SUPPLEMENTARY MATERIAL

SUPPLEMENTARY METHODS

Systematic Search (Supplementary Table 1)

A search of the Medline, EMBASE and Cochrane library databases was performed for original articles reporting relationships between non-radiographic imaging-assessed subchondral bone pathologies joint replacement, pain or structural progression in knee, hip, hand, ankle and foot OA

The bone pathological changes include bone marrow lesions (BMLs), osteophytes, attrition, cysts, as well as changes in shape, bone mineral density, bone morphometry (bone volume fraction, trabecular number, spacing and thickness), and bone signal from positron emission tomography and scintigraphy.

Data extraction

Papers meeting the inclusion/exclusion criteria were divided into longitudinal and cross-sectional papers. Longitudinal papers included prospective and retrospective cohorts and case-control studies with longitudinal data (i.e. nested case control studies). Extracted data included (a) patient demographics (age, sex and body mass index) (b) OA (clinical, radiographic or diagnostic) classification used, with the definition and prevalence of radiographic OA, (c) subchondral bone pathology feature, (d) joint replacement, pain or structural progression outcome measure (e) presence/absence of a relationship between feature and outcome (f) statistical results with or without adjustment for confounders and (g) the ipsicompartmental or contralateral compartment structural progression in relation to the bone pathology in longitudinal studies.

Quality Assessment (Supplementary Table 2)

A standardised quality scoring tool, previously used in other similar systematic reviews[1, 2] was adapted to assess the following components: (a) study population, (b) MRI subchondral bone feature, (c) pain or structural progression outcome, (d) study design and (e) analysis and data presentation (Supplementary Table 2). A score of ‘1’ or ‘0’ was allocated for each question according to whether the study fulfilled the criteria or not respectively. Where multiple bone features were assessed per article (e.g. criteria 11) the mean score was used. Any discordance in opinion was recorded and where consensus could not be achieved a third reviewer (PC) was consulted. The number of criteria applied to each type of study (e.g. cohort n=18 and cross-sectional n=14) varied and therefore scores were compared as percentages of the maximum score. A study was considered to be high quality if it exceeded or equaled the mean score in its class.

Most studies selected patients from existing cohorts rather than from the general population (criteria 1) and patients were selected by a minimum of evidence of OA (e.g. KL≥2) rather than at a uniform stage of OA severity (e.g. KL=2) (criteria 2). Most studies did not provide evidence of assessing the bone image feature before the knee OA outcome (criteria 9) and similarly did not indicate a prospective analysis plan for the relationship between bone image feature and OA outcome (criteria 17).

Best evidence synthesis

An association of a bone feature with a longitudinal OA outcome (structural progression, longitudinal change in pain, incident pain or joint replacement) was determined from cohort studies only. If a prospective cohort study analysis was of above average quality and found a statistically significant association between a bone feature and a longitudinal outcome after adjustment for at least age, gender and body mass index (referred to in the text as 'well-adjusted') this association was referred to as an 'independent' association. These three criteria were determined for all longitudinal analyses and if any of these three criteria were not fulfilled, the association was referred to simply as an association. The validity of cross-sectional associations was determined using cross-sectional and case-control studies and establishing whether the analysis of the association of severity was well-adjusted or not. This data is summarised in Table 5 of the main manuscript.

SUPPLEMENTARY TABLE 1

EMBASE (1980 to September 2014):

1	osteoarthri*	42	25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41
2	osteoarthro*	43	"magnetic resonance imag*".ti,ab
3	(arthri* adj2 degenerative)	44	mri.ti,ab
4	exp OSTEOARTHRITIS	45	mr.ti,ab
5	1 or 2 or 3 or 4	46	"magnetic resonance".ti,ab
6	knee*.ti,ab	47	NUCLEAR MAGNETIC RESONANCE IMAGING/
7	KNEE/	48	43 or 44 or 45 or 46 or 47
8	hand*.ti,ab	49	24 AND 42 and 48
9	HAND/	50	DEXA
10	Hip*.ti,ab	51	DXA
11	HIP/	52	DUAL ENERGY X RAY ABSORPTIOMETRY
12	foot*	53	50 OR 51 or 52
13	exp FOOT/	54	"bone mineral density"
14	ankle*	55	BMD
15	exp ANKLE/	56	BONE DENSITY/
16	6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15	57	54 or 55 or 56
17	5 and 16	58	24 and 53 and 57
18	HAND OSTEOARTHRITIS	59	"Computed tomography"
19	HIP OSTEOARTHRITIS	60	CT
20	coxarthr*.ti,ab	61	COMPUTER ASSISTED TOMOGRAPHY
21	KNEE OSTEOARTHRITIS/	62	"micro-computed tomography"
22	gonarthr*.ti,ab	63	pQCT
23	18 or 19 or 20 or 21 or 22	64	HR-pQCT
24	17 or 23	65	59 or 60 or 61 or 62 or 63 or 64
25	"subchondral bone".ti,ab	66	57 or 42
26	bml.ti,ab	67	24 and 65 and 66
27	"bone marrow lesion*".ti,ab	68	PET
28	"bone marrow oedema".ti,ab	69	24 and 68
29	"bone marrow edema".ti,ab	70	scintigraphy
30	BONE MARROW EDEMA/	71	24 and 70
31	osteophyte*.ti,ab	72	Bone shape
32	OSTEOPHYTE/	73	24 and 72
33	"bone cyst*".ti,ab	74	49 or 58 or 67 or 69 or 71 or 73
34	BONE CYST/	75	74 limit to humans
35	"bone area*".ti,ab		
36	"bone shape".ti,ab		
37	"bone attrition".ti,ab		
38	"trabecular".ti,ab		
39	TRABECULAR BONE/		
40	"volume fraction".ti,ab		
41	"BV/TV".ti,ab		

Medline (1950 to September 2014):

1	osteoarthri*	40	"magnetic resonance imag*"
2	osteoarthro*	41	mri
3	(arthri* adj2 degenerative)	42	mr
4	exp OSTEOARTHRITIS	43	"magnetic resonance"
5	1 or 2 or 3 or 4	44	MAGNETIC RESONANCE IMAGING/
6	knee*	45	40 OR 41 or 42 OR 43 OR 44
7	knee/ OR exp KNEE JOINT/	46	23 AND 39 and 45
8	hand*	47	DEXA
9	hand/ OR exp HAND joint	48	DXA
10	Hip*	49	Absorbtiometry, photon/
11	hip/ OR exp HIP JOINT	50	47 or 48 or 49
12	foot*.ti,ab	51	"bone mineral density"
13	foot/ OR exp FOOT JOINTS/	52	BMD
14	ankle*.ti,ab	53	BONE DENSITY/
15	ankle / OR exp ANKLE JOINT/	54	51 OR 52 or 53
16	6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15	55	23 AND 50 and 54
17	5 and 16	56	"Computed tomograph*"
18	osteoarthritis hip	57	CT
19	coxarthr*	58	tomography, X-RAY COMPUTED/
20	osteoarthritis knee	59	**"micro-computed tomography"**
21	gonarthr*	60	pQCT
22	18 or 19 or 20 or 21	61	HR-pQCT
23	17 or 22	62	56 or 57 or 58 or 59 or 60 or 61
24	"subchondral bone"	63	54 or 39
25	bml	64	23 and 62 and 63
26	"bone marrow lesion*"	65	PET
27	"bone marrow oedema"	66	23 and 65
28	"bone marrow edema"	67	Scintigraphy
29	osteophyte*	68	23 and 67
30	OSTEOPHYTE/	69	Bone shape
31	"bone cyst*"	70	23 and 69
32	BONE CYSTS/	71	46 or 55 or 64 or 66 or 68 or 70
33	"bone area*"	72	71 limit to humans
34	"bone shape"		
35	"bone attrition"		
36	trabecular		
37	"volume fraction"		
38	"BV/TV"		
39	24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32 OR 33 OR 34 OR 35 OR 36 OR 37 OR 38		

SUPPLEMENTARY TABLE 2 – QUALITY SCORING TOOL

Item	Criterion	CC	CH	CS
Study population				
1	Recruitment from the general population	1	1	1
2	Selection occurred before disease onset or at a uniform point. A uniform point was considered to be equal baseline grade of structural progression (e.g. Kellgren Lawrence grade) or an analysis within the same osteoarthritic joint	1	1	1
3	Cases and controls drawn were from the same population	1		
4	Participation rate >80% for cohort studies (retrospective cohort studies score zero automatically)		1	
5	Sufficient description of baseline characteristics - must include age, gender and BMI (or height and weight)	1	1	1
6	Baseline characteristics comparable between cases and controls - must include age, gender and BMI (or height and weight)	1		
Assessment of Imaging-detected subchondral bone risk factor or feature				
7	Risk factor / feature assessed with a standardised method (e.g. WORMS BML scoring or an automated calculation of bone area but not a subjective opinion of a radiologist on the presence of bone attrition)	1	1	1
8	Risk factor / feature assessment was identical (performed the same way) in the studied population(s)	1	1	1
9	Risk factor / feature was assessed prior to the outcome (structural progression or pain). A score of zero was allocated if the methods did not describe this.	1	1	1
Assessment of joint OA outcome (pain or structural progression)				
10	Outcome assessment was identical in the studied population(s)	1	1	1
11	Outcomes were assessed reproducibly (intraclass correlation coefficient > 0.81 with a standardised assessment). If multiple outcomes were measured the mean reproducibility score was used.	1	1	1
12	Outcome classification was standardised (e.g. the WOMAC pain score but not a subjective opinion of a patient's pain)	1	1	1
Study design				
13	Prospective study design used		1	
14	Follow up time > 3 years	1	1	
15	Information provided on completers vs withdrawls in cohorts (without prospective trial data cohorts automatically score zero)		1	
16	Outcome evaluators were blinded to feature (risk factor)	1	1	1
17	Analysis of relationship between feature and outcome was planned prospectively	1	1	1
Analysis and data presentation				
18	The frequency of most important outcomes were given	1	1	1
19	appropriate analysis techniques used (statistical or comparative techniques)	1	1	1
20	adjusted for at least age, BMI and gender	1	1	1
	Maximum Score	17	18	14

