2.89)	90/170	53	2.14	(1.44, 3.17)	100/206	49	1.37	(0.97, 1.95)	110/206	53	1.94	(1.37, 2.77)
70–89	69/103	67	3.13	(1.94, 5.05)	71/103	69	4.22	(2.59, 6.87)	77/120	64	2.61	(1.69, 4.02)	81/120	68	3.52	(2.26, 5.49)
Trend, p			<0.01				<0.01				<0.01				<0.01	

OR=odds ratio CI=confidence interval

Table 3

Association between age and progression of moderate-to-severe disc height narrowing (DHN) at the thoracic and lumbar spine in men and women, The Framingham Study. Progression to moderate-to-severe DHN is defined as grades 0 or 1 at baseline and grades 2 or 3 at follow-up, or grade 2 at baseline and grade 3 at follow-up.

	Men N=540						Women N=655					
	Thoracic Spine			Lumbar Spine			Thoracic Spine			Lumbar Spine		
Age (years)	n/N	%	OR	95% CI	n/N	%	n/N	%	OR	95% CI	n/N	%
40–59	31/267	12	1.00	--	55/267	21	55/329	17	1.00	--	89/329	27
60–69	44/170	26	2.66	(1.6, 4.42)	58/170	34	62/206	30	2.14	(1.42, 3.25)	74/206	36
70–89	30/103	29	3.13	(1.78, 5.51)	39/103	38	48/120	40	3.32	(2.08, 5.29)	51/120	43
Trend, p			<0.01						<0.01			

OR=odds ratio CI=confidence interval

Table 4

Association between age and baseline prevalence of moderate-to-severe facet joint osteoarthritis (FJOA) at the thoracic and lumbar spine in men and women, The Framingham Study. Prevalence of moderate-to-severe FJOA is defined as grades 2 to 3 at baseline.

	Men N=540						Women N=655					
	Thoracic Spine			Lumbar Spine			Thoracic Spine			Lumbar Spine		
	n/N	%	OR	95% CI	n/N	%	OR	95% CI	n/N	%	OR	95% CI
40–59	172/267	64	1.00	--	118/267	44	1.00	--	232/329	71	1.00	--
60–69	136/170	80	2.21	(1.41, 3.47)	113/170	66	2.49	(1.67, 3.71)	166/206	81	1.63	(1.07, 2.48)
70–89	86/103	83	2.97	(1.65, 5.35)	89/103	86	8.59	(4.57, 16.13)	102/120	85	2.22	(1.27, 3.88)
Trend, p			<0.01				<0.01				<0.01	

OR=odds ratio CI=confidence interval

Table 5

Association between age and progression of moderate-to-severe facet joint osteoarthritis (FJOA) at the thoracic and lumbar spine in men and women, The Framingham Study. Progression to moderate-to-severe FJOA defined as grades 0 or 1 at baseline and grades 2 or 3 at follow-up, or grade 2 at baseline and grade 3 at follow-up.

	Men N=540						Women N=655					
	Thoracic Spine			Lumbar Spine			Thoracic Spine			Lumbar Spine		
	n/N	%	OR	95% CI	n/N	%	n/N	%	OR	95% CI	n/N	%
40–59	24/267	9	1.00	--	62/267	23	46/329	14	1.00	--	120/329	36
60–69	23/170	14	1.58	(0.86, 2.91)	54/170	32	33/206	16	1.15	(0.71, 1.87)	88/206	43
70–89	14/103	14	1.61	(0.80, 3.25)	34/103	33	15/120	13	0.86	(0.46, 1.61)	48/120	40
Trend, p			0.24						0.67			
												0.40

OR=odds ratio CI=confidence interval