THE PREVALENCE OF RADIOGRAPHIC AND MAGNETIC RESONANCE IMAGING-DEFINED PATELLOFEMORAL OSTEOARTHRITIS AND STRUCTURAL PATHOLOGY: A SYSTEMATIC REVIEW AND META- ANALYSIS

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ABSTRACT

Background: Patellofemoral osteoarthritis (OA) is more prevalent than previously thought and contributes to patient's suffering from knee OA. Synthesis of prevalence data can provide estimates of the burden of PF OA.

Objective: To conduct a systematic review and meta-analysis on the prevalence of patellofemoral OA and structural damage based on radiography and magnetic resonance imaging (MRI) studies in different populations.

Methods: We searched six electronic databases and reference lists of relevant cross-sectional and observational studies reporting the prevalence of patellofemoral OA. Two independent reviewers appraised methodological quality. Where possible, data were pooled using the following categories: radiography, and MRI studies.

Results: Eighty-five studies that reported prevalence of patellofemoral OA and structural damage were included in this systematic review. Meta-analysis revealed a high prevalence of radiographic patellofemoral OA in knee pain or symptomatic knee OA (43%), radiographic knee OA or at risk of developing OA (48%), and radiographic and symptomatic knee OA (57%) cohorts. The MRI-defined structural patellofemoral damage in knee pain or symptomatic population was 32% and 52% based on bone marrow lesion and cartilage defect, respectively.

Conclusions: One half of people with knee pain or radiographic OA have patellofemoral involvement. Prevalence of MRI findings was high in symptomatic and asymptomatic population. These pooled data and the variability found can provide evidence for future research addressing risk factors and treatments for patellofemoral OA.

Trial registration number: PROSPERO systematic review protocol registration number CRD42016035649

What are the new findings?

- Patellofemoral OA is prevalent in individuals in a very wide range of settings –in asymptomatic individuals as well as in patients with knee pain
- The prevalence rates are influenced by different diagnostic criteria
- MRI-defined patellofemoral structural damage criteria may assist in identifying patients at early disease stages

1. INTRODUCTION

Knee osteoarthritis (OA) is a leading cause of pain and disability worldwide[1]. The patellofemoral joint (PF) is commonly affected in symptomatic knee OA[2] and is a substantial source of symptoms associated with knee OA[3]. Further to this, the PF is often affected by OA before the tibiofemoral (TF) joint and increases the risk of TF OA development and progression.[4 5]

With a recent increase in radiography and magnetic resonance imaging (MRI) based studies focused on PF joint, the evidence on the prevalence of PF OA is expanding rapidly. A 2013 narrative literature review concluded that the prevalence of radiographic PF OA in individuals' post anterior cruciate ligament and/or meniscus ruptures was approximately 50%.[6] A recent systematic review described the prevalence of radiographic PF OA in population- based and in cohorts of people with knee pain.[7] A large number of studies have reported PF OA in different populations (e.g., post-traumatic, and healthy individuals), and knowledge of population-specific prevalence is relevant for clinicians and researchers. An updated review with inclusion of different study samples (e.g., post-traumatic, occupation-based, high risk of OA, healthy individuals) builds considerably on the previous systematic review[7] and extends our current knowledge of PF OA.

Magnetic resonance imaging (MRI) is the modality of choice to assess structural damage in epidemiological studies, to detect early and subtle features of OA (e.g., abnormal cartilage morphology and bone marrow lesions) not seen on radiography.[8] Thus, the prevalence of PF structural damage using MRI may be higher than the prevalence determined by radiography. Including radiography and MRI based studies in community and specific study populations provide a comprehensive evaluation of the prevalence of PF OA and PF structural damage and extends prior reviews in this area. Thus, the objective of the current study was to perform a systematic review and meta-analysis with the aim to determine the prevalence of PF OA using radiographs and MRI-defined structural PF damage in a variety of study populations.

2. METHODS

The study protocol was developed in consultation with guidelines provided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) statement. The protocol was prospectively registered on the PROSPERO International prospective register for systematic reviews website (http://www.crd.york.ac.uk/PROSPERO) (Registration #: CRD42016035649). The reporting of this study followed the PRISMA checklist.

2.1 Literature Search Strategy

Using guidelines provided by the Cochrane Collaboration, a comprehensive search strategy was devised from the following electronic databases with no date restrictions: i) MEDLINE via OVID; ii) EMBASE via OVID; iii) CINAHL via EBSCO; iv) Scopus; v) Web of Science; and vi) SPORTDiscus. The primary search strategy included search for original publications. The search strategy was deliberately simplified to ensure inclusion of all relevant papers, with all terms searched as free text and key words (where applicable): Concept 1, Patellofemoral (Patello-femoral, PF, PFJ, knee joint); Concept 2, Osteoarthritis (OA, arthritis, degenerative arthritis, bone marrow lesion); and Concept 3, Prevalence (prevalence, morbidity, epidemiology, diagnosis, incidence). All search terms were exploded and scope notes from each database were examined for other possible terms for modification of search strategies. The MEDLINE search strategy was adapted for other databases (Supplementary Table 1). The search strategy was limited to English language and full-text. All potential references were imported into Endnote X7 (Thomson Reuters, Carlsbad, California, USA) and duplicates were removed. Two reviewers (HFH, NW) reviewed all titles returned by the database searches and retrieved suitable abstracts. Where abstracts suggested that papers were potentially suitable, the full-text versions were screened and included in the review if they fulfilled the selection criteria. Reference lists of all publications considered for inclusion were hand-searched recursively and citation tracking was completed using Google Scholar until no additional eligible publications were identified. A third reviewer was consulted in case of disagreements (JJS).

2.2 Selection Criteria

Cross-sectional and longitudinal studies reporting the prevalence or frequency of PF OA or PF structural damage were included. No restrictions were placed on age, sex or method of recruitment. Reviews, case reports and unpublished studies, as well as non-human studies were excluded.

2.3 Assessment of Methodological Quality and Risk of Bias

Two independent reviewers (NW, ZM), who remained blind to authors, affiliations, and the publishing journal, rated the methodological quality of included studies using the Critical Appraisal tool.[9] The Critical Appraisal tool was developed to appraise prevalence and incidence based studies and consists of eight items (maximum score possible 8). Final study ratings for each reviewer were collated and examined for discrepancies. Any inter-rater disagreement was discussed in a consensus meeting, and unresolved items were taken to a third reviewer (HFH) for consensus. Total scores were normalized to a scale ranging from 0 to 2, for each study to assign level of methodological quality. Studies were then classified as high quality (≥1.4), moderate quality (1.1 - 1.4) or poor quality (<1.1) based on normalized scores.[10]

2.4 Data Management and Statistical Analysis

For the purposes of this systematic review, we defined prevalence as the prevalence of PF OA in community-based studies and the reported frequencies of PF OA in other populations. Data pertaining to population, sample size, sex, age, type of imaging (MRI, radiography), grading criteria, units of analysis (number of participants affected or number of knees affected) and prevalence of radiographic PF OA and MRI-defined PF structural damage (isolated PF OA/PF structural damage; combined PF OA and TF OA/PF and TF structural damage; and unclear, not clearly described whether the prevalence was isolated or combined) were independently extracted and entered into an Excel spreadsheet. If sufficient data were not reported in the published article or supplementary material provided, the corresponding author was contacted to request further data. If multiple studies presented data from one cohort, the study with the most complete data was included. PF OA and MRI-defined PF structural damage prevalence data were reported for: (i) isolated, (ii) combined (PF and TF) and (iii) any (isolated, combined and unclear). Meta-analysis for proportions with random effects model were performed using MedCalc for Windows, Version 16.8 (MedCalc Software, Ostend, Belgium). Heterogeneity tests were also conducted and interpreted as follows: $I^2 \leq 25\%$, low heterogeneity; $I^2 = 25$ to $\leq 50\%$, moderate heterogeneity; and $I^2 \geq 75\%$, high heterogeneity.[11] Data were divided into two categories based on imaging technique used: (i) Radiography and (ii) MR imaging

