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Prevalence of symptomatic hip and knee osteoarthritis: a two-phase population-based survey[1]

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SUMMARY

Objective: Osteoarthritis (OA) epidemiologic data are scarce in Europe. To estimate the prevalence of symptomatic knee and hip OA in a multiregional sample in France.
Design: A two-phase population-based survey was conducted in six regions in 2007–2009. On initial phone contact using random-digit dialing, subjects 40–75 years old were screened with a validated questionnaire. Subjects screened positive were invited for ascertainment: physical examination and hip and/or knee radiography (Kellgren–Lawrence grade ≥ 2). Multiple imputation for data missing not-at-random was used to account for refusals.
Results: Of 63,232 homes contacted, 27,632 were eligible, 9621 subjects screened positive, 3707 participated fully in the ascertainment phase, and 1010 had symptomatic OA: 317 hip, 756 knee. Hip OA prevalence according to age class ranged from 0.9% to 3.9% for men and 0.7–5.1% for women. Knee OA ranged from 2.1% to 10.1% for men and 1.6–14.9% for women. Both differed by geographical region. The hip and knee standardized prevalence was 1.9% and 4.7% for men and 2.5% and 6.6% for women, respectively.
Conclusions: This confirmed the feasibility of using a screening questionnaire for eliciting population-based estimates of OA. In France, it increases with age and is greater among women above the age of 50. The geographical disparity of hip and knee OA parallels the distribution of obesity.
Study registration ID number 906297 at http://www.clinicaltrials.gov/.

Introduction

Osteoarthritis (OA) is a major cause of disability in elderly people, the main source of hip and knee arthroplasty and therefore a major public health problem. Although known as a frequent disease increasing with age, the population-based prevalence of hip and knee OA has seldom been reported, especially in Europe.

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Geographic or ethnic differences in prevalence estimates have been reported[1], but discrepant estimates of prevalence mainly result from variable definitions of hip and knee OA. The definitions are of three categories: radiological OA, clinical OA, and both, for symptomatic OA confirmed on radiographs. The definition combining radiological and clinical features is the most important in public health because it reflects the real burden of disease, need for care and access to health care providers.

Only a few studies of OA prevalence have been conducted in large general-population samples[2]. These include the Framingham OA study[3], the NHANES survey III[4], the Johnston County OA project[5,6], the Zoetermeer survey[7] and the Quintana study in Spain[8]. Two of these studies are more than 15 years old. Most of the other studies were of limited sample size. Overall, prevalence estimates ranged from 6% to 17% and 2–10% for knee and hip OA, respectively, which indicates that OA is the most frequent musculoskeletal disease. Data from studies conducted in Europe indicate some geographical disparity (Appendix 1).

Estimating prevalence of OA in a population requires directly examining clinical and radiographic data in a large population sample, with therefore a large proportion of unjustified radiography results. Although some studies have attempted to collect cases with such a direct approach, they did not use radiography for ascertainment. Indeed, conducting radiography in a large population can be unrealistic and unethical. Therefore, a two-phase survey is necessary: a screening phase that identifies putative cases, and a clinical and radiography examination phase to confirm OA cases. In a preliminary work we have developed a telephone-administered questionnaire for screening OA in the general population, assessed its validity (sensitivity and specificity) in a case–control study[9] and tested the feasibility of this two-phase strategy[10].

Here, we report on a two-phase, population-based survey of subjects aged 40–75 years in a multiregional representative sample in France to estimate the prevalence of symptomatic radiologically confirmed knee and hip OA.

Method

A two-phase survey with population-screening and case-ascertainment phases was conducted in Brittany (West), Côte d'Azur (South-East), Lorraine (East), Picardie (North), Paris (North-Centre) and Toulouse (South-West) areas representing a widespread coverage of the population in France and allowing for study of geographical distribution. Each area was selected to cover households within 1-h by public or private transportation to the university hospital investigating centre. The survey was conducted from April 2007 to October 2009.

Screening phase

The first phase of sampling conducted by telephone involved use of a random selection of telephone numbers in each selected area. Interviewers systematically asked whether phone numbers were of enterprises, businesses, seniors' residences or second homes, and therefore excluded.

We randomly selected one adult in each household by using the next birthday method[11]. The person first answering the phone was asked to name the household residents who were between 40 and 75 years old. The person with a birthday closest to the interview date was then invited to answer the screening questionnaire. Except for age, no exclusion criteria were applied.

The screening questionnaire comprises four items about the hip and four about the knee and was developed from a literature review and the American College of Rheumatology (ACR) criteria for OA[12,13] (Appendix 2). It asks about typical symptoms of knee or hip OA during the previous 4 weeks and includes one question about self-reported OA diagnosis. The questionnaire as a whole has a sensitivity of 96% and a specificity of 90%[9]. Subjects who screened positive for presence of OA (presence of at least one of the listed characteristic symptoms and/or self-reporting OA diagnosis, i.e., any positive answer to one among the four items) were invited to participate in the ascertainment phase in the investigation centre.

Ascertainment phase

The case-ascertainment phase was conducted by physicians trained in rheumatology. Subjects underwent clinical examination and knee and/or hip radiography. Data for both clinical diagnosis (i.e., physician judgment) and ACR criteria for hip and knee OA were collected on standard forms.

Subjects who gave positive answers for one or more items about the knee on the screening questionnaire underwent radiography to obtain weight-bearing anteroposterior (AP), posteroanterior semi-flexed and axial/sky views of the knee. Subjects who gave positive answers for one or more hip items underwent radiography to obtain AP pelvis and oblique (Lequesne) views of the hip. Radiography was not performed in those who had one of correct quality in the past 12 months. All radiographs were read centrally by two readers (BM, EV) who were blinded to clinical condition and questionnaire results. Single reading of radiographs was prepared by training both readers on a pilot study sample ($N = 1380$)[10]. Target hip and knee femoro-tibial compartments were scored by the Kellgren–Lawrence (K–L) method[14] on the basis of the degree of osteophyte formation, joint space narrowing, sclerosis, and joint deformity distinguished in five grades (0: no OA, 1: doubtful, 2: minimal, 3: moderate, 4: severe). Cases were defined as symptomatic OA according to the physician (clinical) and OA with K–L ≥ 2 on radiography for the same joint.

The study protocol was approved by institutional review boards (*Comité Consultatif sur le Traitement de l'Information en matière de Recherche dans le domaine de la Santé, and Comité National Informatique et Liberté*).

Statistical analysis

Prevalence of OA was estimated for each sex, age class (40–49, 50–59, 60–69, 70–75 years) and geographic area. To account for nonparticipants at various steps of the screening and ascertainment processes, a multistep statistical procedure was developed to control for non-response bias by the multiple imputation technique[15].