CC: case control, CH cohort (prospective and retrospective), CS: cross sectional

SUPPLEMENTARY TABLES 3: QUALITY SCORING RESULTS CROSS-SECTIONAL STUDIES

		Quality Scoring Criteria																					
No.	Cross-sectional Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	%
1	Ai 2010 [3]	0	0			0		1	1	0	1	1	1				1	0	1	1	0	8	57%
2	Akamatsu 2014 [4]	0	0			1		1	1	0	1	0	1				1	0	1	1	0	8	57%
3	Antoniades 2000 [5]	0	0			1		1	1	0	1	1	1				1	0	1	1	0	9	64%
4	Baranyay 2007 [6]	0	1			1		1	1	0	1	1	1				0	0	1	1	1	10	71%
5	Bilgici 2010 [7]	0	0			1		1	1	0	1	1	1				1	0	0	1	0	8	57%
6	Burnett 2012 [8]	0	0			0		1	1	0	1	1	1				1	0	1	1	0	8	57%
7	Chaganti 2010 [9]	0	0			1		1	1	0	1	0	1				1	0	1	1	1	9	64%
8	Chiba 2011[10]	0	0			0		1	1	1	1	0	1				1	0	1	1	0	8	57%
9	Chiba 2012 [11]	0	0			1		1	1	0	1	0	1				1	0	1	1	0	8	57%
10	Crema 2010 [12]	0	0			1		1	1	0	1	1	1				0	0	1	0	0	7	50%
11	Dawson 2013 [13] abstract	0	0			1		0	0	0	0	0	0				0	0	0	0	1	2	14%
12	Ding 2005 [14]	0	0			1		1	1	0	1	1	1				0	0	1	1	1	9	64%
13	Dore [15] 2009	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
14	Driban [16] 2011	0	0			1		1	1	0	1	1	0				1	0	1	1	1	9	64%
15	Driban [17]2011	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
16	Eckstein [18] 2010	0	0			1		1	1	0	1	0	1				0	0	1	0	0	6	43%
17	Felson 2001 [19]	0	0			1		1	1	0	1	0.5	1				0	0	1	1	0	7.5	54%
18	Fernandez-Madrid1994 [20]	0	0			1		0	0	0	1	0.5	1				1	0	1	1	0	6.5	46%
19	Frobell 2010 [21]	0	0			1		1	1	0	1	0	1				0	0	1	1	1	8	57%
20	Gosvig 2010 [22]	0	0			0		1	1	0	1	0	1				0	0	1	1	1	7	50%
21	Gudbergsen [23]	0	0			1		1	1	0	1	0	1				0	0	1	1	1	8	57%
22	Guymer 2007 [24]	0	1			1		1	1	0	1	1	1				0	0	1	1	1	10	71%
23	Haugen 2012 [25]	0	0			1		1	1	0	1	1	1				1	0	1	1	0	9	64%
24	Haugen 2013 [26]	0	0			0		1	1	0	1	0	1				0	0	1	1	0	6	43%
25	Haugen 2012 [27]	0	0			1		1	1	0	1	1	1				1	0	1	1	0	9	64%
26	Haverkamp 2011 [28]	0	0			1		1	1	0	1	0	1				0	0	0	1	0.5	6.5	46%
27	Hayashi [29]	0	0			1		0	1	0	1	1	1				1	0	1	1	0	8	57%

No.	Cross-sectional Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	%
28	Hayes [30]	0	0			1		1	1	0	1	0.5	1				1	0	1	1	0	8.5	61%
29	Hernandez-Molina 2008 [31]	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
30	Ip [32]	0	0			1		1	1	0	1	0.5	1				1	0	1	1	1	9.5	68%
31	Jones 2004 [33]	0	0			0		1	1	0	1	1	1				0	0	0	1	1	7	50%
32	Kalichman [34] 2007	0	0			1		1	1	0	1	0	1				1	0	1	1	1	9	64%
33	Kalichman [35] 2007	0	0			1		1	1	0	1	0	1				0	0	1	1	1	8	57%
34	Kim [36]	0	0			0		1	1	0	1	1	1				1	0	1	1	1	9	64%
35	Knupp 2009 [37]	0	0			0		1	1	0	1	1	1				1	0	1	1	0	8	57%
36	Kornaat [38] 2006	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
37	Kornaat [39] 2005	0	0			1		1	1	0	1	1	1				0	0	1	1	0	8	57%
38	Kraus 2009 [40]	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
39	Kraus 2013 [41]	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
40	Kumar [42]	1	0			1		1	1	0	1	1	1				1	0	1	1	0	10	71%
41	Lindsey [43]	0	0			1		1	1	0	1	1	1				1	0	1	1	0	9	64%
42	Link [44] 2003	0	0			0		1	1	0	1	0.5	1				1	0	1	1	0	7.5	54%
43	Lo 2005 [45]	0	0			1		1	1	0	1	1	1				0	0	1	0	0	7	50%
44	Lo [46] 2009	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
45	Lo [47] 2012	0	0			1		1	1	0	1	1	1				1	0	1	1	0	9	64%
46	Lo [48] 2006	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
47	Macfarlane 1993 [49]	0	0			0		1	1	0	1	1	1				1	0	1	1	0	8	57%
48	Maksymowych 2014 [50]	0	0			1		1	1	0	1	1	1				1	0	1	1	0	9	64%
49	McCauley 2001 [51]	0	0			0		1	1	0	1	0	1				0	0	0	0	0	4	29%
50	McCrae 1992 [52]	0	0			1		1	1	0	1	0	1				0	0	1	1	0	7	50%
51	Meredith 2009 [53]	0	1			0		1	1	0	1	0	1				0	0	1	1	0	7	50%
52	Moisio [54] 2009	0	0			1		1	1	0	1	1	1				1	0	0	1	1	9	64%
53	Neumann 2007 [55]	0	0			0		1	1	0	1	0	1				0	0	1	1	0	6	43%
54	Ochiai [56] 2010	0	0			0		0	1	0	1	1	1				1	0	1	1	0	7	50%
55	Okazaki [57] 2014	0	0			0		1	1	0	1	0	1				1	0	1	1	0	7	50%
56	Ratzlaff [58] 2013	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
57	Ratzlaff [59] 2014	0	0			1		1	1	0	1	1	1				1	0	1	1	0	9	64%
58	Reichenbach 2008 [60]	0	0			1		1	1	0	1	0	1				0	0	1	0	0	6	43%

No.	Cross-sectional Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	%
59	Reichenbach 2011 [61]	0	1			1		1	1	0	1	0	1				0	0	1	1	1	9	64%
60	Roemer [62] 2012	0	0			1		1	1	0	1	0	1				0	0	1	1	1	8	57%
61	Scher 2008 [63]	0	0			0		1	1	0	1	0	1				0	0	1	1	0	6	43%
62	Sengupta [64] 2006	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
63	Sharma [65] 2014	0	0			1		1	1	0	1	1	1				1	0	1	1	1	10	71%
64	Sowers 2003 [66]	0	0			1		1	1	0	1	0.5	1				0	0	1	1	0	7.5	54%
65	Stefanik [67] 2014	0	0			1		1	1	0	1	1.0	1				1	0	1	1	1	10	71%
66	Stefanik [68] 2012	0	0			1		1	1	0	1	0	1				0	0	1	1	1	8	57%
67	Stehling 2010 [69]	0	1			1		1	1	0	1	1	1				0	0	1	1	1	10	71%
68	Torres 2006 [70]	1	0			1		1	1	0	1	0.5	1				0	1	1	1	0	9.5	68%
69	Wang 2005 [71]	0	0			0		1	1	0	1	1	1				0	0	1	1	1	8	57%
70	Zhai 2006 [72]	1	0			1		1	1	0	1	1	1				1	0	1	1	1	11	79%
																				Mean		8.3	59%
																				Max		14	