Radiography studies

The Kellgren and Lawrence (KL) grading criteria[12] and Osteoarthritis Research Society International (OARSI) atlas[13] are used to define radiographic OA in the TF compartments. There is no KL or OARSI atlas definition of PF OA based on radiographs; however, both criterions are often used to quantify the severity of radiographic OA in the PF using the skyline and/or lateral radiograph views. For the purposes of this systematic review and meta-analysis, osteophytes and joint space narrowing were used to define PF OA. If prevalence for multiple radiographic OA features (e.g. prevalence based on osteophytes and joint space narrowing) was reported, then prevalence based on osteophytes was chosen. Data were pooled based on the following study populations: (i) community-based (individuals randomly recruited from community), (ii) knee pain/ symptomatic (individuals recruited based on knee-related symptoms), (iii) radiographic and symptomatic OA (individuals recruited based on symptoms and radiographic OA), (iv) healthy individuals (no pain, injury or OA), (v) radiographic or high risk of OA (individuals recruited based on radiographic OA or risk of developing radiographic OA without regard to knee pain/symptoms), (vi) occupational-based (individuals recruited based on their occupation/sports), and (vii) post-sports-related traumatic (individuals with previous knee-related trauma, such as anterior cruciate ligament injury or reconstruction or meniscal injury). Given that, individuals recruited based on high risk of OA may or may not have had previous trauma; data from individuals with high risk of OA were not included in the post-traumatic category. The occupation-based category included different sporting and occupational activities such as long distance runners, shooters, graphic designers, and monks. To determine the prevalence in individuals exposed to different activities, the data from sports and occupational activities were pooled together. Data were stratified based on intensity of activity (e.g. high: soccer graphic; low: graphic designers) activities. For longitudinal studies, data from the latest time point (rather than baseline) were included. Within the eight study population categories, sensitivity analyses were conducted when > 1 study reported sufficient data for pooling based on disease severity, compartment-specific OA pattern, age and sex. Disease severity was defined as mild, presence of at least mild radiographic PF OA; and definite, presence of definite radiographic PF OA (Supplementary Table 2). Compartment-specific OA pattern was defined as: (i) isolated PF OA, (ii) combined PF OA and TF OA, and (iii) any PF OA. Age groups for sensitivity analyses were categorized as: (i) mean age: <50 years, (ii) mean age: ≥50 years. These sensitivity analyses are presented in text for any PF OA, and in supplementary material (Supplementary Table 3) for the isolated and combined TF OA and PF OA groups. Where possible, medial and lateral PF OA prevalence was described.

Magnetic resonance imaging studies

Currently, there is no accepted definition of MRI-defined PF OA. A definition was proposed by Hunter et al.[14], which included a definite osteophyte and partial or full thickness cartilage loss. However, this proposed definition of MRI-defined PF OA has not been further validated. Furthermore, most previous studies do not provide data on osteophytes to enable calculation of PF OA prevalence using this definition. Therefore, for the purposes of this SR we will report MRI-defined structural damage. Data were pooled based on study populations described above (except for occupational-based population) as well as general population (studies that could not be categorized into one of the categories described above). Within each study population category, data were pooled based on cartilage defect and bone marrow lesions (BML) MR features. Authors used the following terms to define cartilage defect: cartilage abnormalities, cartilage defect, full cartilage thickness loss, cartilage pathology and cartilage lesion; and the following terms were used to define BML, marrow abnormities, marrow lesion and bone marrow edema. To allow data pooling where possible other scoring systems were compared to the Whole-Organ Magnetic Resonance Imaging Score (WORMS)[15] and MRI Osteoarthritis Knee Score (MOAKS)[16] based on the explanation of the scoring system provided in the paper. Data were stratified based on compartment-specific OA pattern (isolated PF OA, combined PF OA and TF OA, and any PF OA). Where possible, stratified analyses were conducted based on age (mean age: <50 years, ≥50 years) and sex. If possible, medial and lateral PF OA prevalence was described. Most longitudinal MR imaging studies provided most complete data at baseline rather than at later time points (dropouts or only odds ratios data for later time points); thus, this review included baseline data.

3. RESULTS

3.1 Search Strategy, Methodological Quality and Risk of Bias

The comprehensive search strategy identified 2681 titles, with the last search conducted on February 25th, 2016. Following removal of duplicate publications and conference proceedings, titles of 1105 publications were evaluated. Thirteen titles were obtained from other resources (Google scholar and hand-searching). The full texts of 144 articles were retrieved, with 117 articles meeting the selection criteria. Following removal of studies with duplicate data, 85 studies (63 radiography studies,[2 17-78] 24 MRI studies[39 79-101]) were included in this systematic review (Table 1 and 2, Figure 1). There was one study that reported data on radiographic PF OA and MRI-defined PF structural damage.[35] The methodological quality scores ranged from 0 to 2 (out of 2) (Supplementary Table 4). There were 15 studies of high quality, 16 were moderate, and 54 were low quality. Most studies scored negatively on items 1 (i.e., study design/sampling method) and 6 (i.e., response rate) and positively on items 4 (i.e., measurement criteria) and 8 (i.e., study subjects described) of the critical appraisal tool. A high level of heterogeneity was noted within radiography and MRI studies (I^2 range 96% to 100%). The level of heterogeneity remained high (I^2 range 70% to 100%), when studies were further sub grouped based on population, OA severity pattern, age and sex. Exclusion of low methodological quality studies did not decrease the heterogeneity levels.

Table 1: Details of included radiography studies

Author, Year	Additional information	Sex	Age	N (knees)	Diagnostic criteria	Isolated PF OA (%)			Combined (%)	Unclear PF OA (%)			Severity
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral	
Community-based population													
Arfaj 2002	First two patients visiting a clinical invited everyday)	W	40±15	133	KL					81			Definite
		M	40±15	167	KL					88			Definite
Baker Xu 2004	Randomly from community over the age of 60 years	W	68±6	1475	KL	8			26				Definite
		M	69±6	997	KL	9			12				Definite
Braga 2009	African-Americans (>45 years) recruited by probability sampling	W	62±11	283	KL					53			Definite
		M	60±11	147	KL					60			Definite
	Caucasians (>45 years) recruited by probability sampling	W	62±11	799	KL					42			Definite
		M	61±10	728	KL					54			Definite
Cho 2016	Random sample of individuals (>65 years) selected from a longitudinal study	W	72±5	383		3	0	2	28	29	2	15	Definite
		M	71±5	298		5	1	4	8	13	1	7	Definite
Cicuttini 1997	Unrelated women selected from a group participating in twin study of OA	W	59±7	325	Burnett, 1994 (JSN & osteophyte)	13			15				Mild

Author, Year	Additional information	Sex	Age	N (knees)	Diagnostic criteria	Isolated PF OA (%)			Combined (%)	Unclear PF OA (%)			Severity
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral	
Gross 2012	Offspring (and their spouses) of participants from original Framingham heart study and population-based sample of Framingham community	WM	63±9	985 (1159)	OARSI					8			Definite
Hunter Zhang 2007	Random sample from Health ABC study	WM	74±3	595	OARSI					49			Mild
Lanyon 1998	Random sampling, stratified by age from the lists of two general practitioner	WM	62 (40-80)	452	Altman					13			Definite
Szoeke 2006	Post-menopausal women selected from another population-based study	W	60±3	224	OARSI					22			Mild
Tangtrakulwanich 2012	Individuals (>40 years) without rheumatic diseases using primary care	WM	>40	576	0-3 scale					38			Mild
Healthy individuals													
Englund 2005		WM	56±21	68	OARSI					9			Mild
McAlindon 1992		M	>55	78						5			Mild
		W	>55	162						5			Mild
Naredo 2005		WM	68±8	10	KL					70			Mild
Spector 1996		W	54±6	215	KL					28			Mild
Knee pain or symptomatic population													
Barret 1990		WM	78 (51-93)	1894 (2197)	Alhback	3.8				18			Mild
Bennett 2007		WM	54±13	39	ACR					62			Mild
Davies 2002		WM	>40	174 (206)	Ahlback	9			13				Mild
Duncan 2006		WM	66 (50-93)	777	KL	24			40				Definite