We found screening refusers (refusals before responding the screening questionnaire), early ascertainment refusers (refusals to enter the ascertainment phase despite a positive answer on the screening questionnaire), subjects who were secondarily unreachable (not reached on the phone for the ascertainment phase), late ascertainment refusers (refusals to schedule an ascertainment visit) and withdrawers (subjects who did not show up at the scheduled visit) (Fig. 1). Completers were subjects screened negative for OA and subjects who completed the whole ascertainment phase.

Differences between participants and nonparticipants were examined by multinomial logistic regression, with the different types of nonparticipation treated as dependent variables. Tested variables were age, sex, socio-professional category in eight classes according to national statistics institute (INSEE), geographic area and the eight items of the screening questionnaire, data that were available for all subjects except screening refusers, for whom data were limited to age, sex and geographic location. The same variables were tested in multivariate logistic regression to determine factors predicting symptomatic hip and/or knee OA in participants at the 0.05 significance level. Final

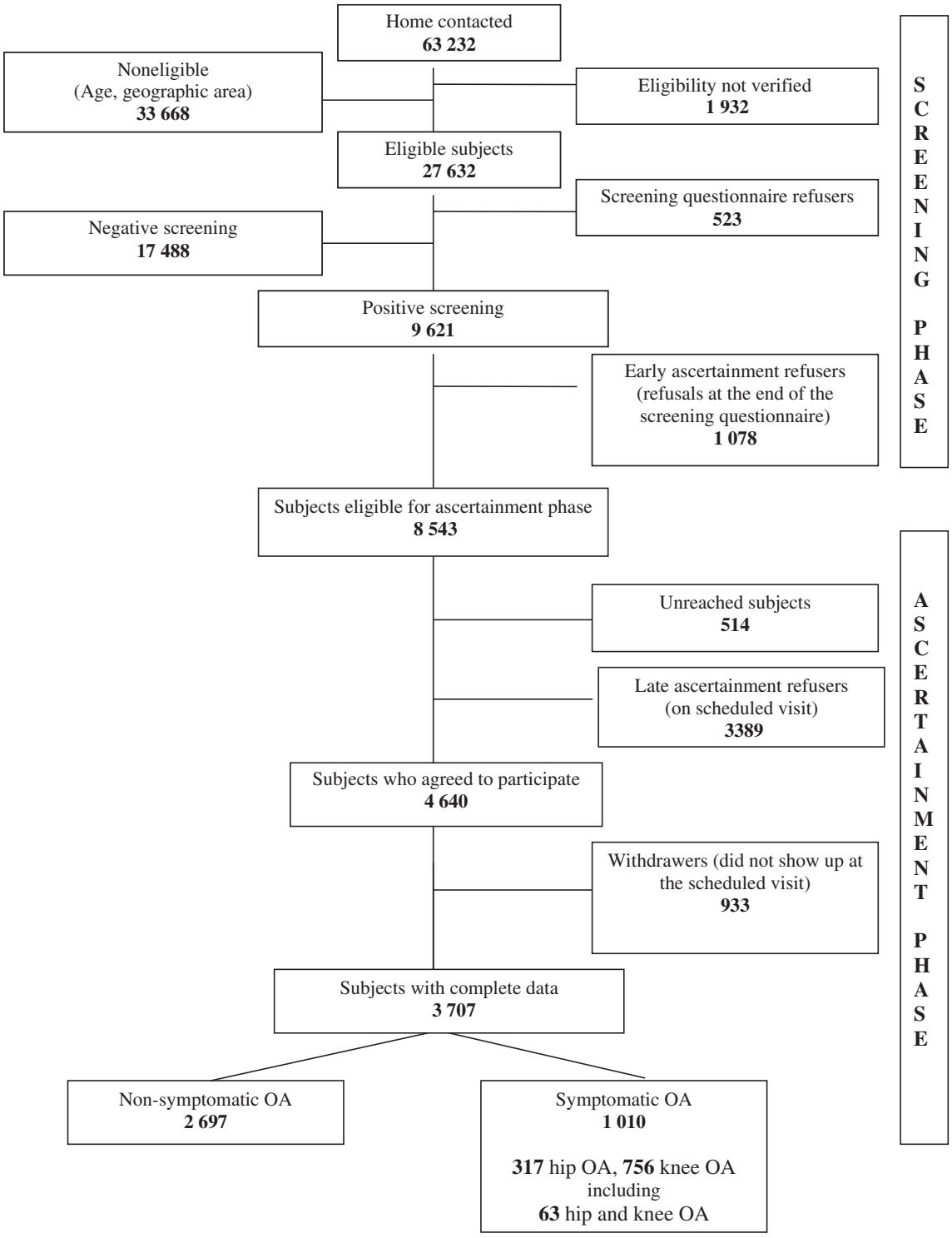

Fig. 1. Flow-chart of the study.

regression models were constructed from all potential predictors, and their (predictive) validity was assessed with Harrell's *c* statistic (which varies from 0 to 1, indicating higher validity when closer to 1). These models were further used to estimate the corrected numerator of prevalence in multiple imputation as implemented in Proc MI of SAS software (SAS Inst., Cary, NC). We analyzed the resulting datasets (100 copies of the data, each with missing values suitably imputed) with Proc MIANALYZE of SAS, which incorporates the uncertainty caused by the imputation.

Denominators were the numbers of subjects eligible within the regions of the survey.

Prevalence estimates and 95% confidence intervals (95% CIs) were finally corrected by the sensitivity error (sensitivity = 0.983) of the screening questionnaire according to an equation previously

developed for such survey design[16]. All analyses were stratified by joint, age class and sex. A correlation of standardized prevalence estimates with prevalence estimates of obesity by region[17] was sought using Spearman rank correlation coefficient.

Standardized prevalence estimates were calculated according to the European age and sex distribution for 2006 (Eurostat).

From pilot study results[10], we estimated that a sample size of at least 2500 (completers) in each considered age/sex strata was needed to provide a precision of at least ±1.5% for prevalence of hip and knee OA ranging between 2% and 17%. So, the estimated number of completers needed was 20,000.