SUPPLEMENTARY TABLES 4: QUALITY SCORING RESULTS COHORT STUDIES

		Quality Scoring Criteria																					
No.	Cohort Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	total	%
1	Agricola 2013 [73]	0	1		1	1		1	1	0	1	1	1	0	1	0	0	0	1	1	1	12	67%
2	Agricola 2013 [74]	0	1		1	1		1	1	0	1	1	1	0	1	0	0	0	1	1	1	12	67%
3	Agricola 2013 [75]	0	1		1	1		1	1	0	1	1	1	0	1	0	1	0	1	1	1	13	72%
4	Bruyere[76] 2003	0	0		0	0		1	1	0	1	0	1	0	0	0	1	0	1	1	1	8.0	44%
5	Carnes [77] 2012	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	9.0	50%
6	Carrino [78] 2006	0	0		0	0		0	1	0	1	0	1	0	0	0	0	0	1	0	0	4.0	22%
7	Cicuttini 2004 [79]	0	0		1	1		1	1	0	1	1	1	1	1	1	1	0	1	1	1	14	78%
8	Crema 2013 [80]	0	0		0	1		1	1	0	1	0	1	0	0	0	0	0	1	1	1	8.0	44%
9	Crema 2014 [81]	1	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	10.0	56%
10	Davies-Tuck [82] 2008	0	0		0	1		1	1	0	1	1	1	0	0	1	0	0	1	1	1	10.0	56%
11	Davies-Tuck 2010 [83]	0	1		0	1		1	1	0	1	1	1	0	0	1	0	0	1	1	1	11	61%
12	De-Lange 2014 [84]	0	0		0	1		1	1	0	1	0	1	1	1	0	1	0	1	1	1	11	61%
13	Dieppe 1993 [85]	0	0		0	1		1	1	0	1	0	1	0	1	0	1	0	1	1	0	9.0	50%
14	Ding 2006 [86]	1	0		1	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	11	61%
15	Ding [87] 2008	1	0		0	1		1	1	0	1	1	1	1	0	1	0	1	1	1	1	13	72%
16	Dore 2010 [88]	1	0		0	1		1	1	0	1	1	1	0	0.5	0	1	0	1	1	1	11.5	64%
17	Dore 2010 [89]	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	9.0	50%
18	Dore 2010 [90]	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	9.0	50%
19	Driban [91] 2011	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	9.0	50%
20	Driban [92] 2012	0	0		0	1		0	1	0	1	0	1	0	0	0	0	0	0	1	0	5.0	28%
21	Driban [93] 2013	0	0		0	1		1	1	0	1	1	1	0	1	0	1	0	1	1	1	11.0	61%
22	Everhart [94] 2014	0	0		0	1		1	1	0	1	1	1	0	1	0	1	0	1	1	1	11.0	61%
23	Felson [95] 2003	0	0		1	1		1	1	1	1	1	1	1	0	1	1	1	1	1	1	15.0	83%
24	Foong [96] 2014	0	0		0	1		1	1	0	1	1	1	0	1	1	1	0	1	1	1	12.0	67%
25	Guermazi [97] 2014	0	0		0	1		1	1	0	1	0	1	0	1	0	1	0	1	1	1	10.0	56%
26	Haugen [98] 2014	0	0		0	1		1	1	0	1	1	1	0	1	0	1	0	1	1	1	11.0	61%
27	Haugen [99] 2014	0	0		0	1		1	1	0	1	1	1	0	1	0	1	0	1	1	1	11.0	61%
28	Hernandez-Molina [100]2008	0	0		0	1		0	1	0	1	1	1	0	0	0	0	0	1	1	1	8.0	44%

No.	Cohort Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	total	%
29	Hochberg 2014 [101]	0	0		1	0		1	1	0	1	1	1	0	1	0	1	0	1	1	1	11.0	61%
30	Hudelmaier [102] 2013	0	0		0	1		1	1	0	1	1	1	0	0	0	1	0	1	1	0	9.0	50%
31	Hunter [103] 2006	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	0	8.0	44%
32	Kornaat [104] 2007	0	0		0	1		1	1	0	1	1	1	0	0	0	1	0	1	1	1	10.0	56%
33	Koster 2011 [105]	0	0		0	1		0	1	0	1	0	1	1	0	1	0	0	1	1	0	8	44%
34	Kothari [106] 2010	1	0		0	1		1	1	0	1	0	1	0	0	0	0	0	1	1	1	9.0	50%
35	Kubota[107] 2010	0	0		0	1		0	1	0	1	0	1	1	0	0	0	0	1	1	0	7.0	39%
36	Liu 2014 [108]	0	1		1	0		1	1	0	1	1	1	1	0	0	0	0	0	1	0	9.0	50%
37	Lo [109] 2012	0	0		0	1		1	1	0	1	0	1	0	0	0	1	0	1	1	1	9.0	50%
38	Madan-Sharma [110] 2008	0	0		0	1		1	1	0	1	0.5	1	0	0	0	0	0	1	1	1	8.5	47%
39	Mazzuca 2004 [111]	0	0		1	1		1	1	0	1	1	1	0	0	0	1	0	1	1	1	11	56%
40	Mazzuca 2005 [112]	0	0		1	1		1	1	0	1	1	1	0	0	0	1	0	1	1	0	10	56%
41	Moisio [54] 2009	0	0		0	1		1	1	0	1	1	1	0	0	0	1	0	1	1	1	10.0	56%
42	Parsons [113] 2014	0	0		0	1		1	1	0	1	0	1	0	0	0	1	0	1	1	1	9.0	50%
43	Pelletier [114] 2007	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	9.0	50%
44	Raynauld [115] 2008	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	9.0	50%
45	Raynauld 2011 [116]	0	0		0	1		1	1	0	1	1	1	0	1	0	1	0	1	1	1	11.0	61%
46	Raynauld 2013 [117]	0	0		0	1		1	1	0	1	1	1	0	1	0	1	0	1	1	1	11.0	61%
47	Roemer [118] 2009	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	9.0	50%
48	Roemer [119] 2009	0	0		0	1		1	1	0	1	0	1	0	0	0	0	0	1	1	1	8.0	44%
49	Roemer [120] 2012	0	0		0	1		1	1	0	1	0	1	0	0	0	0	0	1	1	1	8.0	44%
50	Scher 2008 [63]	0	1		0	1		1	1	0	1	1	1	0	0	0	1	0	1	1	0	10	56%
51	Sowers [121] 2011	0	0		0	1		1	1	0	1	0.5	1	0	1	0	1	0	1	1	0	9.5	53%
52	Tanamas [122] 2010	0	0		0	1		1	1	0	1	1	1	0	0	1	0	0	1	1	0	9.0	50%
53	Tanamas [123] 2010	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	0.5	8.5	47%
54	Wildi [124] 2010	0	0		0	1		1	1	0	1	1	1	0	0	0	0	0	1	1	1	9.0	50%
55	Zhang [125] 2011	0	0		0	1		1	1	0	1	1	1	0	0	0	1	0	1	1	0	9.0	50%
																					mean	9.7	54%
																					Max	18.0	

SUPPLEMENTARY TABLES 5: QUALITY SCORING RESULTS CASE-CONTROL STUDIES

		Quality Scoring Criteria																					
No.	Case control study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	total	%
1	Aitken 2013 [126]	0	0	0		0	0	1	1	0	1	0	1		1		0	0	1	1	1	8	47%
2	Barr 2012 [127]	0	1	1		1	0	1	1	0	1	1	1		1		1	0	1	1	1	13	76%
3	Bennell 2008 [128]	0	0	0		1	0	1	1	0	1	1	1		0		1	0	1	1	1	10	59%
4	Bowes 2013 [129]	0	1	1		1	0	1	1	0	1	0	1		1		1	0	1	1	1	12	71%
5	Doherty 2008 [130]	0	0	0		1	0	1	1	0	1	1	1		0		0	0	1	1	1	9	53%
6	Felson 2007 [131]	0	1	1		1	0	1	1	0	1	1	1		0		1	0	1	1	1	12	71%
7	Hunter 2013 [132]	0	0	1		1	0	1	1	0	1	0	1		1		1	0	1	1	0	10	59%
8	Javaid 2012 [133]	0	0	1		1	1	1	1	0	1	1	1		0		0	0	1	1	0	10	59%
9	Javaid 2010 [134]	0	1	1		1	1	1	1	0	1	1	1		0		1	0	1	1	1	13	76%
10	Neogi 2013 [135]	0	1	1		1	0	1	1	0	1	0	1		0		1	0	1	1	1	11	65%
11	Neogi 2009 [136]	0	0	1		1	1	1	1	0	1	0	1		0		0	0	1	1	1	10	59%
12	Nicholls 2011 [137]	0	0	1		1	1	1	1	0	1	1	1		1		1	0	0	1	1	12	71%
13	Ratzlaff 20148 [138]	0	1	1		0	0	1	1	0	1	1	1		0		1	0	1	1	1	11	65%
14	Stahl 2011 [139]	0	0	1		1	0	1	1	0	1	1	1		0		0	0	1	0	0	8	47%
15	Wluka 2005 [140]	0	0	0		1	0	1	1	0	1	1	1		0		0	0	0	1	1	8	47%
16	Zhao 2010 [141]	1	0	0		1	0	1	1	0	1	0.5	1		0		0	1	1	1	0	9.5	56%
																					mean	10.1	59%
																					max	17	