Author, Year	Additional information	Sex	Age	N (knees)	Diagnostic criteria	Isolated PF OA (%)			Combined (%)	Unclear PF OA (%)			Severity
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral	
Hinman 2014		WM	54±10	224		25	3	11	44				Definite
Kumm 2012	6 years follow-up	WM	51±6	128	Line drawing atlas	19			38				Mild
Lacey 2008		W	50-64	200	KL	19			27				Definite
		M	50-64	158		35			25				Definite
		W	>65	207		21			47				Definite
		M	>65	180		24			62				Definite
McAlindon 1992		M	>55	86	KL					12			Mild
		W	>55	187						26			Mild
McAlindon 1996		WM	81±5	608	Osteophyte /JSN	5			20				Definite
Neame 2004	Right knee	WM	64±9	1729 (1718)						14			Definite
	Left knee	WM		(1723)						14			Definite
Sadat Ali 1996		M	41±7	103 (126)	JSN, osteophytes & varus deformity	45			30				Mild
Thorstensson 2009			45 (35-54)	125	JS width <5mm					33			Mild
Radiographic knee OA or high risk of knee OA													
Eti 1998	Knee OA	WM	56±11	240 (369)	Altman					34			Unclear
Glass 2014	Knee OA or High risk	W	62±8	1618 (3236)	KL					22			Definite
	Knee OA or High risk	M	62±8	1094 (2188)	KL					18			Definite
Huang 2000	Hand, hip or knee OA	W	64 (29-87)	270	KL					62			Definite
Jones 1993	Knee OA	WM	62 (18-91)	30 (60)	Osteophyte					75			Mild

Author, Year	**Additional information**	**Sex**	**Age**	**N (knees)**	**Diagnostic criteria**	**Isolated PF OA (%)**			**Combined (%)**	**Unclear PF OA (%)**			**Severity**
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral	
Radiographic and symptomatic OA													
Cicuttini 2002		M	63±10	44	Osteophyte & JSN					48			Definite
		W	63±10	66	Osteophyte & JSN					38			Definite
Cooper 1994		WM	>55	109	Radiograph Atlas of knee OA	31							Mild
Elahi 2000		WM	66±11	292	OARSI	11							Mild
Ersoz 2003		WM	62±9	20 (40)	KL					88			Mild
Farrokhi 2013		WM	65±9	167	KL					80			Mild
Hinman 2002		WM	68±7	41	ACR					81			Mild
Hunter Niu 2005		W	68±6	1500	KL					35.7			Mild
		M	74±3	595	KL					25.9			Mild
Kerna 2013		WM	45±6	438	Line drawing atlas					48			Mild
Ledingham 1993		WM	65 (34-91)	252	Modified Thomas 1995	24			64				Definite
Messier 2005		WM	74±1	10	KL					90			Mild
Szebenyi 2006			66±10	167 (334)	OARSI					65			Mild
Van der Esch 2014		WM	62±8	298	Osteophyte					86			Mild
Post-traumatic population													
Ahn 2012	Post-operative ACLR	WM	29±9	117	IKDC					60			Mild
Barenius 2014	ACLR with patellar graft	WM	39±6	69	KL					32			Definite
	Uninjured contralateral	WM			KL					12			Definite
	Semitendinosus ACLR graft	WM	42±7	65	KL					36			Definite

Author, Year	**Additional information**	**Sex**	**Age**	**N (knees)**	**Diagnostic criteria**	**Isolated PF OA (%)**			**Combined (%)**	**Unclear PF OA (%)**			**Severity**
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral	
Barenius 2014	Uninjured contralateral	WM	42±7	65	KL					12			Definite
Bourke 2012	Isolated ACL injury with ACLR	WM		118	IKDC					12			Mild
Cohen 2007	ACLR	WM	27 (15-46)	62	Fairbank					74			Mild
Culvenor 2014	ACLR	WM	45±10	36	OARSI	20				48			Mild
Englund 2005	Medial meniscectomy	WM	54±11	250	OARSI				19				Mild
	Lateral meniscectomy	WM	54±11	67	OARSI				27				Mild
Hertel 2005	ACLR -Patellar	WM	42 (22-62)	67	IKDC					19			Mild
Hulet 2015	Arthroscopic partial lateral meniscectomy	WM	57±12	89	IKDC				33				Mild
Jarvela 2001	ACLR with patellar graft	WM	31 (15-61)	100	IKDC					47			Mild
Keays 2007	ACLR with patellar /semitendinosus and gracilis graft	WM	27 (18 - 38)	56					25				Mild
Li 2011	ACLR	WM	26±10	249	KL					11			Mild
Li 2011	Uninjured contralateral	WM	26±10	249	KL					3			Mild
Liden 2008	ACLR with patellar graft	WM	30 (17-52)	72	Ahlback and Fairbank					14			Mild
	ACLR with hamstring graft	WM	29 (15-59)	41						5			Mild
Lohmander 2004	ACL injury with surgery	W	31 (26-40)	41	OARSI					20			Mild
	ACL injury without surgery	W	31 (26-40)	26						4			Mild
Murray 2012	ACLR with patellar graft	WM		83	IKDC					76			Mild
	Uninjured contralateral	WM		42						59			Mild
Neuman 2009	ACL injury with meniscal injury	WM	43±8	22	OARSI					18			Mild
	ACL injury without meniscal injury	WM	43±8	38	OARSI					3			Mild

Author, Year	Additional information	Sex	Age	N (knees)	Diagnostic criteria	Isolated PF OA (%)			Combined (%)	Unclear PF OA (%)			Severity
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral	
Neuman 2009	ACLR with meniscal injury	WM	43±8	11	OARSI					55			Mild
	ACLR without meniscal injury	WM	43±8	4	OARSI					25			Mild
	Overall (ACL with or with meniscal or reconstruction)	WM	43±8	75	OARSI				9				Mild
Oiestad 2013	ACLR	WM	71±8	181						26			Mild
Roth 1985	ACLR (non-augmented)	WM		38	Osteophyte size						13	40	Mild
	ACLR (Augmented)	WM		43	Osteophyte size						4	14	Mild
Sajovic 2006	ACLR with semitendinosus and gracilis	WM	24 (14-42)	28	IKDC					7			Mild
	ACLR patellar tendon	WM	27 (16-46)	26	IKDC					12			Mild
Salmon 2006	ACLR - 13 years follow-up	WM	27 (25-28)	43	IKDC					26			Mild
Sward 2013	ACL injured (with or without ACLR) with varus alignment	WM	42±7	36	OARSI				22				Mild
	ACL injured (with or without ACLR) with valgus/neutral	WM	39±6	29	OARSI				7				Mild
Occupation-based population													
Kujala 1995	Long distance runners	M	60±5	28	KL					11			Definite
	Soccer players	M	57±5	31	KL					16			Definite
	Weight lifters	M	60±5	29	KL					28			Definite
	Shooters	M	61±5	29	KL					3			Definite
Rytter 2009	Floor layers	M	53 (39-68)	134	Modified Ahlback Scale					9			Mild

Author, Year	**Additional information**	**Sex**	**Age**	**N (knees)**	**Diagnostic criteria**	**Isolated PF OA (%)**			**Combined (%)**	**Unclear PF OA (%)**			**Severity**
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral	
Rytter 2009	Graphic designers	M	58 (40-70)	120	Modified Ahlback Scale					18			Mild
Spector 1996	Ex-athletes	W	52±6	81	KL					42			Mild
Tangtrakulwanich 2006	Monk		44±18	261	KL	19			33				Mild

Abbreviations are as follows: M, men; W, women; WM, both women and men; OA, osteoarthritis; PF OA, patellofemoral osteoarthritis; JSN, joint space narrowing; OARSI, osteoarthritis Research Society International; ACR, American College Rheumatology; IKDC, International Knee Documentation Committee; ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction. Where possible, age is presented as mean ± standard deviation or mean (range). Mild severity indicates at least mild OA severity and definite indicates definite OA severity (equivalent to KL≥2)