Results

During the study period, someone in 63,232 homes answered a phone call, and 27,632 homes had at least one person between 40 and 75 years old. Among these people, 523 were screening refusers, 17,488 screened negative for presence of OA and 9621 screened positive. Of these latter subjects, 1078 were early ascertainment refusers (Fig. 1). A total of 3707 positive-screened subjects participated fully in the ascertainment phase, for 21,195 completers. Reasons for nonparticipation included inability to contact to arrange a visit to the clinic (514), refusal to participate in the ascertainment visit (3389 late ascertainment refusers) and not showing up to the scheduled visit (933 withdrawers). On scheduling the ascertainment visit, 433 subjects reported no pain for several months, 53 pain with joint prosthesis, 46 inflammatory arthritis (rheumatoid arthritis, spondylarthropathy) and 13 pain due to recent bone fracture. These subjects were considered free of symptomatic OA. Among the 3707 subjects who completed the whole ascertainment phase, 2697 had non-symptomatic OA, 427 (11.5%) and 1066 (28.8%) met the ACR clinical criteria for hip and knee OA respectively, and 1010 had symptomatic and radiological OA, of which 317 was hip OA and 756 knee OA, affecting both joints in 63 subjects.

The participation rate differed according to region, age, sex and socio-professional category, and missing data varied for the different items of the screening questionnaire (Table I). Older subjects were significantly more likely to be refusers (all types), whereas younger subjects had a higher probability of being unreachable or withdrawing. Refusers were more frequently women, and the frequency differed by region. Nonparticipants (all types) more frequently gave a positive answer to the survey item about pain, which indicated a not-at-random missingness process; knee swelling was more frequent in early and late ascertainment refusers; and self-reporting of knee or hip OA was more frequent for late ascertainment refusers or withdrawers.

Imputation models were constructed for screening refusers using documented variables found associated with OA in participants: age, sex and region (Harrell's $c = 0.72$ for hip and 0. 71 for knee); and for all other nonparticipants groups using age, region, pain (Q1), mobility limitation (Q2) and self-reported diagnosis for hip OA (Harrell's $c = 0.97$) and age, sex, region, pain items (Q5, Q6) and self-reported diagnosis for knee OA (Harrell's $c = 0.94$).

Corrected estimates of prevalence and their 95% CIs by age class for hip and knee symptomatic and radiological OA for observed (completers) and imputed (eligible) subjects and ascertained cases are in Appendix 3. Among 9172 eligible male subjects, the prevalence of symptomatic and radiological hip OA ranged from 0.9% to 3.9% for subjects aged 40–49 to 70–75 years old, and the prevalence of symptomatic and radiological knee OA ranged from 2.1% to 10.1%. Among 18,460 eligible female subjects, the prevalence of symptomatic and radiological hip OA by age class ranged from 0.7% to 5.1% and that of symptomatic and radiological knee OA from 1.6% to 14.9%

Table I
Participation and characteristics of subjects with a positive answer about OA on screening questionnaire*

	Completers	Screening refusers	Early ascertainment refusers	Secondarily unreachable	Late ascertainment refusers	Withdrawals	All eligible
	$N = 21,195$	$N = 523$	$N = 1078$	$N = 514$	$N = 3389$	$N = 933$	$N = 27,632$
	N (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)
Sex							
Male	7406 (34.9)	147 (28.1)	263 (24.4)	181 (35.2)	924 (27.3)	251 (26.9)	9172 (33.2)
Female	13,789 (65.1)	376 (71.9)	815 (75.6)	333 (64.8)	2465 (72.7)	682 (73.1)	18,460 (66.8)
Age							
40–49 y	6856 (32.3)	84 (16.1)	168 (15.6)	178 (34.6)	741 (21.9)	284 (30.4)	8311 (30.1)
50–59 y	6600 (31.1)	145 (27.7)	311 (28.8)	156 (30.4)	954 (28.1)	277 (29.7)	8443 (30.6)
60–69 y	5144 (24.3)	141 (27.0)	368 (34.1)	121 (23.5)	940 (27.7)	216 (23.2)	6930 (25.1)
70–75 y	2595 (12.2)	153 (29.3)	231 (21.4)	59 (11.5)	754 (22.2)	156 (16.7)	3948 (14.3)
Screening questionnaire							
Q1. Hip, groin or up thigh pain	1761 (8.3)	–	456 (42.3)	229 (44.6)	1510 (44.6)	454 (48.7)	*4410 (16.3)*
Q2. Hip pain in climbing up stair or steep street	990 (4.7)	–	276 (25.6)	135 (26.3)	901 (26.6)	272 (29.2)	*2574 (9.5)*
Q3. Hip mobility limitation	500 (2.4)	–	111 (10.3)	61 (11.9)	387 (11.4)	127 (13.6)	*1186 (4.4)*
Q4. Hip OA	728 (3.4)	–	186 (17.3)	72 (14.0)	591 (17.4)	187 (20.0)	*1764 (6.5)*
Q5. Knee pain	2341 (11.0)	–	659 (61.1)	314 (61.1)	2084 (61.5)	606 (65.0)	*6004 (22.1)*
Q6. Knee pain in stepping stairs down or walking in steep street	1573 (7.4)	–	425 (39.4)	203 (39.5)	1355 (40.0)	437 (46.8)	*3993 (14.7)*
Q7. Knee swelling	465 (2.2)	–	108 (10.0)	57 (11.1)	360 (10.6)	129 (13.8)	*1119 (4.1)*
Q8. Knee OA	1093 (5.2)	–	282 (26.2)	114 (22.2)	930 (27.4)	252 (27.0)	*2671 (9.9)*
Region in France							
Picardie (North)	3303 (15.6)	73 (14.0)	139 (12.9)	56 (10.9)	630 (18.6)	17 (1.8)	4218 (15.3)
Brittany (West)	3166 (14.9)	85 (16.3)	139 (12.9)	24 (4.7)	410 (12.1)	76 (8.1)	3900 (14.1)
Lorraine (East)	5381 (25.4)	146 (27.9)	271 (25.1)	40 (7.8)	578 (17.1)	302 (32.4)	6718 (24.3)
Côte d'Azur (South-East)	1497 (7.1)	32 (6.1)	110 (10.2)	29 (5.6)	283 (8.4)	110 (11.8)	2061 (7.5)
Paris area (North-Centre)	3391 (16.0)	84 (16.1)	199 (18.5)	207 (40.3)	627 (18.5)	290 (31.1)	4798 (17.4)
Toulouse area (South-West)	4457 (21.0)	103 (19.7)	220 (20.4)	158 (30.7)	861 (25.4)	138 (14.8)	5937 (21.5)

* Italicized figures in "all eligible" column represent the number (%) of interviewed subjects with positive answers to each item.