SUPPLEMENTARY TABLES 6: - A DESCRIPTION OF THE INCLUDED STUDIES, THE RELATIONSHIPS EXAMINED AND THE QUALITY OF EACH PAPER

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
Knee cohort studies						
Bruyere 2003 [76]	56	Knee OA (ACR criteria), gender distribution unknown, mean age 65 yrs	Subchondral tibial bone BMD (DXA) (C)	Minimum medial JSW TFJ after one year (L)	Multiple regression	Low (44)
Carnes 2012 [77]	395	Randomly selected older adults with over 52% knee ROA. 50% female, mean age 63 yrs. TASOAC	MRI tibial Bone area (C)	Semi-quantitative cartilage defect progression TFJ (L)	Logistic regression	Low (50)
Carrino 2006 [78]	32	Chronic knee pain with MRI features of OA. 63% female, mean age 51 yrs. USA	Crude presence of MRI BML, bone cyst TFJ (C) and (L)	Graded cartilage defect TFJ (L)	Crude comparison	Low (22)
Cicuttini 2004 [79]	113	Symptomatic, clinical (ACR) knee OA with mild to moderate TFJ ROA, mean age 64yrs, mean BMI 29, 58% females. Australia	Baseline Quantitative MRI tibial bone area (C)	TKR incidence (L) over 4 years	Logistic regression	High (78)
Crema 2013 [80]	1351	Knee OA or at high risk of it. 39% ROA, 62% female, mean age 62 yrs. MOST	MRI Incident BML (WORMS) TFJ (L)	Progressive (30 month) semi-quantitative cartilage defect (WORMS) TFJ (L)	Logistic regression	Low (44)
Crema 2014 [81]	163	Clinical knee OA, 37% knee ROA, 54% female, Mean age 58 yrs.	MRI BML (semi-quantitative) (C) (all regions)	Cartilage loss (semi-quantitative) (L) (all regions)	Logistic regression	High (56)
Davies-Tuck 2008 [82]	117	ACR knee OA. 58% female, mean age 64 yrs. Australia	Baseline MRI tibial bone plateau area (C) TFJ	Progressive semi-quantitative cartilage defect score (L) medial and lateral TFJ	Linear regression	High (56)

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
Davies-Tuck 2010 [83]	271	No clinical knee OA (ACR clinical criteria) and no current or historic knee pathology, mean age 58yrs, 65% female, mean BMI 25. Melbourne.	Incident BML (new BML after 2 years with no BMLs at baseline) MRI TFJ (L)	Progression in semi-quantitative MRI cartilage defects score after 2 years. TFJ (L)	Logistic regression	High (61)
De-Lange 2014 abstract [84]	133	Symptomatic OA knee. ROA Knee (>50%), 80% female, mean age 60 yrs. GARP study	MRI osteophytes (medial or lateral TFJ) (C)	Radiographic JSN progression (OARSI) (L)	Generalised estimation equation models	High (61)
Dieppe 1993 [85]	94	Symptomatic and ROA knee (100%). 96% women, mean age 64 yrs, mean BMI 26. Referrals to hospital rheumatology unit	Baseline late and or early-phase subchondral bone scintigraphy signal (C)	Progression of JSN by ≥2mm or knee operation after 5 years (L)	Pearson Chi squared test	Low (50)
Ding 2006 [86]	325	Mostly no ROA knee (17% ~ KL =1), 58% female, Mean age 45 yrs. Mean BMI 27. Offspring study	Baseline MRI tibial bone area (C) TFJ	Change in semi-quantitative MRI cartilage defect scores over 2.3 yrs (L) TFJ	Logistic regression	High (61)
Ding 2008 [87]	252	Randomly selected adults with 15% knee ROA. 58% female, mean age 45 yrs.	Baseline MRI tibial bone area (C) TFJ	Progressive Cartilage volume loss (L) TFJ	Multivariable linear regression	High (72)
Dore 2010 [88]	395	Symptomatic knee OA, knee ROA (58%). 51% female, mean age 63 yrs, mean BMI 28. TASOAC	MRI BML size (L) regional or whole TFJ over 2.7 years	Change in WOMAC pain (L) over 2.7 years Incident TKR over 5 years (L)	Mixed effects models	High (64)
Dore 2010 [89] 12(6)	405	Prevalent knee OA, 50% female, Mean age 63 yrs. TASOAC	Baseline semi-quantitative BML severity (C) TFJ	Ipsi-compartmental cartilage volume loss (L)	Logistic regression and generalised estimating equations	Low (50)

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
Dore 2010 [90]	341	Older adult cohort. Right knees only. Mean age 63 yrs, ~48% female, mean BMI 27. TASOAC	Baseline proximal tibial BMD, DXA Baseline tibial bone area MRI (C)	Increase or no increase in semi-quantitative MRI cartilage defects over 2.7 years (L)	Logistic regression	Low (50)
Driban 2011 [91]	44	ACR knee OA(100%). 100% knee ROA, , 52% female, Mean age 65 yrs. Clinical trial of Vitamin D	Baseline 3D BML volume (C) and 24 month change in 3D BML volume (L) in TFJ compartments	24 month change in ipsicompartmental full thickness cartilage lesion area (L)	Multiple linear regression, Spearman correlations	Low (50)
Driban 2012 [92] Abstract	38	Knee ROA (100%). 66% female, mean age 61 yrs. OAI	MRI BML volume change (L) TFJ over 24 months	Change in cartilage thickness and denuded area of bone (L) TFJ over 24 months	Pearson correlation coefficients	Low (28)
Driban 2013 [93]	404	Prevalent ROA knee (71%) 49% female, mean age 63 yrs. OAI	Knee baseline BML volume (C) BML volume 48 month change (L) (TFJ)	48 month change in WOMAC pain (L) and OARSI JSN grade (L) (TFJ)	Multiple linear regressions & logistic regression	High (61)
Everhart 2014 [94]	1338	Prevalent ROA knee (74%) 60% female, Mean age 62 yrs. OAI	Baseline TFJ subchondral surface ratio of medial and lateral TFJ compartments (C)	Incident frequent knee pain at 48 months or radiographic progression of lateral or medial knee TFJ OA at 48 months (L)	Logistic regression	High (61)
Felson 2003	223	ACR knee OA and 75% ROA. 42%	Baseline	OARSI JSN grade	Generalised	High

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
[95]		female, mean age 66 yrs. BOKS	presence of BML in medial or lateral TFJ (C)	progression of TFJ (L)	estimating equations	(83)
Foong 2014 [96]	198	17% ROA knee, 42% female, Mean age 47 yrs. Offspring study	Change in quantitative BML size (L) and incident BMLs (L) In all three knee compartments over 8 years	WOMAC Knee pain severity over 8 years (L)	Linear regression	High (67)
Guermazi 2014 Abstract [97]	196	Knee ROA (24%), 62% female, mean age 60 yrs	Semi-quantitative BML score WORMS (C) TFJ	Cartilage thickness loss over 30 months (L)	multivariable logistic regression,	High (56)
Hernandez-Molina 2008 [100]	258	ACR knee OA and 77% ROA. 43% female, mean age 67 yrs. BOKS	Crude presence of central BMLs on MRI (C) TFJ	Semi-quantitative cartilage defect (WORMS) (L) TFJ	Logistic regression	Low (44)
Hochberg 2014 Abstract [101]	1024	100% Symptomatic and radiographic knee OA (the 'progressor' arm). OAI	Semi-quantitative MRI baseline femoral condyle BML size (C)	Incident TKR over 6 years (L)	Multivariable Cox proportional hazard models	High (61)
Hudelmaier 2013 [102] abstract	899	Prevalent ROA knee, ROA 60%, 60% women, mean age 62 yrs, OAI	Annual change in Segmented MRI knee bone area (L)	Baseline KL grade (C)	Non-paired t-test	Low (50)
Hunter 2006 [103]	217	ACR knee OA. 44% female, mean age 66 yrs. BOKS	Change in MRI semi-quantitative BML score (L) TFJ	Change in semi-quantitative cartilage defect score (WORMS) (L) TFJ	Generalised estimating equations	Low (44)
Kornaat 2007 [104]	182	OA knee symptoms (38%) and ROA (38%). 80% female, mean age 59 yrs. GARP	Semi-quantitative MRI BML change over 2 years (L) TFJ	Mean WOMAC pain over 2 years	Linear mixed models	High (56)
Koster 2011	117	One year follow up after acute knee	Baseline BML	Any progression in	Logistic	Low