Table 2: Details of included magnetic resonance imaging studies

Author, Year	**Additional information**	**Sex**	**Age**	**N (knees)**	**Diagnostic criteria**	**Isolated PF OA (%)**			**Combined (%)**	**Unclear PF OA (%)**			**Feature**	**Case definition**
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral		
Community-based population														
Ding 2005	<45years	WM	<45	167	0-4 scale					16			Cartilage defect	≥2
	>45years	WM	≥45	205						38			Cartilage defect	≥2
Gross 2012*	FOA cohort	WM	64±9	985 (1159)	WORMS		50	18					Cartilage damage	≥2
Stefanik 2013	FOA cohort	WM	64±8	970	WORMS	20			44				Cartilage damage	≥2
Wang 2015	TASOAC cohort	WM	62±7	904	WORMS					19			BML	≥1
										40			Cartilage defect	≥2
Healthy individuals														
Sharma 2014	OAI cohort	M	60±9	375	MOAKS	25			33				Cartilage damage	>0
					WORMS	33			18				BML	>0
		W	60±9	474	MOAKS	34			30				Cartilage damage	>0
					WORMS	35			17				BML	>0
Wang 2012		WM	42±7	38	0-4 scale					3			Cartilage defect	≥2
Knee pain or symptomatic population														
Amin Baker 2009*	BOKS cohort	M	68±9	154	WORMS						81	68	Maximal cartilage morphology	≥2
		W	64±9	111	WORMS						91	84	Maximal cartilage morphology	≥2
Amin Goggins 2008*	Heavy lifting [BOKS cohort]	M	69±9	40	WORMS					60			Cartilage morphology	≥2
	Occupational exposures	M	64±9	47	WORMS					72			Cartilage morphology	≥2
	No heavy lifting/ occupational exposures	M	70±9	98	WORMS					47			Cartilage morphology	≥2

Author, Year	Additional information	Sex	Age	N (knees)	Diagnostic criteria	Isolated PF OA (%)			Combined (%)	Unclear PF OA (%)			Feature	Case definition
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral		
Amin Guermazi 2008	BOKS cohort	WM	67±9	265	WORMS					91			Cartilage morphology	≥2
Cai 2015	Anhui osteoarthritis cohort	WM	56±12	174	0-4 scale					82			Cartilage damage	≥2
		WM			0-3 scale					52			BML	≥1
Crema 2014		WM	58±10	163	0-3 scale					13			BML	≥1
Peterfy 2004		WM	61±8	19	WORMS					94			Cartilage abnormality	≥1
										16			BML	≥1
										81			Osteophytes	≥1
Tsavalas 2012	Various knee-related clinical conditions	WM	≤50	315	ICRS					5			Cartilage lesion	≥2
		WM	>50	200	ICRS					33			Cartilage lesion	≥2
Radiographic knee OA or high risk of knee OA														
Gross 2012	MOST cohort	WM	62±8	1381 (1621)	WORMS		69	36					Cartilage damage	≥2
Stefanik Gross 2015* (O&C)	MOST cohort	WM	69±8	1137	WORMS		22	13		63			BML	≥1
Stefanik Gross 2015Ɨ (ACR)	MOST cohort	W	66±8	653 (2594)	WORMS					51			Cartilage damage	≥2
										29			BML	≥1
		M	66±8	400 (1486)	WORMS					43			Cartilage damage	≥2
										23			BML	≥1
Runhaar 2014		W	56±3	348 (529)	MOAKS	44	35	18					BML	≥1
				348 (467)		47	42	18					Cartilage defect	≥1
				348 (408)		33	27	25					Osteophytes	≥1

Author, Year	Additional information	Sex	Age	N (knees)	Diagnostic criteria	Isolated PF OA (%)			Combined (%)	Unclear PF OA (%)			Feature	Case definition
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral		
Radiographic and symptomatic OA														
Chan 1991		WM	58	20	0-3 scale	0			75				Cartilage loss	≥1
						0			75				Osteophytes	≥1
Post-traumatic population														
Culvenor 2015	ACLR with or without meniscus repair	WM	30±8	111	MOAKS	12					2	3	BML	≥1
Van Meer 2016	ACL rupture	WM	25±33	143	MOAKS					29			Osteophytes	≥1
Wang 2012	Arthroscopic partial medial meniscectomy (2 years post)	WM	43±5	63	0-4 scale	19							Cartilage defect	≥2
General population														
Gross 2011	Framingham Heart study offsprings + spouses, and people from Framingham town	WM	64±9	1094	WORMS						58		Cartilage damage	≥2
				1096								42	Cartilage damage	≥2
Hayes 2005	With or without pain or OA	W	46±1	117 (232)	Modified Nayes arthroscopy system					66			Cartilage defect	≥IIA
Kornaat 2005	40-70 years with familial generalized OA	WM	60 (43-77)	205	KOSS	66							Cartilage defect	≥1
Sowers 2011	Middle-aged women	W	56±5	360 (724)						89			Cartilage defect	
										45			BML	

Author, Year	Additional information	Sex	Age	N (knees)	Diagnostic criteria	Isolated PF OA (%)			Combined (%)	Unclear PF OA (%)			Feature	Case definition
						Overall	Medial	Lateral	PF + TF OA	Overall	Medial	Lateral		
Sowers 2011	Middle-aged women	W	56±5	360 (724)						56			Osteophytes	
Teng 2015	Without no OA or isolated OA	WM	51±10	61	WORMS					46			Cartilage lesion	>1

Abbreviations are as follows: FOA, Framingham Osteoarthritis; TASOAC, Tasmanian Older Adult Cohort; OAI, Osteoarthritis Initiative; BOKS, Boston Knee Osteoarthritis Study; MOST, Multicenter Knee Osteoarthritis; M, men; W, women; WORMS, Whole-organ Magnetic Resonance Imaging Score; MOAKS, MRI Osteoarthritis Knee Score; BML, bone marrow lesion; ICRS, International Cartilage Repair Society; KOSS; Knee Osteoarthritis Scoring System; ACL, Anterior cruciate ligament; ACLR, anterior cruciate ligament reconstructed; OA, osteoarthritis; PF OA, patellofemoral osteoarthritis. Where possible, age is presented as mean ± standard deviation or mean (range). * symbol indicates studies included in subgroup analyses, łpercentage based on regions

3.2 Prevalence of patellofemoral OA based on radiography

Community-based population

In community-based populations, the overall prevalence of isolated PF OA from four studies[19 24 26 28] was [mean proportion: (95% confidence interval)] 7% (5 to 10), combined PF OA and TF OA from four studies[19 24 26 28] was 17% (10 to 26), and any PF OA based on nine studies[18 19 24 26 28 39 46 54 75] was 38% (28 to 50) (Figure 2 A-C). In the any PF OA group, the prevalence of mild OA severity was 33% (17 to 51) from three studies[28 46 75] and definite OA severity was 40% (28 to 53) from six studies.[18 19 24 26 39 54] The prevalence of any PF OA in community-based population was 32% (24 to 42) in those aged 50 years or over from eight studies[19 24 26 28 39 46 54 75]. Only one study described prevalence of isolated compartment-specific PF OA[26], with prevalence of medial PF OA at 0.3% in women and 0.7% in men, and the prevalence of lateral PF OA at 1.6% in women and 3.7% in men. Sensitivity analyses based on sex revealed that the prevalence of any PF OA in women was 41% (31 to 51) from six studies[18 19 24 26 28 75] and 47% (23 to 71) in men from four studies.[18 19 24 26]