Table II
Prevalence of hip symptomatic and radiological OA overall and by region

	Eligible subjects	All regions		Picardie		Brittany		Lorraine		Côte d'Azur		Paris area		Toulouse area	
	N	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Male															
40–49 y	2920	0.96	0.28, 1.91	3.11	0.80, 6.54	0.47	0.00, 2.27	0.59	0.00, 2.14	0.29	0.00, 2.38	0.73	0.00, 2.78	0.63	0.00, 2.26
50–59 y	2811	1.58	0.59, 2.77	2.58	0.56, 4.57	1.49	0.58, 3.39	1.66	0.55, 3.57	1.83	0.55, 5.09	0.56	0.51, 3.59	1.56	0.52, 3.67
60–69 y	2303	3.17	1.58, 4.93	4.65	1.34, 6.89	4.18	1.30, 8.36	3.89	1.37, 6.51	1.19	1.33, 6.25	3.15	1.25, 6.35	1.61	1.29, 5.79
70–75 y	1138	3.90	1.39, 6.87	2.26	1.16, 8.66	5.63	1.12, 10.73	5.36	1.09, 10.27	2.04	1.06, 7.71	3.54	1.00, 8.52	3.29	1.01, 9.22
Female															
40–49 y	5391	0.76	0.19, 1.45	1.00	0.01, 2.77	0.68	0.00, 2.33	0.97	0.20, 2.34	0.52	0.00, 2.38	0.68	0.00, 2.21	0.38	0.00, 1.41
50–59 y	5632	2.17	1.16, 3.23	2.92	0.68, 5.62	3.10	1.08, 6.08	2.58	0.93, 4.69	0.87	0.00, 3.59	1.27	0.00, 3.33	1.52	0.16, 3.44
60–69 y	4627	4.17	2.63, 5.76	4.98	1.87, 8.72	5.41	1.89, 9.80	5.05	2.20, 8.31	1.61	0.00, 4.80	3.47	0.26, 7.60	3.28	0.64, 6.50
70–75 y	2810	5.13	2.87, 7.50	6.59	1.95, 12.13	4.99	0.84, 10.11	5.78	1.37, 10.84	4.60	0.47, 11.08	4.43	0.30, 10.18	3.86	0.59, 8.29

(Tables II, III and Fig. 2). Given the high sensitivity of the screening questionnaire, these estimates corrected for sensitivity error increased by 3.9% and 1.7% for knee and hip estimates, respectively.

Hip and knee OA prevalence increased with age similarly for both sexes and was higher for females >50 years old. Hip OA prevalence was higher in the northern regions, namely, Picardie, Lorraine and Brittany, whereas knee OA was higher in the northeastern regions, namely, Picardie and Lorraine, for males and females, particularly for those with older age. Hip and knee OA prevalence correlated with the prevalence of obesity by region (rho = 0.92 and 0.54 respectively) (Table IV).

On standardization for the European population 40–75 years old, the prevalence of hip and knee symptomatic and radiological OA was 1.9% and 4.7% for men and 2.5% and 6.6% for women, respectively.

Discussion

This study of a representative population area in France gives accurate national estimates of the prevalence of symptomatic hip and knee OA in France. The age-related prevalence of symptomatic hip OA of radiographic K–L ≥ 2 ranged from 0.9% to 3.9% and 0.7–5.1% for men and women, respectively, and that of symptomatic knee OA of K–L ≥ 2 from 2.1% to 10.1% and 1.6–14.9% for men and women, respectively. The prevalence increased with age, was higher among women >50 years old, and differed by geographical region for both hip and knee OA.

This study has several strengths. First, it involved a large, multiregional representative sample. The precision of the overall estimates is high, and the sample size was large enough to obtain multiregional estimates with reasonable precision. The scarcity of comparable data from other European countries limits drawing any inferences from our observations. Second, the careful development and validation of the OA screening questionnaire contributed to the internal validity of our study; a similar initiative was developed in Spain and published after the start of our study[8,18]. The expense of the two-phase design is primarily in the sensitivity error of the screening questionnaire, for which we developed and applied a specific correction method[16]. The questionnaire is available and can be replicated in other countries. The 35% frequency of symptoms detected by this screening questionnaire was high as compared with other population-based surveys[3–8]. Developed to maximize sensitivity of screening, the instrument detects a low level of symptoms in subjects. Third, this study involved both clinical and radiological criteria, which is preferable to the use of only radiological criteria, because symptoms drive the need to seek care and for interventions. Clinical ACR criteria or self-reported diagnosis alone seem to have inadequate sensitivity or specificity[19,20] as compared with the clinical exam for ascertainment. Such combination of clinical and radiological criteria should be recommended for future prevalence surveys.

Our study has some limitations. The participation rate was not optimal but similar to that seen in previous studies with a similar design[8,21–23]. A potential non-response bias, because of non-respondents at the various steps of the two-phase procedure, was unavoidable. This difficulty has been shown with surveys of other musculoskeletal conditions[24,25]. Adjusting prevalence estimates on various hypotheses (similarity of non-respondents, maximum bias) does not help control such a selection bias. In contrast, the recently developed multiple imputation techniques we used in this study (contrary to previous ones) allow for using

Table III
Prevalence of knee symptomatic and radiological OA overall and by region

	Eligible subjects	All regions		Picardie		Brittany		Lorraine		Côte d'Azur		Paris area		Toulouse area	
	N	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Male															
40–49 y	2920	2.09	0.93, 3.86	2.51	0.00, 6.21	1.20	0.00, 4.43	2.78	0.87, 6.22	1.30	0.00, 7.37	1.31	0.00, 5.42	2.24	0.04, 5.60
50–59 y	2811	4.72	2.99, 7.04	5.52	1.63, 10.73	2.28	0.47, 5.73	6.84	3.56, 11.79	3.23	0.00, 11.60	3.43	0.04, 8.69	4.30	1.14, 9.02
60–69 y	2303	6.80	4.53, 9.87	9.04	3.33, 15.90	4.79	0.62, 10.70	8.11	3.76, 14.15	6.06	1.45, 15.99	4.34	0.82, 11.23	6.46	2.04, 12.99
70–75 y	1138	10.14	6.31, 15.25	7.70	0.04, 16.70	4.78	0.00, 12.53	11.11	4.00, 20.95	6.38	0.19, 18.42	13.60	4.34, 27.35	11.78	4.29, 21.97
Female															
40–49 y	5391	1.64	0.74, 2.59	2.04	0.40, 4.49	0.69	0.00, 2.42	2.08	0.43, 4.17	1.18	0.00, 4.17	2.43	0.26, 5.17	1.10	0.00, 2.72
50–59 y	5632	5.87	4.26, 7.50	6.96	3.78, 10.72	3.27	1.00, 6.24	8.01	4.82, 11.45	2.73	0.00, 7.27	6.08	2.20, 10.23	5.30	2.15, 8.78
60–69 y	4627	10.54	8.18, 12.91	12.59	7.34, 18.46	6.69	2.72, 11.49	14.49	9.58, 19.60	8.03	2.37, 14.67	9.29	3.44, 15.38	9.00	4.55, 13.79
70–75 y	2810	14.96	11.40, 18.51	17.18	9.92, 25.41	9.67	3.76, 16.31	19.96	12.55, 27.78	10.81	3.15, 20.47	15.69	6.39, 25.45	13.35	6.20, 20.92