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
[105]		trauma in primary care, 12% ROA knee, mean age 41yrs, 43% female, mean BMI 26, HONEUR	presence (C) TFJ	KL grade over 1 year (L) TFJ	regression	(44)
Kothari 2010 [106]	177	Some WOMAC dysfunction and >74% ROA knee, 79% female, mean age 66 yrs. MAK-2	Semi-quantitative baseline MRI BML, bone cyst and attrition (WORMS) (C) TFJ	Semi-quantitative cartilage defect score change over 2 years (WORMS) (L) TFJ.	Logistic regression, with generalised estimating equations	Low (50)
Kubota 2010[107]	122	Clinical and ROA (80%) of the knee. >90% female, mean age 68 yrs. Japan	MRI BML semi-quantitative volume score change over 6 months (L) TFJ	KL grade progression over 6 months (L) TFJ	Mann-Whitney U-test	Low (39)
Lo 2012 [109]	497	52% ROA knee, 47% female , Mean age 64 yrs. OAI	DXA measured medial:lateral periarticular BMD and MRI BVF, trabecular number, thickness and spacing (C)	OARSI medial TFJ JSN grade progression between 24 and 48 months (L)	Logistic regression	Low (50)
Liu 2014 S470 Abstract [108]	128	Medial knee OA, KL grade 4. Japan	Baseline Semi-quantitative osteophyte score (WORMS) (C) TFJ	Incident TKR at 6 months follow up (L)	Mann Whitney-U test & ROC curve	Low (50)
Madan-Sharma 2008 [110]	186	Prevalent ROA knee (40%). 81% female, mean age 60 yrs. GARP	Baseline MRI semi-quantitative BML, bone cyst (C) TFJ	OARSI medial TFJ JSN grade progression over 2 years (L) TFJ	Logistic regression	Low (47)
Mazzuca 2004 [111]	86	100% female, mean age 55 yrs, mean BMI 37.	Baseline late-phase bone scintigraphy (adjusted for	Progression of minimum JSN of the medial TFJ from baseline to 30	Pearson correlation coefficients	High (56)

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
			normal bone uptake) of the medial tibia and whole knee (C)	months (L)		
Mazzuca 2005 [112]	174	100% female, mean age 56 yrs, mean BMI 36. A placebo controlled trial of doxycycline	Baseline late-phase bone scintigraphy (adjusted for normal bone uptake) of the medial tibia and whole knee (C)	Progression of minimum JSN of the medial TFJ from baseline to 30 months (L)	multiple linear regression	High (56)
Moisio 2009 [54]	168	Some WOMAC dysfunction and 90% ROA knee. 78% female, mean age 66 yrs. MAK-2	Baseline MRI semi-quantitative BML score (C) TFJ and PFJ	Incident frequent knee pain 2 years after baseline (L)	Logistic regression	High (56)
Parsons 2014 Abstract [113]	559	Knee ROA (100%), 73% female, mean age 63 yrs. SEKOIA	Baseline semi-quantitative BML score (C)	Annual TFJ JSN (L)	Linear regression	Low (50)
Pelletier 2007 [114]	107	100% radiographic OA knee, 64% female, Mean age 62 yrs. Bisphosphonate Trial	Regional semi-quantitative baseline BML score (medial or lateral TFJ) (C)	Regional cartilage volume over 24 months (medial or lateral TFJ) (L)	Multivariate regression	Low (50)
Raynauld 2008 [115]	86	64% female, Mean age 61 yrs. Trial of bisphosphonate	Change in BML size (L) at 24 months in TFJ	Medial cartilage volume loss (L) at 24 months in TFJ	Multivariate linear regression	Low (50)
Raynauld 2011 [116]	123	Symptomatic knee OA of the medial TFJ, 65% female, mean age 61 yrs, mean BMI 32.	Baseline semi-quantitative BML score (C) TFJ	Incidence of TKR over 3 years (L)	Logistic regression	High (61)
Raynauld 2013 [117]	57	Patients from a chondroitin trial 81% female, mean age 63, mean BMI 31.	Baseline semi-quantitative BML WORMS score (C)	Incident TKR (L) 4 year follow up Time to TKR	Logistic regression, Cox regression	High (61)

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
			Medial TFJ			
Roemer 2009 [118]	395	Knee OA or at high risk of it. 33% ROA. 68% female, mean age 63 yrs. MOST	Change in MRI semi-quantitative BML size over 30 months (WORMS) (L) TFJ and PFJ	Progression in semi-quantitative cartilage defects in (WORMS) over 30 months (L) TFJ and PFJ	Logistic regression	Low (50)
Roemer 2009 [119]	347	Knee OA or at high risk of it. 14% ROA. 65% female, mean age 64 yrs. MOST	Baseline MRI BML crude presence or absence (WORMS) (L) TFJ	Semi-quantitative cartilage defect progression over 30 months (WORMS) (L) TFJ	Logistic regression	Low (44)
Roemer 2012 [120]	177	Chronic knee pain, 71% knee ROA, 49% female. Mean age 52 yrs. Glucosamine trial	Semi-quantitative BML (WORMS) TFJ and PFJ (C)	Semi-quantitative cartilage score 6-month progression TFJ and PFJ (L)	Logistic regression	Low (44)
Sowers 2011[121]	363	Minor OA symptoms with18% ROA knee. 100% female, median age 45 yrs. SWAN	Semi-quantitative MRI BML, osteophyte, bone cyst size in TFJ (C)	Progression in KL grade and WOMAC pain score (11 years follow up) (L)	Chi-square tests or Fisher exact tests. Logistic regression	Low (53)
Tanamas 2010 [123]	109	ACR knee OA, 73% ROA. 40% female, mean age 63 yrs. Australia	Semi-quantitative change in MRI Bone cyst or BML size (L)	Knee cartilage volume loss over 2 years (L) TFJ Incident TKR over 4 years	Logistic regression	Low (47)
Tanamas 2010 [122]	109	ACR knee OA, 72% ROA. 50% female, mean age 63 yrs, mean BMI 29. Australia	Baseline semi-quantitative MRI BML size (C)	Cartilage volume change over 2 years (L) TFJ Annual change in WOMAC pain(L) Incident TKR over 4 years	Logistic regression	Low (50)

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
Wildi 2010 [124]	161	Symptomatic medial TFJ OA knee (ACR criteria). 100% ROA knee, 66% female, Licofelone trial	24 month change in regional TFJ BML score WORMS (L)	24 months change in WOMAC pain (L) or regional change in cartilage volume (L)	Multivariate regression	Low (50)
Zhang 2011 [125]	570	Patients with knee OA or at high risk of it. 41% ROA knee. 68% female, mean age 62 yrs. MOST	Semi-quantitative change in MRI BML size (L) TFJ over 30 months	Incidence of frequent knee pain, and categorical severity (L) over 30 months	Logistic regression	Low (50)
Knee case-controls studies						
Aitken 2013 [126] Abstract	220	57% female, Mean age 45 yrs. Prevalence of ROA unknown. Offspring	Semi-quantitative BMLs tibia, femur & patella (C)	Cartilage volume and defect score Tibia and femur (L)	Linear regression	Low (47)
Bowes 2013 [129]	2197	Cases of clinical knee OA (100% ROA, n=1312), control healthy knees (0% ROA, n=885). 56% female, mean age 61 yrs. OAI dataset	Change in segmented MRI 3D Bone area over 4 year (L)	KL grade defined ROA knee (C)	ANCOVA model	High (71)
Bennell 2008 [128]	116	Cases of ACR medial knee OA (100% medial TFJ ROA) (n=75), asymptomatic control knees (n=41). 54% female, mean age 64 yrs. Australia	Volumetric BMD of tibial subchondral trabecular bone (qCT) (C)	KL grade (C)	Generalised linear models	Low (59)
Felson 2007 [131]	330	Patients at high risk of knee OA , cases with incident pain (n=110, ROA 30%), controls without pain (n=220,ROA 20%); 66%female, mean age 63 yrs. MOST	Semi-quantitative MRI BML size increase (WORMS) (L) TFJ & PFJ	Incident frequent pain at 15 months (L)	Multiple logistic regression,	High (71)
Hunter 2013 Abstract [132]	636	636 knees at risk of OA (ROA=0% at baseline). Cases of incident ROA n=318, Controls without incident ROA n=318, 67% female. Mean age 60 yrs. OAI	MRI bone area 8 knee regions (L)	Incident ROA knee (KL grade ≥2) (TFJ) (L)	Discrete-time Cox Proportional Hazards Regression	Low (59)
Javaid 2012	636	Patients with prevalent ROA. Cases	Baseline Semi-	Presence of	Conditional and	Low

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
[133]		have painful knees (n= 546), controls have no knee pain (n=90); 65% female, mean age 73 yrs. Health aging and body composition study	quantitative MRI BML, bone cyst and attrition size (WORMS) (C) TFJ & PFJ	frequent knee pain (C) after 2 years	marginal logistic regression	(59)
Javaid 2010 [134]	155	Clinical knee OA, cases with incident pain (n=33), controls without pain (n=122); 67% female, mean age 59 yrs. ROA 0%; MOST	Baseline semi-quantitative MRI BML, osteophyte, bone cyst size (WORMS) (C) TFJ & PFJ	Incident frequent knee pain after 15 months (L)	Logistic regression	High (76)
Neogi 2013 [135]	531	Incident knee TFJ ROA cases (n=178), controls did not develop ROA (n=353); 62% female, mean age 61 yrs. OAI dataset	MRI 3D bone shape (Tibia, Femur and patella) (C)	Incident TFJ ROA KL grade ≥2 (L)	Conditional Logistic regression	High (65)
Neogi 2009 [136]	4446	Clinical knee OA. Within-knee subregion cases (n=973) had cartilage loss, controls (n=3473) had not. 64% female, mean age 63 yrs; ROA 59% MOST	Baseline semi-quantitative MRI Bone attrition size (WORMS) (C) TFJ	Cartilage defects progression (WORMS) after 30 months TFJ	Logistic regression	Low (59)
Ratzlaff 2014 [138]	278	59% female, mean age 64, mean BMI 30. 138 cases of TKR and 138 ROA matched controls. OAI	Total tibial BML volume 12 and 24 months before TKR and interval change between 12 and 24 (C) and (L)	Incident TKR (L)	Conditional logistic regression	High (65)
Scher 2008 [63]	65	Patients with OA knee based upon radiography (>50% ROA), 54% female, mean age 51 yrs. USA	Presence of any baseline semi-quantitative MRI BMLs (C)	Incident TKR (L) over 3 years	Generalised estimating equations	High (56)
Stahl 2011 [139]	60	Clinical and 100% ROA knee cases (n=30) ; controls – healthy knees ROA 0% (n=30); All female, mean	Semi-quantitative MRI BML size (WORMS) (L)	Semi-quantitative Cartilage defect size (L) TFJ	Generalised estimating equations	Low (47)