Knee pain or symptomatic population

Overall prevalence of isolated PF OA was 19% (11 to 29) from eight studies,[2 21 32 42 52 53 59 69] combined PF OA and TF OA was 34% (25 to 43) from seven studies[2 32 42 52 53 59 69] and any PF OA was 43% (32 to 55) from 12 studies[2 21 22 32 42 52 53 59 60 64 69 77] (Figure 2 D-F). For any PF OA, the prevalence of mild and definite OA severity was 37% (24 to 51) from seven studies[2 21 22 32 52 60 69] and 49% (30 to 67) from six studies,[2 42 53 59 64 77] respectively. Age-based prevalence of any PF OA in individuals under 50 years was 54% (16 to 90) from two studies [69 77] and in those 50 years or over was 43% (31 to 56) from eight studies.[2 21 22 42 53 59 60 64] Sex-based prevalence of any PF OA was 46% (23 to 70) in women[53 60] and 58% (27 to 86) in men.[53 60 69]

Radiographic and symptomatic knee osteoarthritis

Overall prevalence of isolated PF OA was 20% (11 to 32) from four studies,[25 30 33 55] combined PF OA and TF OA was 43% (8 to 83) from two studies[25 55] and any PF OA was 57% (43 to 70) from 13 studies[25 27 30 33 35 37 41 45 50 55 61 74 78] (Figure 2 G -I). In the any PF OA group, the prevalence of mild severity was 56% (41 to 70) from 12 studies.[25 30 33 35 37 41 45 50 55 61 74 78] The prevalence in individuals 50 years or over was 58% (42 to 72) from 12 studies[25 27 30 33 35 37 41 45 55 61 74 78] and the prevalence of any PF OA in women was 36% (33 to 38)[27 45] and men was 35% (16 to 58) from two studies.[27 45]

Healthy individuals

Data from four studies were included in meta-analyses to determine the prevalence of PF OA in healthy individuals.[34 60 63 72] Overall prevalence of any PF OA in healthy individuals (no pain, injury or OA) was 17% (6 to 33) (Figure 3A). Sensitivity analyses based on sex could only be performed in women revealing the prevalence of PF OA in healthy women at 15% (1 to 43) from two studies.[60 72]

Radiographic knee osteoarthritis or at risk of developing osteoarthritis

Overall prevalence of any PF OA in individuals with radiographic OA or at risk of OA was 48% (35 to 61) from four studies[36 38 43 48] (Figure 3B), with prevalence based on mild and definite OA severity as follows: 54% (17 to 89) from two studies[36 48] and 45% (30 to 60) from two studies,[38 43] respectively. In this group, the prevalence of any PF OA in women was 41% (8 to 80) from two studies.[38 43]

Occupation-based population

Four studies reported occupation-based prevalence of PF OA.[51,68,72,76] Overall prevalence of any PF OA in individuals in occupations or sports such as long distance running, soccer, shooting, floor layers, graphic designers and monks was 21% (9 to 37) (Figure 3C). For any PF OA, the prevalence based on mild OA severity was 29% (10 to 52) from three studies.[68,72,76] The prevalence of any PF OA in individuals 50 years and over was 18% (9 to 28) from three studies.[51,68,72] Sensitivity analyses based on sex revealed the prevalence of any PF OA in men was 14% (9 to 20) from two studies.[51,68] Analysis could not be performed in women. For any PF OA, the prevalence of any PF OA in high intensity activity population was 19% (11 to 29) from one study[51] and 19% (3 to 45) in low intensity activity population based on three studies.[51,68,76]

Post-traumatic population

The overall prevalence of isolated PF OA from two studies was 17% (5 to 34) from two studies[49,65] (Figure 3D). In the injured knee, the overall of prevalence of any PF OA in post-traumatic population (range: 5 to 22 years) was 27% (19 to 34) from 19 studies[17,20,23,29,31,34,40,44,47,49,56-58,62,65,66,70,71,73] (Figure 3E). For any PF OA, the prevalence of mild OA severity was 26% (18 to 34) from 18 studies.[17,23,29,31,34,40,44,47,49,56-58,62,65,66,70,71,73] Sensitivity analyses based on age revealed the prevalence of any PF OA was 27% (18 to 36) in individuals under 50 years[17,20,23,29,31,40,47,49,56-58,65,66,70,71,73] and 26% (17 to 35) in those 50 years or over.[34,44] In the uninjured knee, overall prevalence of any PF OA was 18% (3 to 42) from three studies,[20,56,62] with prevalence of mild OA severity at 25% (2 to 87) from two studies.[56,62]

3.3 Prevalence of patellofemoral OA based on magnetic resonance imaging

Community-based population

The prevalence of isolated PF structural damage and combined PF and TF structural damage based on cartilage defect were 20% and 44% (respectively) and BML was 18% and 22% (respectively) based on a single study.[95] The prevalence of any PF structural damage based on cartilage defects was 44% (25 to 65) from three studies[86 95 99] and BML was 29% (11 to 51) from two studies[95 99] (Figure 4A-B).

Knee pain or symptomatic population

The prevalence of overall isolated PF structural damage and combined PF and TF structural damage could not be calculated for this study population. The prevalence of any PF structural damage was 52% (9 to 93) based on cartilage defect[81 82 97] and 32% (3 to 72) based on BML[82 84] (Figure 4C-D). Data from one study could not be pooled because of WORMS definition used for OA diagnosis (Cartilage damage defined as ≥1 grade in this study compared to ≥2 grade used in other studies),[90] with PF structural damage prevalence of 94%, 16% and 81% based on cartilage defect, BML and osteophytes, respectively. Data stratified based on age revealed that the prevalence of any PF structural damage was 71% (33 to 97) in individuals 50 years or over based on cartilage defect.[81 82 97]

Radiographic knee osteoarthritis or at risk of developing osteoarthritis

An overall prevalence of isolated PF structural damage, combined PF and TF structural damage and any PF structural damage based on cartilage defect or BML could not be determined for this study population. Two studies reported prevalence of isolated PF structural damage in the medial and lateral PF compartments based on cartilage defect[39 91] and BML.[39 101] The prevalence of isolated medial and lateral PF structural damage was 56% (29 to 81) and 27% (11 to 46), respectively[39 91] based on cartilage defect and 28% (17 to 41) and 15% (11 to 20), respectively[39 101] based on BML (Figure 4E-F). A single study described PF structural damage prevalence based on PF compartment regions (not based on number of individuals or knees)[94] and reported prevalence of any PF structural damage based on cartilage defect and BML in women (51% and 29%, respectively) and men (43% and 23%, respectively).[94] No further analyses could be conducted in this study population.

Healthy individuals

The overall prevalence of any PF structural damage based on cartilage defect was 40% (19 to 63)[92 100] (Figure 4G). Since there were only two studies included in this study population, no further analyses could be conducted.

Radiographic and symptomatic knee osteoarthritis

The prevalence of combined PF and TF structural damage was 75% based on cartilage defect and osteophytes from a single study,[83] and no further analyses could be conducted.

Post-traumatic population

Two studies reported prevalence based on osteophytes in ACL injured or reconstructed,[85 98] with the prevalence of any PF structural damage at 29%[98] and compartment-specific prevalence of medial and lateral PF structural damage at 23% and 7%, respectively.[85] The prevalence of medial and lateral PF structural damage based on BML were 2% and 3%, respectively.[85] The prevalence of any PF structural damage was 36% in an ACL ruptured population based on cartilage defect.[98] In individuals two years post arthroscopic partial medial meniscectomy the prevalence of isolated PF structural damage was 19% based on cartilage defect.[100]

General population

Five studies were included in the general population category.[87-89 93 96] The cartilage defect based prevalence of any PF structural damage was 49% (36 to 62) from two studies using the WORMS[87 96] and was 75% (56 to 91) from three studies using the KOSS.[88 89 93] The prevalence of any PF structural damage based on BML and osteophytes were 45% and 56%, respectively.[93]

4. DISCUSSION

Summary of findings

This systematic review with meta-analysis synthesized prevalence of PF OA, and included 85 studies. Meta-analysis revealed the prevalence of any radiographic PF OA in knee pain or symptomatic, radiographic TF OA or at risk of developing TF OA, and radiographic and symptomatic knee OA cohorts was 43%, 48% and 57%, respectively. The prevalence of any MRI-defined PF structural damage in knee pain or symptomatic population was 32% and 52% based on BML and cartilage defect, respectively. This systematic review and meta-analysis highlights the high prevalence of PF OA/ PF structural damage in a wide range of study populations using different imaging tools.