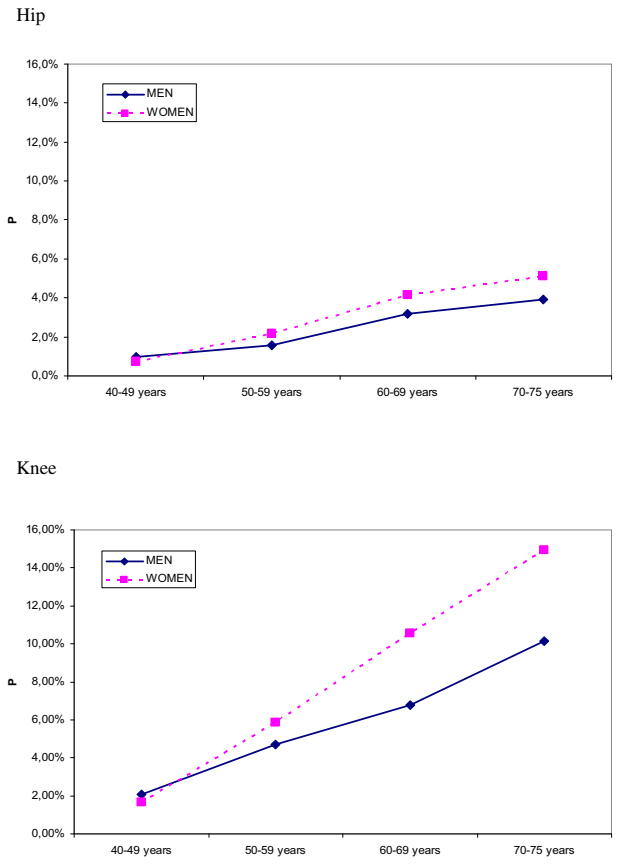

Fig. 2. Hip and knee symptomatic and radiological OA prevalence by age and sex.

all information obtained for non-respondents at various steps to derivate estimates accounting for these corrections. These techniques are particularly useful even when non-response occurs not-at-random[26], as was observed in our study. Notably, women are overrepresented among the eligible subjects, probably because they answered the phone more frequently than did men and did not fully respect the subject selection by closest birthday date. However, a response bias due to this phenomenon is unlikely or minimal, because the subject selection occurred before we mentioned that OA was the goal of the survey (health survey) and asked screening questions. Second, the reliability of the reading of radiographs, although tested in a pilot study, was not assessed in the survey sample. Third, our estimates are not valid for an elderly population living in institutions because we chose the upper boundary of 75 years of age and household phone number. Fourth, the cost of the survey was relatively high (up to 925 € per confirmed case), given the strategy used to identify cases from population-based screening.

Table IV
Standardized hip and knee OA and obesity prevalence by region[17]

Region in France	Knee OA (%)	Hip OA (%)	Obesity (%)
Picardie (North)	6.6	3.2	14.4
Brittany (West)	3.3	2.6	9.2
Lorraine (East)	7.5	2.6	13.1
Côte d'Azur (South-East)	3.9	1.2	7.7
Paris area (North-Centre)	5.3	1.7	8.1
Toulouse area (South-West)	5.2	1.6	8.8
Spearman rho*	0.54	0.92	

* Spearman correlation coefficient of joint OA with obesity prevalence.

Our prevalence estimates are lower than others. Several explanations are possible. First, our cases of symptomatic OA relied on self-reported symptoms or diagnosis and on radiographic evidence checked by a rheumatologist. Many subjects seen by rheumatologists had self-reported symptoms or met clinical ACR criteria for OA, or had referred pain. These cases could have been classified as OA in other studies by self-reported symptoms alone or by a combination of self-reported symptoms and radiography results. The consequences of the disease for public health (i.e., access to care, impact on daily life of this chronic condition), as well as clinically (i.e., health care use, development of new treatments to alleviate symptoms and disease progression) are major justifications to focus on symptomatic OA. Second, the timeframe of the question about pain or symptoms probably affects prevalence estimates. The NHANES III study recorded lifetime history of knee pain with a 6-week duration and the estimates for knee OA were 10.0% and 13.6% for men and women respectively. The Framingham Study recorded lifetime prevalence of knee pain of 1-month duration, and found estimates of 6.2% in men and 7.6% in women. Other studies have used "current knee pain on most days," as in the Johnston County OA project where prevalence estimates were 13.5% and 18.7% for men and women knee OA respectively and 8.3% and 11.1% for hip OA. In our study, we recorded symptoms occurring during the previous 4 weeks. This time period may have lowered the prevalence by excluding data on intermittent symptoms becoming asymptomatic between the screening and ascertainment phases.

Previous prevalence estimates differ by population and methods used (Appendix 1). In surveys with screening questionnaires, the estimates vary greatly depending on the questions used to elicit symptom information. Radiography protocols differ between studies. We obtained weight-bearing AP, weight-bearing posteroanterior semiflexed and axial views for knees and an AP view of the pelvis and oblique view for the hip. Such complete radiography assessment can potentially classify more subjects as having OA[27]. Very few studies are directly comparable to ours because published prevalence estimates are rarely provided in a similar format by sex and age class, thus preventing us from calculating standardized prevalence estimates for direct comparison. Our population sample included subjects up to 75 years old, whereas other studies did not. The prevalence of OA increased with age for both sexes and was greater for women than men from age 50 years, as was found in numerous other studies[28]. Over time, raw estimates from studies of previous decades have probably increased with the aging of the population and increase in obesity, a known and increasingly frequent risk factor for OA. The prevalence of obesity and ethnic minorities showing differential risk for OA differ between industrialized countries in Europe and the United States. The prevalence of symptomatic OA (clinical criteria) in European countries is estimated to range from 5.4% to 29.8% and 0.9–9.7% for knee and hip OA, respectively. Our results show geographic heterogeneity with a decreasing north–south gradient for hip OA and a decreasing north-east to south-western gradient for knee OA. Interestingly, a similar and correlated distribution of the prevalence of obesity was consistently reported over the past decades in regions in France we investigated[17]. This ecological observation gives some additional validity to our estimate of regional heterogeneity. Compared to other European studies, our multiregional observations are similar, for a higher prevalence reported in northern countries, although we used different methods and OA definitions. The findings are similar to those for knee OA but lower than those for hip OA reported from Spain[8]. Of note, inflammatory rheumatic diseases show a similar direction gradient in prevalence in France[29] and in Europe[1]. Most

of the other estimates are from smaller, nonrepresentative studies or from studies involving only self-reported symptoms without radiographic ascertainment.

