Defining and mapping the person with osteoarthritis for population studies and public health

Elaine Thomas¹, George Peat¹ and Peter Croft¹

Abstract

Objective. To determine population-based estimates for the prevalence of the person with OA, predicted to be the single greatest cause of disability in the general population by 2030, in order to inform the planning and commissioning of health, social care and prevention services.

Methods. A postal survey to all adults ≥50 years of age registered with eight general practices in the UK. Self-reported data on chronic joint pain in four body regions (hand, hip, knee, foot) and the disabling nature of the pain was collected to determine gender and age-group specific prevalence estimates of clinical OA in the joint region and in the person. Multiple imputation and weighted logistic regression was used to allow for missing data.

Results. A total of 26,705 mailed surveys resulted in 18,474 responses (adjusted response = 71.8%). Approximately half of the mailed population had OA in at least one of the four regions (53.23%, 95% CI 52.3, 54.1) and less than half of these had disabling OA (21.87%, 95% CI 21.2, 22.5). The more joint regions involved, the more likely that the OA was disabling. OA prevalence was higher in females and increased with age. Applied to the population of England, this yielded an estimated 3.5 million persons with disabling OA, including 1.45 million people between 50 and 65 years of age and 370,000 ≥85 years of age.

Conclusions. A simple approach to defining the person with OA can contribute to population comparisons, public health projections and health care needs assessments.

Key words: osteoarthritis, epidemiology, prevalence, service planning.

Introduction

OA is a major cause of disability around the world [1]. In the UK it is the most common chronic condition seen in primary care [2], and it is predicted to be the single greatest cause of disability in the general population by 2030 [3]. The potential to prevent, control and treat OA underlines its public health importance [4].

Although OA is understood as a structural joint disease, typified radiographically by cartilage loss and bone changes, it is also a clinical syndrome of pain, stiffness and restricted mobility, and people with similar X-ray appearances can have different symptoms and degrees of disability in their daily lives. Influences on structural OA include systemic joint disease and damage (genetic, metabolic, inflammatory), local risks (undue mechanical stress, injury, childhood structural anomalies, repetitive use), age-related tissue changes (cell senescence, increased bone turnover) and function (sarcopenia, reduced proprioception) [5]. Other structural changes, such as synovitis [6], may contribute to OA pain. However, the clinical syndrome of OA is often influenced by a broader set of factors than radiographically defined OA alone. Factors such as muscle strength, mood, cognition and co-morbid illness affect joint pain and disability [7]. The burden of OA also depends on the individual context—e.g. occupation and the availability of social support or public transport [8]. This complex mixture of ageing, disease, symptoms, mobility restriction and the psychosocial environment constitutes the phenomenon of OA in populations [9, 10].

However, information about the occurrence and burden of symptomatic and disabling OA in populations is...
currently based on studies of disease in individual joints or of recalled diagnosis of arthritis from a health professional [9]. There is a strong case that the planning and commissioning of health, social care and prevention services for OA needs to focus on people with OA rather than on individual joint diseases [11, 12]. This article uses self-reported data from a large population-based cohort of older adults to determine population estimates of the prevalence of the person with OA in order to address this gap.

Methods

The design was a two-stage cross-sectional postal survey of an older adult population using questionnaires [the baseline phase of the North Staffordshire Osteoarthritis Project (NorStOP)]. The two stages involved an initial Health Survey (HS) and a subsequent Regional Pains Survey (RPS). Ethical approval was from the North Staffordshire Research Ethics Committee (references 1351 and 1430). A completed returned questionnaire provided consent for inclusion.

Study population

Full details of the study design, methods and response have been presented elsewhere [13, 14]. The sampling frame was all adults ≥50 years of age registered with eight primary care general practices in North Staffordshire, UK. The general practitioners screened out people with severe psychiatric or terminal illness from the mailing. In the UK ~98% of the population are registered with a GP and practice registers provide a convenient frame for sampling a local population, regardless of the extent or nature of any contacts with the practice. Baseline questionnaires were mailed, and reminders were sent to non-responders after 2 and 4 weeks.