Author of longitudinal studies	Patient number (n)	Study demographics	Subchondral bone feature assessed	Structural progression or severity / pain measure	Statistical analysis	Quality (score %)
		age 58 yrs. USA	TFJ	WOMAC score		
Wluka 2005 [140]	149	ACR knee OA cases (n=68), controls (n=81) without OA; 54% female, mean age 64 yrs. Australia	Change in MRI Tibial bone area (L)	Baseline radiographic JSN (C)	Logistic regression	Low (47)
Zhao 2010 [141]	38	Clinical and ROA cases (n=24), control (n=14) knees (KL=0); 54% female, mean age 52 yrs	MRI BML volume (C) TFJ	Overlying cartilage defect progression after one year (WORMS) (L) TFJ WOMAC pain	Student's t test	Low (56)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
Knee cross-sectional studies						
Ai 2010 [3]	28	Clinical knee OA. 55% ROA, 57% female, mean age 61 yrs. China	Semi-quantitative MRI BML and osteophytes (C)	Pain verbal rating scale (Likert) (C)	Fisher exact test	Low (57)
Akamatsu 2014 [4] Abstract	192	Varus ROA Knee 94%, 100% female, mean age 70 yrs. Japan	BMD (DXA) (C) (medial tibia & femoral condyle)	Medial TFJ JSN radiographic (C)	Pearson's Correlation	Low (57)
Baranyay 2007 [6]	297	No clinical knee OA (ACR clinical criteria) and no current or historic knee pathology, mean age 58yrs, 63% female, mean BMI 25. Melbourne	MRI BML defined as large or not large / absent in the medial and lateral compartments of TFJ (C)	MRI semi-quantitative cartilage defects of medial and lateral compartments of TFJ Quantitative Cartilage volume medial and lateral TFJ (C)	Logistic regression	High (71%)
Bilgici 2010 [7]	34	ACR knee OA. ROA 65%, 71% female, mean age 50 yrs.	MRI BML (WORMS) (C)	WOMAC pain & pain VAS (C)	Linear regression	Low (57)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
		Turkey				
Burnett 2012 [8]	42	Knees with OA awaiting total knee replacement, 100% ROA, 60% Female, mean age 64 yrs. Canada	BMD of patellar facets (qCT) (C)	WOMAC pain – knee pain at rest (C)	Independent t-test	Low (57)
Chiba 2012 [11]	60	Prevalent Knee OA. ROA 50%. 100% female, mean age 68 yrs Japan	MRI Bone volume fraction & trabecular thickness of the medial & lateral femur & tibia. (C)	Metric JSW (radiographic) (C) of the medial and lateral TFJ	Pearson's Correlation	Low (57)
Crema 2010 [12]	1283	Knee OA or at high risk of OA. ROA knee 44%. 60% female, mean age 62 yrs.	MRI Bone cysts (WORMS) (C)	Cartilage defect (WORMS) (C)	Comparison of tabulated data	Low (50)
Ding 2005 [14]	372	Mostly no ROA knee (17% ~ KL =1), 58% female, Mean age 45 yrs. Mean BMI 27. Offspring study	MRI quantitative tibial bone area (C)	Semi-quantitative MRI knee cartilage defect severity scores (C) TFJ	Linear regression	High (64)
Dore 2009 [15]	740	>15% ROA knee, 52% female, Mean age 62 yrs. TASOAC	DXA Tibial subchondral BMD (C)	Radiograph JSN grade and MRI cartilage defect and volume (C)	Multivariable analysis	High (71)
Driban 2011 [16] Abstract	421	NR	MRI Bone volume fraction (C)	Radiographic JSN (C)	Multiple linear regression	High (64)
Driban 2011 [17] Abstract	285	OAI Progression Cohort. No other demographic data available.	MRI bone volume fraction, trabecular number, spacing & thickness of medial tibia (C)	The presence of any grade of radiographic medial & lateral JSN (C)	Multiple linear regression	High (71)
Eckstein 2010 [18]	73	ROA knee (100%), 63% female with mean age of 61 yrs. OAI	MRI Tibial bone area (segmented) (C)	OARSI JSN grade (C)	Paired t-tests	Low (43)
	401	Prevalent knee OA	Semi-quantitative	KL grade	Chi-square or	Low (54)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
Felson 2001 [19]		(ACR criteria) and assumed ROA knee of 100%. 41% female, and mean age of 67 yrs. BOKS	MRI BMLs (C)	chronic knee pain presence (C)	fisher exact test & logistic regression	
Fernandez-Madrid 1994 [20]	90	ACR knee OA, 66% knee ROA, 65% female, mean age 55 yrs. USA	Crude presence of MRI BMLs, osteophytes (C)	KL grade and crude pain presence (C)	Chi-square	Low (46)
Frobell 2010 [21]	891	Three groups; pre-radiographic OA (KL grade <2), ROA and controls without OA, (total ROA knee 89%), 60% female, mean age 61 yrs. OAI	MRI Bone area – manual segmentation (C)	KL grade, OARSI JSN grade (C)	T tests and multivariate analyses	Low (57)
Gudbergsen [23] 2013	192	Obesity and knee OA (ACR criteria). 81% female, mean age 63 yrs. Denmark	Semi-quantitative MRI BML (BLOKS) (C)	KL grade (C)	Spearman correlation analyses	Low (57)
Guymer 2007 [24]	176	No clinical knee OA (ACR clinical criteria) and no current or historic knee pathology, mean age 52 yrs, 100% female, mean BMI 27. Melbourne.	Presence or absence of MRI BMLs (C) TFJ	Presence or absence of semi-quantitative cartilage defects (C) TFJ	Logistic regression	High (71)
Haverkamp 2011 [28]	609	1201 knees with 6% knee ROA and 25% knee pain prevalence, 100% female, and mean age 54 yrs, mean BMI 27. Rotterdam study	2D bone shape knee 1. femur & tibial width 2. elevation of lateral tibial plateau (C)	1.Presence of diffuse cartilage defects semi-quantitative scoring (MRI). 2.Presence of ROA knee (KL≥2) 3.Pain severity VAS (C)	Logistic and linear generalised estimating equation regression models	Low (46)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
Hayashi 2012 [29]	40	ROA knee 57% with and without pain, 75% female, mean age 57 yrs. USA	Crude presence of MRI osteophytes, bone cysts (C)	Presence of pain on WOMAC pain subscale (C)	Logistic regression	Low (57)
Hayes 2005 [30]	232	Clinical and ROA knee or healthy patients. 36% ROA knee, 100% female, mean age 46 yrs. Southeast Michigan Cohort.	Semi-quantitative MRI BML, osteophyte, bone cyst (C)	KL grade and chronic pain presence (C)	Fisher Exact Test, Chi-squared test	High (61)
Hernandez-Molina 2008 [31]	1627	Patients >50 yrs of age with and without knee pain. ROA knee 22%, 59% female, mean age 64 yrs. Framingham OA cohort	Semi-quantitative MRI bone attrition (WORMS) (C)	Pain severity and nocturnal pain (WOMAC) (C)	Logistic regression	High (71)
Ip 2011 [32]	255	Knee pain. ROA 38%, 56% female, median age 62 yrs. Canada	Semi-quantitative MRI BML (C)	WOMAC pain, KL grade (C)	Logistic regression & Pearson chi-squared	High (68)
Jones 2004 [33]	372	Mean age 45yrs, right knees, early ROA knee (3-14%), 58% female, mean BMI 27. Offspring	Tibial bone area (MRI) (C)	Radiographic JSN (C)	Linear Regression	Low (50)
Kalichman 2007 [34]	213	Predominantly knee OA (ACR criteria). ROA knee 75%, 41% female, mean age 67 yrs. BOKS	MRI patellar length ratio, trochlea sulcus angle (C)	JSN grade (C)	Logistic regression	High (64)
Kalichman 2007 [35]	213	Predominantly knee OA (ACR criteria). ROA knee 75%, 41% female, mean age 67 yrs. BOKS	MRI patellar length ratio, trochlea sulcus angle (C)	Cartilage defect (WORMS) (C)	Logistic regression	Low (57)
Kim 2013	358	Aging population with	Summary score and	WOMAC pain (C) or	Logistic	High (64)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
[36]		35% ROA knee. 51% female, mean age 72 yrs. Hallym Aging Study	severity of MRI BML (WORMS) (C)	presence of knee pain	regression	
Kornaat 2006 [38]	205	Symptomatic (35%)and ROA (47%) knee. 80% female, median age 60 yrs. GARP	Semi-quantitative MRI osteophyte bone cyst & BML (C)	Chronic pain presence (C)	Logistic regression	High (71)
Kornaat 2005 [39]	205	Symptomatic (35%)and ROA (47%) knee. 80% female, median age 60 yrs. GARP	Semi-quantitative MRI BML (KOSS) TFJ and PFJ (C)	Semi-quantitative cartilage defects (KOSS) TFJ and PFJ (C)	Odds ratio	Low (57)
Kraus 2009 [40]	159	Unilateral symptomatic and ROA knee (100%);74% female, mean age 63 yrs, mean BMI 32. POP	Ipsicompartmental late phase bone scintigraphy, semi-quantitative retention scoring of TFJ (C)	Ipsicompartmental OARSI scale of TFJ JSN (C)	Bivariate and Multivariable generalised linear modelling	High (71)
Lindsey 2004 [43]	74	Prevalent knee ROA (71%), 53% female, mean age 64 yrs,	MRI bone volume fraction & trabecular spacing (lateral TFJ) (C)	Cartilage volume in (contralateral TFJ) compartment (C)	Spearmans correlation	High (64)
Link 2003 [44]	50	Symptomatic knee OA, ROA 80%, 60% female, mean age 64 yrs. USA	Semi-quantitative MRI BML, osteophytes, and crude presence of bone cysts (C)	KL grade, WOMAC pain (C)	Fisher Exact Test, Chi-squared test	Low (54)
Lo 2005 [45]	498	Patients >50 yrs of age with and without knee pain. ROA knee 23%, 59% female, mean age 66 yrs. Framingham OA cohort	Semi-quantitative MRI BML (WORMS≥1) (C)	KL grade≥2 (C)	Crude comparison	Low (50)
Lo 2006 [48]	1612	Prevalent Knee OA, 18% ROA knee, 56% female, mean age 64 yrs. Framingham OA	DXA Medial:lateral BMD ratio at the tibial plateau (C)	Radiographic JSN grade (medial and lateral TFJ) (C)	Logistic regression	High (71)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
		Study Cohort				
Lo 2009 [46]	160	Symptomatic OA knee, 100% ROA. 50% female, mean age 61 yrs. OAI	Semi-quantitative MRI BML (BLOKS) (C)	WOMAC pain (C)	Univariate and multivariate cox regressions	High (71)
Lo 2012 [47]	482	Prevalent knee OA, 54% ROA, 47% female, mean age 64 yrs. OAI	MRI bone volume fraction, trabecular thickness, number and DXA BMD of proximal medial tibia (C)	Radiographic medial JSN grade (C)	Kruskal-Wallis and Mann-Whitney U tests	High (64)
McCauley 2001 [51]	193	Knees referred for MRI 43% female, mean age 40 yrs, mean weight 92kg.	MRI central osteophyte presence (C) TFJ	MRI cartilage lesion presence (C) TFJ	Crude association	Low (29)
McCrae 1992 [52]	30	Clinical or ROA knee (100%). 73% female, mean age 66yrs, Overweight or obese (65%). Recruited from rheumatology clinic	Late phase ‘extended bone uptake’ pattern bone scintigraphy, presence around the TFJ (C)	Radiographic TFJ JSN presence (C)	Chi squared test	Low (50)
Meredith 2009 [53]	140	Knees with MRIs before arthroscopic partial meniscectomy. Median age 61 yrs, 61% female	Sum of semi-quantitative MRI Osteophyte and BML scores in the TFJ and PFJ (C)	Sum of semi-quantitative MRI cartilage defect scores in the TFJ and PFJ (C)	Chi-squared test & Spearman test for non-parametric correlations	Low (50)
Moisio 2009 [54]	305	Patients with some WOMAC dysfunction and 90% ROA knee. 78% female, mean age 66 yrs. MAK-2	Baseline MRI semi-quantitative BML score (C) TFJ and PFJ	Presence of baseline moderate to severe knee pain (C)	Logistic regression	High (64)
Ochiai 2010 [56]	48	Patients with clinical medial knee OA and ROA knee (76%), mean	MRI irregularity of femoral condyle contour (C)	Knee pain VAS (C)	Pearson’s correlation	Low (50)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
		age 73 yrs. Gender distribution unknown. Japan				
Okazaki 2014 [57]	29	Radiographic knee OA (100%), 100% female, Mean age 65 yrs	Number of CT bone cysts (medial femur and tibia) (C)	Knee KL grade (C)	NR	Low (50)
Ratzlaff 2013 [58]	115	Radiographic knee OA (95%), 48% female, age range 45-79 yrs	Total BML volume in the femur or tibia (C)	Weight bearing knee pain WOMAC subscale (C)	Wilcoxon rank sum test, multivariable analysis,	High (71)
Ratzlaff 2014 [59] abstract	115	Knee ROA (90%)	Median BML volume (PFJ, TFJ) (C)	Stair-climbing knee pain WOMAC (C)	Wilcoxon rank sum test	High (64)
Reichenbach 2008[60]	964	Patients over 50 yrs of age with and without knee pain. ROA knee 18%, 57% female, mean age 63 yrs. Framingham OA cohort	Semi-quantitative MRI Bone attrition (WORMS) (C)	KL grade and semi-quantitative cartilage defects (WORMS) (C)	Crude comparison	Low (43)
Roemer 2012[62]	1248	Patients over 50 yrs of age with and without knee pain. ROA knee 23%, 58% female, mean age 64 yrs. Framingham OA cohort	MRI osteophyte (WORMS) (C)	Cartilage defect (WORMS) (C)	Logistic regression and generalised estimating equations	Low (57)
Scher 2008 [63]	73	Patients with OA knee based upon radiography (>50% ROA), 54% female, mean age 51 yrs. USA	Semi-quantitative MRI BML (C)	Semi-quantitative cartilage defect (modified Noyes) (C)	Univariate comparison (t-tests)	Low (43)
Sengupta 2006 [64]	217	Patients with prevalent knee OA (ACR criteria). ROA knee >75%, 25% female, mean age 67 yrs. BOKS	Semi-quantitative MRI Osteophyte (WORMS) (C)	Pain severity WOMAC, chronic pain (C)	Logistic regression	High (71)
Sharma 2014	837	At risk of Knee OA but	Semi-quantitative	Prevalent frequent	Multiple logistic	High (71)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
[65]		without ROA knee, 0% ROA knee, 57% female, mean age 60 yrs. OAI	MRI BML (WORMS) TFJ or PFJ (C)	knee symptoms (C)	regression	
Sowers 2003 [66]	231	Patients with infrequent OA knee symptoms and 15% ROA knee, 100% female, mean age 47 yrs. SWAN	Semi-quantitative MRI BML (C)	Semi-quantitative cartilage defect, chronic pain presence (C)	Wilcoxon or Maentel–Haenszel test of general association and logistic regression	Low (54)
Stefanik 2012 [68]	881	Patients with knee OA or at high risk of it. (ROA knee % unknown), 63% female, mean age 63 yrs. MOST	MRI lateral trochlear inclination and trochlear angle (C)	Semi-quantitative cartilage defect (WORMS) (C)	Logistic regression	Low (57)
Stefanik 2014 abstract [67]	2087	Prevalent clinical knee OA, 60% female, mean age 67 yrs	BML (WORMS) PFJ (C)	Prevalent knee pain (any pain in last 30 days) and pain VAS (C)	Logistic regression	High (71)
Stehling 2010 [69]	236	Knees without pain and with 6% ROA. Mean age 51yrs, 58% female, mean BMI 24. OAI	Presence of any MRI semi-quantitative BMLs, osteophytes or cysts (C)	Presence of any WORMS MRI cartilage defects (C)	Multi-variate regression	High (71)
Torres 2006 [70]	143	Patients with some WOMAC dysfunction and >55% ROA knee, 78% female, mean age 70 yrs. MAK-2	MRI BML, osteophyte, attrition, bone cyst (WORMS) TFJ & PFJ (C)	Pain VAS, semi-quantitative cartilage (WORMS) TFJ & PFJ (C)	Median quantile regression,	High (68)
Wang 2005 [71]	117	Symptomatic, clinical (ACR) knee OA with mild to moderate TFJ ROA, mean age 64yrs, mean BMI 29, males	Annual % change in tibial bone area (L) 2 yr follow up.	Baseline JSN (C)	Linear regression	Low (57)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
		and females. Australia				
Zhai 2006 [72]	500	Randomly selected older adults with over 23% knee ROA. 50% female, mean age 63 yrs. TASOAC	Semi-quantitative MRI BML (C)	WOMAC pain>1 (C)	Multivariable analysis	High (79)
Hip cohort studies						
Agricola 2013 [73]	723	Early symptomatic hip OA, the majority had no ROA hip (with doubtful ROA in 26%), 80% female, mean age 56 yrs, mean BMI 26.1, CHECK	Baseline alpha angle (2D femur shape) dichotomous abnormal >60°, normal ≤60 (C)	Incident ROA hip (KL>1) Incident end-stage ROA hip (KL>2 or THR) at or within 5 yrs (L)	Generalised estimating equations	High (67)
Agricola 2013 [74]	720	Early symptomatic hip OA, the majority had no ROA hip (with doubtful ROA in 24%), 79% female, mean age 56yrs, mean BMI 26.1. CHECK	Baseline 2D Centre edge angle (Acetabular shape): 25°<Normal<40° Undercoverage<25° Overcoverage>40° (C)	Incident ROA hip (KL>1 or THR) at or within 5 yrs (L)	Generalised estimating equations	High (67)
Agricola 2013 [75]	723	Early symptomatic hip OA, the majority had no ROA hip (with doubtful ROA in 24%), 79% women, mean age 56yrs, mean BMI 26.1. CHECK	Baseline 2D femoral and acetabular shape modes (segmented by statistical shape modelling) (C)	Total hip replacement at or within 5 yrs (L)	Generalised estimating equations	High (72)
Hip case-control studies						
Doherty 2008 [130]	2076	Symptomatic radiographic hip OA cases (n=965), asymptomatic controls without radiographic hip OA (n=1111) – GOAL	Non-spherical 2D femoral head shape assessment: 1) Appearance of ‘Pistol grip deformity’ (C)	Presence of radiographic hip OA (JSW≤2.5mm) (C)	Multivariable Logistic regression	Low (53)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
			2) Maximum femoral head diameter divided by minimum parallel femoral neck diameter (C)			
Barr 2012 [127]	141	First presentation of hip pain to primary care, 32% ACR hip OA criteria, 68% female, mean age 63 yrs, mean BMI 27.	2D Shape measures of centre edge angle (acetabular shape) (C)	THR vs no radiographic progression over 5 years (L)	Logistic regression	High (76)
Nicholls 2011 [137]	268	100% women, mean age, 55yrs, mean BMI 66. 243 controls, 25 cases of total hip replacement. Chingford Study	2D CAM deformity; mean modified triangular index height, alpha angle. Acetabular dysplasia; mean lateral center edge angle (C)	Total hip replacement (L)	Logistic regression	High (71)
Hip cross-sectional studies						
Chaganti 2010 [9]	3529	10% ROA hip, 100% male, Mean age 78 years. Cohort of the Study of Osteoporotic Fractures in Men	Femoral neck BMD (C) DXA	Hip ROA Modified croft score (categorical 0-4) (C)	Linear regression	High (64)
Chiba 2011 [10]	47	ROA, 100% female, mean age 69 yrs	Acetabular and femoral head subchondral trabecular morphometry: bone volume fraction, trabecular thickness, number, separation (CT)	Hip joint space volume (CT) (C)	Pearson's correlation test.	Low (57)
Dawson 2013	161	142 asymptomatic hips	Femoral head BMLs	1. Presence of hip OA	Regression	Low (14)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
Abstract [13]		without clinical OA, 19 with hip OA. 56% female, mean age 63yrs, mean BMI 27,	(MRI) (C)	2.Femoral head cartilage volume (MRI) (C)	modelling	
Gosvig 2010 [22]	3620	Mean age 61yrs, 63% female, ROA hip 10.6% (OA substudy - CCHS III)	2D Categorical Hip deformity: 1) Normal 2)'Pistol grip' 3) Deep acetabular socket (C)	Presence of radiographic hip OA (JSW≤2mm) (C)	Multivariate logistic regression	Low (50)
Maksymowych 2014 [50]	40	55% female, mean age 65yrs, symptomatic but not radiographic hip OA	Semi-quantitative BML HIP (HOAMS) (C)	Baseline WOMAC pain (C)	Univariable regression model	High (64)
Neumann 2007 [55]	100	Symptomatic hip OA	Semi-quantitative BMLs (C)	Semi-quantitative Cartilage lesions (C)	Spearman's correlations	Low (43)
Reichenbach 2011 [61]	244	Asymptomatic men (100%). Mean age 20 yrs, mean BMI 23, Sumiswald cohort	The presence or absence of any semi-quantitative MRI-defined CAM-deformity (C)	Combined femoral and acetabular cartilage thickness (C)	Multivariable linear regression. & Wald test	High (64)
Antoniades 2000 [5]	1148	White female twins, 29% hip RO A, 100% female, median age 53 yrs. St. Thomas' UK Adult Twin Register (C)	DXA BMD of the femoral neck of left (nondominant) hip with ROA (C)	Radiographic OA (croft Score) (C)	Logistic regression	High (64)
Kumar 2013 [42]	85	Members of the public with 35% ROA hip, 48% female , mean age 56 yrs (C)	Total hip semi-quantitative BML and subchondral cysts score (C)	Self-reported hip pain HOOS score	Non-parametric Spearman's correlations	High (71)
Hand case-series studies						
Haugen 2014 [98]	74	91% female, Mean age 68 yrs	BMLs – semi-quantitative	Progression of hand ROA (JSN, KL grade	Generalised estimating	High (61)