The frequency of rheumatic diseases is expected to double between 1991 and 2033[30], and OA is the most frequent of these. As a consequence, functional impairment, dependence and cost will increase. Prevalence estimates give a picture of the distribution of the disease in the population. Accurate estimates of OA prevalence are critical for understanding the age and sex distribution of the disease, identifying high-risk groups and guiding intervention efforts efficiently to limit the progression of the disease. This study updates previous estimates, which is particularly important because only a few studies were conducted in the past 10 years, even though the epidemiology of risk factors for OA is changing with an increase in mean body mass index and the aging of the population. These results are important for public health to assess future needs, determine the burden of disease, investigate modifiable risk factors and develop focused interventions to prevent, treat and slow the progression of OA, in other words, help decision-makers forecast future needs at the national and European level. The survey also provides a unique opportunity to recruit a large and representative sample of patients with lower-limb symptomatic OA in a cohort study.

Conclusions

We conducted a two-phase population-based survey to provide prevalence estimates of symptomatic hip and knee OA in France. Our study increases knowledge about population-based prevalence estimates of this condition in Europe. Our estimates suggest that the prevalence of symptomatic hip and knee OA increases by age for both sexes and is higher for women older than 50 years in France. The geographical distribution of hip and knee OA parallels the distribution of obesity over the investigated area.

Author contributions

FG, AS and JC initiated the conception and methods of the study. BF, ACR, JM, JP, CHR, BM, JC and FG wrote the study protocol. LEZ, CHR, PF, BF, AS, BM, EV and ACR recruited participants and collected the data in investigating centres. ACR and FG coordinated the data collection and data management with investigating centres. BM and EV conducted the centralized reading of radiographs. JC conducted statistical analyses in collaboration with JP, ACR and FG. FG, ACR, JP and JC wrote the draft manuscript and initial revision.

FG and JC are guarantors of the study.

Ethical approval

The study protocol was approved by institutional review boards (*Comité Consultatif sur le Traitement de l'Information en matière de Recherche dans le domaine de la Santé, and Comité National Informatique et Liberté*) and participants gave informed consent before taking part

Role of the funding sources

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The study sponsors did not take part in study design, collection, analysis and interpretation of data, in writing of the report and in the decision to submit the article for publication.

Conflict of interest

None.

Appendix 1

Prevalence of symptomatic knee and hip OA by OA definition

Study[reference]		Period	Age class	OA definition	Prevalence*		
					Total	Women	Men
Knee							
France	*Present study*	2007–2009	40–75 y	Screening then clinical exam and radiographs	–	6.6*	4.7*
Spain	Quintana[8]	2002–2003	60–90 y	Screening then clinical exam and radiographs	12.2	14.9	8.7
China	Zhang[31]	1998–2000	≥60 y	Screening then clinical exam and radiographs	–	15.0	5.6
Japan	Muraki[32]	2005	≥60 y	Clinical exam and radiographs	26.1	31.8	15.8
USA	Framingham[3]	1983–1985	63–70 y	Self-reported symptoms and radiographs	7.0	7.6	6.2
	Johnston County OA project[6]	1991–1997	≥45 y	Self-reported symptoms and radiographs	16.4*	18.7*	13.5*
	NHANES III[4]	1991–1994	≥60 y	Self-reported symptoms and radiographs	12.1*	13.6*	10.0*
Italy	Salaffi[33]	2004	≥18 y	ACR clinical criteria	5.4	–	–
	Mannoni[34]	2003	≥65 y	ACR clinical criteria	29.8	–	–
Greece	Andrianakos[35]	1996–1999	≥19 y	ACR clinical criteria	6.0	8.6	3.2
Norway	Grotle[36]	2004	24–76 y	Self-reported diagnosis	7.1	7.9	6.2
Netherlands	Picavet[37]	1998	≥25 y	Self-reported diagnosis	–	13.6*	10.1*
Hip							
France	*Present study*	2007–2009	40–75 y	Screening then clinical exam and radiographs	–	2.5*	1.9*
Spain	Quintana[8]	2002–2003	60–90 y	Screening then clinical exam and radiographs	7.4	8.0	6.7
China	Nevitt[38]	1998–2000	≥60 y	Screening then clinical exam and radiographs	–	0.1	0.0
USA	Johnston County OA project[5]	1991–1997	≥45 y	Self-reported symptoms and radiographs	9.7*	11.1*	8.3*
Italy	Salaffi[33]	2004	≥18 y	ACR clinical criteria	1.6	–	–
	Mannoni[34]	2003	≥65 y	ACR clinical criteria	7.7	–	–
Greece	Andrianakos[35]	1996–1999	≥19 y	ACR clinical criteria	0.9	1.5	0.3
Norway	Grotle[36]	2004	24–76 y	Self-reported diagnosis	5.5	6.2	4.6
NL	Picavet[37]	1998	≥25 y	Self-reported diagnosis	–	9.6*	3.9*

* Indicates standardized prevalence using European Union population (Eurostat).

Appendix 2

Screening questionnaire for symptomatic hip and knee OA[9]

Concerning the hip
Q1. During the last 4 weeks, have you had pain in the hip, groin, or in the upper thigh?
Q2. Do you have pain in the hip, groin, or in the upper thigh while climbing stairs or walking down slopes?
Q3. Do you have a limitation in the range of motion of one or both hips?
Q4. Do you have hip OA?
Concerning the knee
Q5. During the last 4 weeks, have you had knee pain?
Q6. Do you have knee pain while climbing stairs or walking down slopes?
Q7. During the last 4 weeks, have you had swelling in one or both knees?
Q8. Do you have knee OA?