One half (43-57%) of people with symptoms and/or established radiographic TF OA had PF OA based on radiography. Similarly, a high prevalence of post-traumatic population exhibited signs of PF OA (~30). With such a high prevalence of PF OA, treatments designed specifically for the PF compartment may be required in the OA management strategy.[102,103] Clinicans should assess for symptoms of PF pain or PF OA and treat patients accordingly. The few studies that specifically evaluated interventions such as exercise, physical therapy, taping and bracing to address PF OA[98,99,104] provide some evidence for their use. While some studies hypothesize that there is a potential continuum of PF pain PF OA;[105] no high-quality evidence has supported the association between PF pain in younger individuals to the development of PF OA.[106] Unfortunately, studies included in the knee pain or symptomatic OA population category did not differentiate between PF pain and generalized knee pain. Therefore, in the current systematic review, we were not able to determine the prevalence of PF OA in a PF pain population.

Healthy and community cohorts are also likely to demonstrate some PF OA, with radiographic PF OA evident in 17% and 38%, respectively. Since most studies in the community-based meta-analysis were conducted in individuals over the age of 50 years, it appears that radiographic PF OA may be a natural accompaniment to aging. The only study with a mean age of ≤50 years (but a large range 20 to 93 years), described a particularly high PF OA prevalence in women (81%) and men (88%) . The authors hypothesized that cultural factors in Saudi Arabia, such as sitting cross-legged, squatting and praying with knees fully flexed on the ground, may contribute to the high prevalance. Exclusion of this data from meta-analysis revealed the prevalence of any PF OA was 32% in the community population.

The prevalence of MRI-defined PF structural damage in knee pain or symptomatic population was 52%, which was similar to the healthy (40%), community (44%) and general population (49%) cohorts. The high prevalence of MRI-defined PF structural damage may reflect the ability of MRI to detect early changes in the joint that are not visible on radiographs. However, it is unclear whether these findings represent PF OA, as there is no accepted and validated MRI definition of OA. MRI features such as cartilage damage and BMLs can predict incident radiographic OA[107], development of knee pain[108] and future total knee replacement[109]. Thus, it is plausible that these MRI findings may represent early stages of the PF OA disease process. Further research is needed to investigate the clinical relevance of MRI-defined PF structural damage.

The current systematic review extends on the results from a prior study.[7] The previous systematic review reported the radiographic prevalence of PF OA in population- and symptom- based population; whereas, the current review reported prevalence of PF OA in multiple different populations. Thus, an additional 32 studies were included in the meta-analysis. Further to this, the current review included meta-analysis on prevalence of MRI-defined PF structural damage. Furthermore, the current study extends on the findings from the earlier review by categorizing data into multiple study populations and data pooling with sub analysis based on age, sex, compartment-specific OA pattern and OA severity pattern to obtain more accurate estimations of prevalence.

Limitations

This systematic review is not without limitations. Firstly, a very high level of heterogeneity was noted, particularly in the any PF OA group. The inclusion of isolated PF OA, combined PF OA and TF OA, and unclear PF OA (isolated or combined) data in the any PF OA group may explain the high level of heterogeneity. Other potential sources of heterogeneity include differences in diagnostic criteria, populations and case definitions. Secondly, all relevant studies were included in this systematic review, regardless of methodological quality. Data from 54 low methodological quality studies were included in this review. While this systematic review is subject to bias through the inclusion of low quality studies, the levels of evidence applied to the pooled data take into account quality, quantity and homogeneity of studies. Thirdly, we restricted the search to studies published in English. Inclusion of data from non-English language studies may alter the outcomes. Fourthly, a number of diagnostic criteria were converted to allow data pooling, which may have influenced the results of this systematic review. Fourthly, PF structural damage based on MRI should be interpreted with some caution, as fewer studies contributed to meta-analysis within each study population. Lastly, we recognize that there is no accepted and validated definition of radiographic or MRI defined PF OA. Because of this the prevalence data will largely differ in any given study based on different definitions, which may have influenced the results.

Recommendations

Whilst conducting this systematic review, we identified that prevalence data was not well presented in many studies. We recommend that future studies more clearly describe prevalence data based on OA patterns (e.g. isolated PF OA vs. combined PF OA and TF OA, medial vs. lateral PF OA), OA severity (e.g. none, mild, moderate), and subgroups (e.g. age, sex). Further to this, discrepancies in diagnostic criteria definitions and reporting were noted; therefore, the PF OA definitions should be clearly stated. Better standardization of data presentation in future studies will help to better understand PF OA epidemiology.

Implications for research and practice

PF OA is an important source of symptoms in knee OA, and is strongly associated with disability.[60]

Our systematic review and meta-analysis revealed the prevalence of PF OA is high based on radiography and MRI in community, symptomatic, radiographic knee OA and traumatic knee OA populations. Therefore, well-designed studies are required to evaluate biomechanical, functional and psychological impairments associated with PF OA. Addressing potentially modifiable risk factors for PF OA may reduce the risk of development and progression of PF OA and may have implications for TF disease. This systematic review also revealed a higher prevalence of combined PF OA and TF OA pattern than isolated PF OA; therefore, it is important to explore interventions that target both PF and TF joints.

Conclusions

Synthesis of prevalence data on PF OA and MRI-defined PF structural damage indicates that signs of PF damage are common and should not be ignored in research or clinical practice. In the future MRI might become highly relevant in order to identify patients at early disease stages where the disease process may still reversible and amenable to interventions.

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FIGURE AND TABLE CAPTIONS

Figure 1: Flow chart of the study selection process

Figure 2: Prevalence of PF OA in community, knee pain or symptomatic, and radiographic and symptomatic OA populations

Figure 3: Prevalence of PF OA in healthy individuals, radiographic OA, occupation-based OA, and post-traumatic OA populations

Figure 4: Prevalence of MRI-defined PF structural damage in community, knee pain or symptomatic, radiographic OA and healthy individual populations