Author of Cross sectional studies	Patient number (n)	Study demographics	Subchondral bone feature assessed (method) region	Structural progression / pain outcome (method) region	Statistical analysis	Quality (score%)
			At 2^{nd} to 5^{th} IPJs (C)	or new erosion) (L)	equations	
Haugen 2014 Abstract [99]	70	90% female, mean age 68 yrs	Sum scores (0-48) for BMLs (Oslo Hand OA MRI score) (C) IPJS	AUSCAN pain scale (L)	Linear regression	High (61)
Hand cross-sectional studies						
Haugen 2012 Abstract [26]	108	91% women, mean age 69 years, 100% ROA hand Oslo hand osteoarthritis cohort	BML (Oslo MRI hand score) (C) IPJs	Radiographic JSN grade (OARSI atlas) (C) IPJs	logistic regression with generalised estimating equations	Low (43)
Haugen 2012 [27]	106	92% women, mean age 69 years, 100% ROA Oslo hand osteoarthritis cohort	BML, cyst, attrition, osteophyte (Oslo MRI hand score) (C) IPJs	Hand KL grade of IPJs (C)	Generalised estimating equations	High (64)
Haugen 2012 [25]	85	91% female, mean age 69 years, 100% ROA hand. Oslo hand osteoarthritis cohort	BML, cyst, attrition, osteophyte (Oslo MRI hand score) (C) IPJs sum scores	AUSCAN pain scale (C)	Linear regression	High (64)
Macfarlane 1993 [49]	35	100% ROA Hand, 91% female, mean age 62yrs. Rheumatology clinic attenders	Late phase isotope bone scan small joints of the hand (C)	Hand Pain VAS (C)	Kendall's correlation	Low (57)
Ankle cross-sectional studies						
Knupp 2009 [37]	27	Symptomatic ankle varus or valgus deformities refractory to conservative therapy, 37% female, mean age 49 yrs.	Late phase bone scintigraphy, semi-quantitative retention scoring of tibiotalar joint (C)	Tibiotalar ankle joint JSN. (Modified Takakura score) (C)	Mann-Whitney Rank sum test	Low (57)
Kraus 2013 [41]	138	Symptomatic ankle OA (23%), ROA ankle (79%), 74% female, mean age 64yrs, mean BMI 31. POP	Ipsilateral late phase bone scintigraphy, retention presence in tibiotalar joint (C)	Tibiotalar ROA KL grade and JSN (C)	Generalized estimating equations	High (71)