Appendix 3

Prevalence estimates in completers (observed) and noncompleters (imputed) by age class, corrected for sensitivity error of the screening questionnaire

	40–49 y			50–59 y			60–69 y			70–75 y		
	N	%	95% CI	*N*	%	95% CI	*N*	%	95% CI	*N*	%	95% CI
Hip male												
Completers	2413	0.67	0.34, 1.00	2295	1.11	0.66, 1.51	1855	2.36	1.63, 3.00	843	2.53	1.44, 3.55
Screening refusers	28	0.62	0.00, 4.85	43	1.23	0.00, 6.08	42	2.96	0.00, 10.28	34	2.90	0.00, 10.53
Early ascertainment refusers	52	2.39	0.00, 8.74	82	3.09	0.00, 8.17	87	5.43	0.00, 11.96	42	7.53	0.00, 18.52
Unreached subjects	71	2.55	0.00, 7.65	55	3.98	0.00, 11.17	40	5.39	0.00, 15.00	15	9.56	0.00, 30.78
Late ascertainment refusers	263	2.34	0.00, 5.15	262	4.17	0.51, 7.84	228	7.28	2.66, 11.91	171	7.81	2.17, 13.44
Withdrawals	93	2.58	0.00, 6.99	74	3.85	0.00, 9.63	51	8.74	0.00, 19.33	33	12.46	0.00, 28.19
Eligible subjects	2920	0.96	0.28, 1.91	2811	1.58	0.59, 2.77	2303	3.17	1.58, 4.93	1138	3.90	1.39, 6.87
Hip female												
Completers	4443	0.39	0.20, 0.57	4305	1.44	1.08, 1.80	3289	2.66	2.10, 3.22	1752	2.79	2.01, 3.57
Screening refusers	56	0.56	0.00, 3.30	102	1.41	0.00, 4.42	99	2.80	0.00, 7.42	119	2.46	0.00, 6.45
Early ascertainment refusers	116	2.31	0.00, 6.23	229	4.24	0.43, 8.06	281	8.13	3.60, 12.66	189	8.32	2.27, 14.36
Unreached subjects	107	2.64	0.00, 7.12	101	4.14	0.00, 9.47	81	7.49	0.00, 15.55	44	9.04	0.00, 20.70
Late ascertainment refusers	478	2.40	0.20, 4.66	692	4.90	2.37, 7.44	712	8.17	5.33, 11.02	583	10.67	6.73, 14.62
Withdrawals	191	3.35	0.00, 7.09	203	5.35	0.73, 9.97	165	9.48	2.86, 16.11	123	8.56	1.60, 15.52
Eligible subjects	5391	0.76	0.19, 1.45	5632	2.17	1.16, 3.23	4627	4.17	2.63, 5.76	2810	5.13	2.87, 7.50
Knee male												
Completers	2413	1.08	0.66, 1.50	2295	3.26	2.51, 4.01	1855	4.82	3.81, 5.83	843	5.92	4.28, 7.56
Screening refusers	28	1.40	0.00, 7.83	43	2.76	0.00, 9.48	42	5.02	0.00, 15.38	34	6.82	0.00, 19.05
Early ascertainment refusers	52	7.38	0.00, 16.63	82	12.56	2.66, 22.46	87	16.41	6.22, 26.61	42	37.17	16.68, 57.66
Unreached subjects	71	12.33	1.91, 22.74	55	15.12	2.44, 27.79	40	17.75	1.34, 34.15	15	20.30	0.00, 46.53
Late ascertainment refusers	263	8.08	3.54, 12.62	262	13.23	7.46, 18.99	228	17.18	10.12, 24.24	171	25.15	15.93, 34.38
Withdrawals	93	9.16	0.84, 17.49	74	14.57	4.51, 24.62	51	24.72	8.87, 40.57	33	22.46	4.50, 40.41
Eligible subjects	2920	2.09	0.93, 3.86	2811	4.72	2.99, 7.04	2303	6.80	4.53, 9.87	1138	10.14	6.31, 15.25
Knee female												
Completers	4443	0.84	0.57, 1.12	4305	3.74	3.15, 4.33	3289	6.23	5.36, 7.09	1752	8.13	6.79, 9.46
Screening refusers	56	1.41	0.00, 6.03	102	3.41	0.00, 8.64	99	6.26	0.00, 13.15	109	7.85	0.86, 14.84
Early ascertainment refusers	116	6.22	0.47, 11.97	229	11.72	5.85, 17.60	281	19.82	13.38, 26.26	189	25.40	17.03, 33.76
Unreached subjects	107	5.04	0.00, 10.69	101	11.49	3.37, 19.62	81	20.89	9.02, 32.76	44	27.64	10.50, 44.78
Late ascertainment refusers	478	5.03	2.20, 7.85	692	13.92	10.12, 17.72	712	22.72	18.35, 27.08	583	28.24	22.89, 33.59
Withdrawals	191	7.13	1.91, 12.36	203	15.30	8.71, 21.90	165	25.57	16.13, 35.02	123	35.04	23.66, 46.42
Eligible subjects	5391	1.64	0.74, 2.59	5632	5.87	4.26, 7.50	4627	10.54	8.18, 12.91	2800	14.96	11.40, 18.51

Supplementary material

Supplementary data related to this article can be found online at doi:10.1016/j.joca.2011.08.004.

References

1. Silman AJ, Hochberg M. Epidemiology of the Rheumatic Diseases. Oxford University Press; 2001.
2. Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, *et al*. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II. Arthritis Rheum 2008;58:26–35.
3. Felson DT, Naimark A, Anderson J, Kazis L, Castelli W, Meenan RF. The prevalence of knee osteoarthritis in the elderly. The Framingham Osteoarthritis Study. Arthritis Rheum 1987;30:914–8.
4. Dillon CF, Rasch EK, Gu Q, Hirsch R. Prevalence of knee osteoarthritis in the United States: arthritis data from the Third National Health and Nutrition Examination Survey 1991–94. J Rheumatol 2006;33:2271–9.
5. Jordan JM, Helmick CG, Renner JB, Luta G, Dragomir AD, Woodard J, *et al*. Prevalence of hip symptoms and radiographic and symptomatic hip osteoarthritis in African Americans and Caucasians: the Johnston County Osteoarthritis Project. J Rheumatol 2009;36:809–15.