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Figure 1

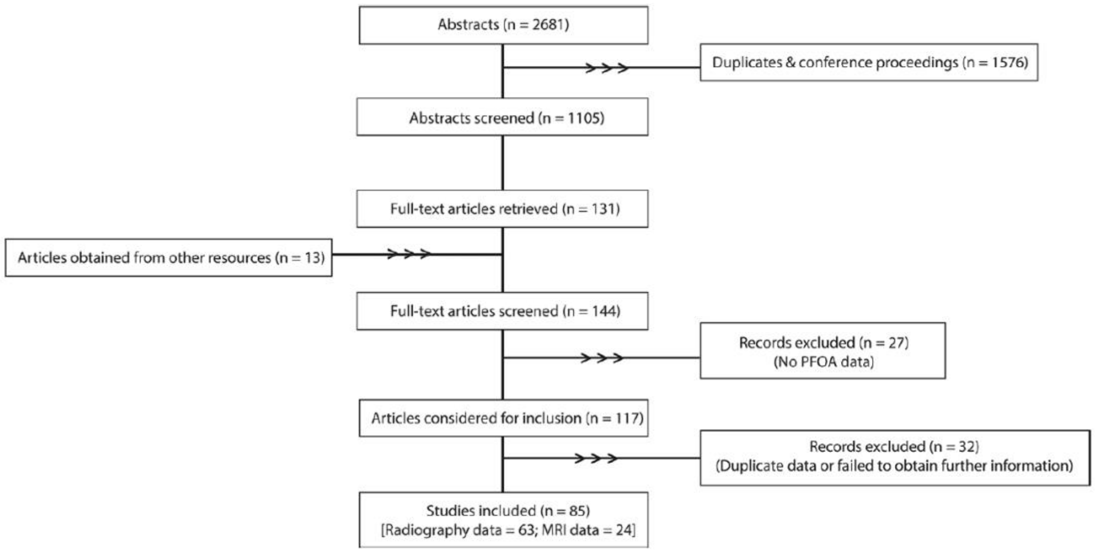
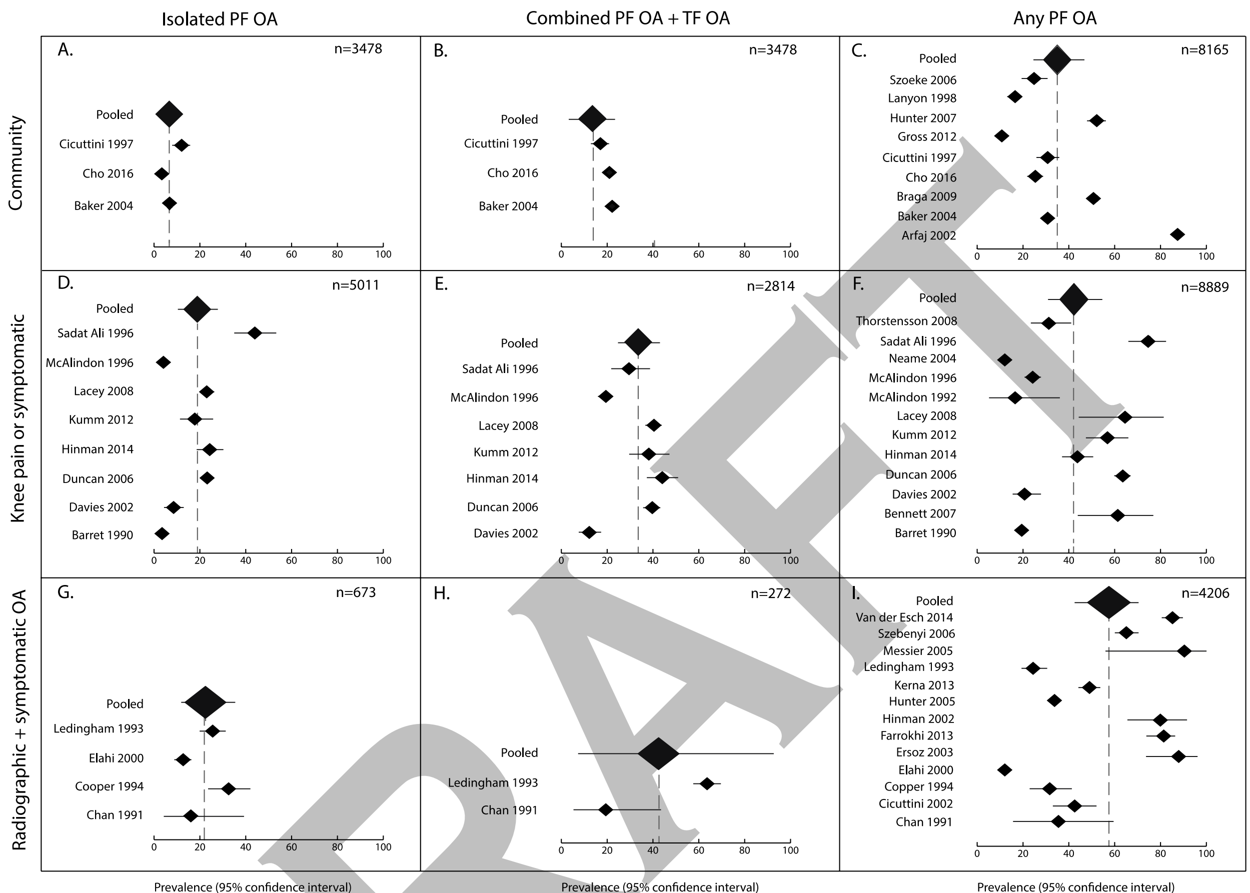
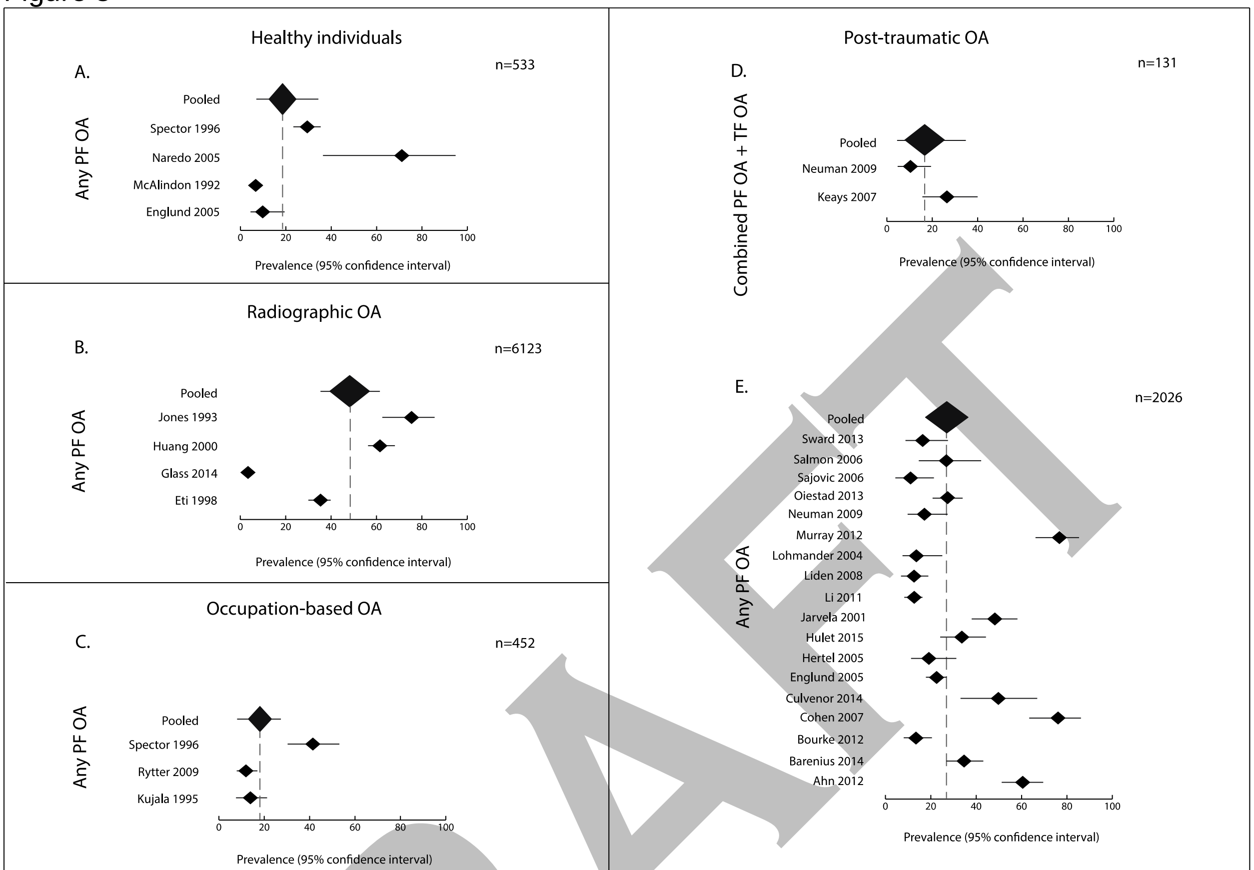

Abstracts (n = 2681)
Duplicates & conference proceedings (n = 1576)
Abstracts screened (n = 1105)
Full-text articles retrieved (n = 131)
Articles obtained from other resources (n = 13)
Full-text articles screened (n = 144)
Records excluded (n = 27)
(No PFOA data)
Articles considered for inclusion (n = 117)
Records excluded (n = 32)
(Duplicate data or failed to obtain further information)
Studies included (n = 85)
[Radiography data = 63; MRI data = 24]