Australian/Canadian Osteoarthritis Hand Index (AUSCAN); Bone mineral density (BMD); Bone marrow lesion (BML); Boston Osteoarthritis of the Knee Study (BOKS), Boston–Leeds. Osteoarthritis Knee Score (BLOKS); a feature or outcome described in cross-section (C); Copenhagen City Heart Study (CCHS); Cohort hip and cohort knee (CHECK); knee pain on most days for at least the last month (chronic pain); Dual-energy X-ray absorptiometry (DXA); Genetics, Osteoarthritis and Progression study (GARP); GOAL (Genetics of Osteoarthritis and Lifestyle); Hip Osteoarthritis MRI scoring system (HOAMS); Hip dysfunction and Osteoarthritis Outcome Score (HOOS); interphalangeal joint (IPJ); joint space narrowing (JSN); joint space width (JSW); Kellgren Lawrence (KL); Knee Osteoarthritis Scoring System (KOSS); a feature or outcome described longitudinally (L); mechanical factors in arthritis of the knee 2 (MAK-2); patellofemoral joint (PFJ); quantitative computed tomography (qCT); radiographic osteoarthritis (ROA); Michigan study of Women's Health across the Nation (SWAN); Multicentre Osteoarthritis Study (most); osteoarthritis (OA); Osteoarthritis Initiative (OAI); Osteoarthritis Research Society International (OARSI); Strategies to Predict Osteoarthritis Progression (POP); Tasmanian Older Adult Cohort (TASOAC); tibiofemoral joint (TFJ); Total hip replacement (THR); visual analogue scale (VAS); Western Ontario and McMaster Universities arthritis index (WOMAC); whole-organ magnetic resonance imaging score (WORMS).

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