6. Jordan JM, Helmick CG, Renner JB, Luta G, Dragomir AD, Woodard J, *et al*. Prevalence of knee symptoms and radiographic and symptomatic knee osteoarthritis in African Americans and Caucasians: the Johnston County Osteoarthritis Project. J Rheumatol 2007;34:172–80.
7. van Saase JL, van Romunde LK, Cats A, Vandenbroucke JP, Valkenburg HA. Epidemiology of osteoarthritis: Zoetermeer survey. Comparison of radiological osteoarthritis in a Dutch population with that in 10 other populations. Ann Rheum Dis 1989;48:271–80.
8. Quintana JM, Arostegui I, Escobar A, Azkarate J, Goenaga JI, Lafuente I. Prevalence of knee and hip osteoarthritis and the appropriateness of joint replacement in an older population. Arch Intern Med 2008;168:1576–84.
9. Morvan J, Roux CH, Fautrel B, Rat AC, Euller-Ziegler L, Loeuille D, *et al*. A case–control study to assess sensitivity and specificity of a questionnaire for the detection of hip and knee osteoarthritis. Arthritis Rheum 2009;61:92–9.
10. Roux CH, Saraux A, Mazieres B, Pouchot J, Morvan J, Fautrel B, *et al*. Screening for hip and knee osteoarthritis in the general population: predictive value of a questionnaire and prevalence estimates. Ann Rheum Dis 2008;67:1406–11.
11. Salmon CT, Nichols JS. The next-birthday method of respondent selection. Public Opin Q 1983;47:270–6.
12. Altman R, Asch E, Bloch D, Bole G, Borenstein D, Brandt K, *et al*. Development of criteria for the classification and reporting of osteoarthritis. Classification of osteoarthritis of the knee. Diagnostic and Therapeutic Criteria Committee of the American Rheumatism Association. Arthritis Rheum 1986;29:1039–49.
13. Altman R, Alarcon G, Appelrouth D, Bloch D, Borenstein D, Brandt K, *et al*. The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the hip. Arthritis Rheum 1991;34:505–14.
14. Kellgren JH, Lawrence JS. Radiological assessment of osteoarthrosis. Ann Rheum Dis 1957;16:494–502.
15. Rubin D. Multiple Imputation for Nonresponse in Surveys. New York: John Wiley and Sons; 1987.
16. Morvan J, Coste J, Roux CH, Euller-Ziegler L, Saraux A, Guillemin F. Prevalence in two-phase surveys: accuracy of screening procedure and corrected estimates. Ann Epidemiol 2008;18:261–9.
17. de Saint PT. Evolution of obesity by social status in France, 1981–2003. Econ Hum Biol 2009;7:398–404.
18. Quintana JM, Arostegui I, Escobar A, Lafuente I, Arenaza JC, Garcia I, *et al*. Validation of a screening questionnaire for hip and knee osteoarthritis in old people. BMC Musculoskelet Disord 2007;8:84.
19. LaValley M, McAlindon TE, Evans S, Chaisson CE, Felson DT. Problems in the development and validation of questionnaire-based screening instruments for ascertaining cases with symptomatic knee osteoarthritis: the Framingham Study. Arthritis Rheum 2001;44:1105–13.
20. Peat G, Thomas E, Duncan R, Wood L, Hay E, Croft P. Clinical classification criteria for knee osteoarthritis: performance in the general population and primary care. Ann Rheum Dis 2006;65:1363–7.
21. Kmetic A, Joseph L, Berger C, Tenenhouse A. Multiple imputation to account for missing data in a survey: estimating the prevalence of osteoporosis. Epidemiology 2002;13:437–44.
22. Peat G, Thomas E, Handy J, Wood L, Dziedzic K, Myers H, *et al*. The Knee Clinical Assessment Study – CAS(K). A prospective study of knee pain and knee osteoarthritis in the general population: baseline recruitment and retention at 18 months. BMC Musculoskelet Disord 2006;7:30.
23. Lohmander LS, Gerhardsson de Verdier M, Rollof J, Nilsson PM, Engstrom G. Incidence of severe knee and hip osteoarthritis in relation to different measures of body mass: a population-based prospective cohort study. Ann Rheum Dis 2009;68:490–6.
24. Urwin M, Symmons D, Allison T, Brammah T, Busby H, Roxby M, *et al*. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. Ann Rheum Dis 1998;57:649–55.
25. Thomas E, Hay EM, Hajeer A, Silman AJ. Sjogren's syndrome: a community-based study of prevalence and impact. Br J Rheumatol 1998;37:1069–76.
26. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, *et al*. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ 2009;338:b2393.
27. Duncan RC, Hay EM, Saklatvala J, Croft PR. Prevalence of radiographic osteoarthritis – it all depends on your point of view. Rheumatology (Oxford) 2006;45:757–60.
28. Anderson JJ, Felson DT. Factors associated with osteoarthritis of the knee in the first national Health and Nutrition Examination Survey (HANES I). Evidence for an association with overweight, race, and physical demands of work. Am J Epidemiol 1988;128:179–89.
29. Roux CH, Saraux A, Le Bihan E, Fardellone P, Guggenbuhl P, Fautrel B, *et al*. Rheumatoid arthritis and spondyloarthropathies: geographical variations in prevalence in France. J Rheumatol 2007;34:117–22.
30. Badley EM, Wang PP. Arthritis and the aging population: projections of arthritis prevalence in Canada 1991 to 2031. J Rheumatol 1998;25:138–44.
31. Zhang Y, Xu L, Nevitt MC, Aliabadi P, Yu W, Qin M, *et al*. Comparison of the prevalence of knee osteoarthritis between the elderly Chinese population in Beijing and whites in the United States: The Beijing osteoarthritis study. Arthritis Rheum 2001;44:2065–71.
32. Muraki S, Oka H, Akune T, Mabuchi A, En-yo Y, Yoshida M, *et al*. Prevalence of radiographic knee osteoarthritis and its association with knee pain in the elderly of Japanese population-based cohorts: the ROAD study. Osteoarthritis Cartilage 2009;17:1137–43.
33. Salaffi F, De Angelis R, Grassi W. Prevalence of musculoskeletal conditions in an Italian population sample: results of a regional community-based study. I. The MAPPING study. Clin Exp Rheumatol 2005;23:819–28.
34. Mannoni A, Briganti MP, Di Bari M, Ferrucci L, Costanzo S, Serni U, *et al*. Epidemiological profile of symptomatic osteoarthritis in older adults: a population based study in Dicomano, Italy. Ann Rheum Dis 2003;62:576–8.
35. Andrianakos AA, Kontelis LK, Karamitsos DG, Aslanidis SI, Georgountzos AI, Kaziolas GO, *et al*. Prevalence of symptomatic knee, hand, and hip osteoarthritis in Greece. The ESORDIG study. J Rheumatol 2006;33:2507–13.
36. Grotle M, Hagen KB, Natvig B, Dahl FA, Kvien TK. Prevalence and burden of osteoarthritis: results from a population survey in Norway. J Rheumatol 2008;35:677–84.
37. Picavet HS, Hazes JM. Prevalence of self reported musculoskeletal diseases is high. Ann Rheum Dis 2003;62:644–50.
38. Nevitt MC, Xu L, Zhang Y, Lui LY, Yu W, Lane NE, *et al*. Very low prevalence of hip osteoarthritis among Chinese elderly in Beijing, China, compared with whites in the United States: the Beijing osteoarthritis study. Arthritis Rheum 2002;46:1773–9.