Figure 2



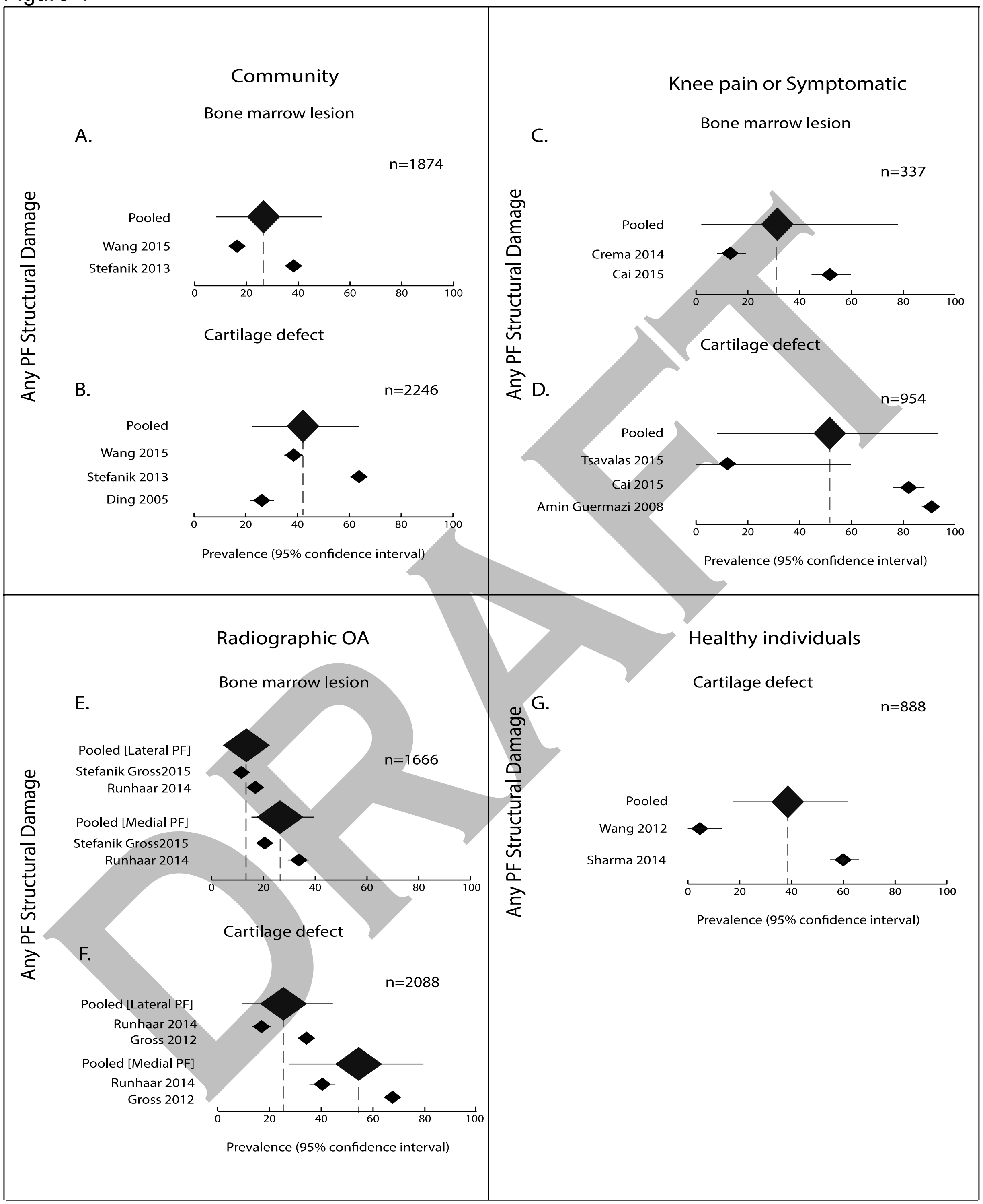
Isolated PF OA
Combined PF OA + TF OA
Any PF OA
Community
Knee pain or symptomatic
Radiographic + symptomatic OA
A.
n=3478
Pooled
Cicuttini 1997
Cho 2016
Baker 2004
B.
n=3478
Pooled
Cicuttini 1997
Cho 2016
Baker 2004
C.
n=8165
Pooled
Szoeke 2006
Lanyon 1998
Hunter 2007
Gross 2012
Cicuttini 1997
Cho 2016
Braga 2009
Baker 2004
Arfaj 2002
D.
n=5011
Pooled
Sadat Ali 1996
McAlindon 1996
Lacey 2008
Kumm 2012
Hinman 2014
Duncan 2006
Davies 2002
Barret 1990
E.
n=2814
Pooled
Sadat Ali 1996
McAlindon 1996
Lacey 2008
Kumm 2012
Hinman 2014
Duncan 2006
Davies 2002
F.
n=8889
Pooled
Thorstensson 2008
Sadat Ali 1996
Neame 2004
McAlindon 1996
McAlindon 1992
Lacey 2008
Kumm 2012
Hinman 2014
Duncan 2006
Davies 2002
Bennett 2007
Barret 1990
G.
n=673
Pooled
Ledingham 1993
Elahi 2000
Cooper 1994
Chan 1991
H.
n=272
Pooled
Ledingham 1993
Chan 1991
I.
n=4206
Pooled
Van der Esch 2014
Szebenyi 2006
Messier 2005
Ledingham 1993
Kerna 2013
Hunter 2005
Hinman 2002
Farrokhi 2013
Ersoz 2003
Elahi 2000
Copper 1994
Cicuttini 2002
Chan 1991
0 20 40 60 80 100
Prevalence (95% confidence interval)
Prevalence (95% confidence interval)
Prevalence (95% confidence interval)

Figure 3



Healthy individuals
A.
n=533
Any PF OA
Pooled
Spector 1996
Naredo 2005
McAlindon 1992
Englund 2005
0 20 40 60 80 100
Prevalence (95% confidence interval)
Radiographic OA
B.
n=6123
Any PF OA
Pooled
Jones 1993
Huang 2000
Glass 2014
Eti 1998
0 20 40 60 80 100
Prevalence (95% confidence interval)
Occupation-based OA
C.
n=452
Any PF OA
Pooled
Spector 1996
Rytter 2009
Kujala 1995
0 20 40 60 80 100
Prevalence (95% confidence interval)
Post-traumatic OA
D.
n=131
Combined PF OA + TF OA
Pooled
Neuman 2009
Keays 2007
0 20 40 60 80 100
Prevalence (95% confidence interval)
E.
n=2026
Any PF OA
Pooled
Sward 2013
Salmon 2006
Sajovic 2006
Oiestad 2013
Neuman 2009
Murray 2012
Lohmander 2004
Liden 2008
Li 2011
Jarvela 2001
Hulet 2015
Hertel 2005
Englund 2005
Culvenor 2014
Cohen 2007
Bourke 2012
Barenius 2014
Ahn 2012
0 20 40 60 80 100
Prevalence (95% confidence interval)

Figure 4


Community
Bone marrow lesion
A.
n=1874
Pooled
Wang 2015
Stefanik 2013
Cartilage defect
B.
n=2246
Pooled
Wang 2015
Stefanik 2013
Ding 2005
Prevalence (95% confidence interval)
Any PF Structural Damage
Knee pain or Symptomatic
Bone marrow lesion
C.
n=337
Pooled
Crema 2014
Cai 2015
Cartilage defect
D.
n=954
Pooled
Tsavalas 2015
Cai 2015
Amin Guermazi 2008
Prevalence (95% confidence interval)
Radiographic OA
Bone marrow lesion
E.
n=1666
Pooled [Lateral PF]
Stefanik Gross2015
Runhaar 2014
Pooled [Medial PF]
Stefanik Gross2015
Runhaar 2014
Cartilage defect
F.
n=2088
Pooled [Lateral PF]
Runhaar 2014
Gross 2012
Pooled [Medial PF]
Runhaar 2014
Gross 2012
Prevalence (95% confidence interval)
Healthy individuals
Cartilage defect
G.
n=888
Pooled
Wang 2012
Sharma 2014
Prevalence (95% confidence interval)
0 20 40 60 80 100
DRAFT