Questionnaires

Stage 1—the HS questionnaire

This included information on socio-demographics [15, 16], general and mental health [17, 18], the presence of joint pain and interference of pain [17].

For each of the four joint regions (hand, hip, knee and foot) participants were asked, ‘Have you had any pain in your (joint region) over the last year?’ Those responding positively to any of these four questions and giving permission for further contact were mailed the RPS questionnaire.

The impact of pain was measured using a single item from the Medical Outcomes Study Short Form 12 (MOS SF-12) [“During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework?)”] [17], which has five response options, dichotomized for this analysis: (i) Pain interference—Moderately, Quite a bit or Extremely and (ii) No pain interference—Not at all or A little bit. This approach has been used in previous population-based surveys of pain [14, 19-23].

Stage 2—the RPS questionnaire

For each joint region, data were gathered on the duration of pain in the last 12 months (<7 days, 1-4 weeks, more than 1 month but <3 months, 3 months or more) and a joint-specific measure of pain and function [Australian/Canadian (AUSCAN) OA Hand Index for hands [24], WOMAC for hips and knees [25] and Manchester Foot Pain and Disability Index (FPDI) for feet] [26].

Definition of OA

Three questionnaire components were used to define and characterize OA at the joint region level and the person level, i.e. presence and duration of pain in the four joint regions and pain interference using the single SF-12 item [17].

For each joint region (hand, hip, knee, foot), two region-level definitions were applied: (i) OA—presence of pain lasting >3 months in the last 12 months, and (ii) disabling OA—OA plus the presence of pain interference.

The definition of OA in the person drew on these two region-level definitions as follows: (i) OA in the person—presence of OA in one or more of the four joint regions and (ii) disabling OA in the person—OA in the person plus the presence of pain interference.

At the person level, the sum of the number of painful joint regions with OA or disabling OA (from zero to four) provided a grading of the extent of OA or disabling OA in the person. We classified and estimated the extent of OA and disabling OA as (i) one or more joint regions, (ii) two or more regions, (iii) three or more regions and (iv) all four regions.

Statistical analysis

The sample eligible for the prevalence analysis were all those not excluded at any stage of the study from either the GP screen or during the mailing. The definitions above were applied to calculate prevalence estimates of OA and disabling OA for each joint region and for the whole person, overall, by gender, by age group (50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, ≥85 years) and by age group within gender.

Missing data were defined on two levels: (i) item level—questionnaire(s) had been completed but single items were missing and (ii) study level—no questionnaires were completed by the individual.

Multiple imputation using chain equations [27] was used to impute missing data at the item level using the ICE command in Stata 11 (StataCorp, College Station, TX, USA). Putative auxiliary variables for inclusion in the imputation included all the socio-demographic and general health data, and the joint region-specific measures of pain and function. A single imputation process was applied to all baseline responders to impute all baseline variables of interest using appropriate distributions (linear, logistic, ordinal and multinomial logistic regression for numerical, binary, ordinal categorical and nominal categorical variables, respectively). The number of imputations was set at 20 and imputed data sets were combined using Rubin’s combination rules [28]. The logit command was used to

www.rheumatology.oxfordjournals.org 339
determine the coefficients ($b$) (and 95% CIs) from a logistic model from which the prevalence estimates (and 95% CIs) were calculated [$\text{prevalence} = e^{b}/(1 + e^{b})$] for the total baseline responder population.

Weighted estimates were used to adjust for missing data at the study level, to account for any initial selective non-response. Information on age, gender and general practice location was available for all individuals. This information was used to determine a weight to reflect the likelihood that a person with a particular combination of age, gender and practice location would return the baseline HS questionnaire. Weighted logistic regression within the imputed data sets was performed to determine prevalence estimates (and 95% CIs) in the total baseline eligible mailed population.

Application of prevalence estimates to standard populations

The derived prevalence estimates of the person with disabling OA were applied to the age- and gender-stratified population distribution for England, taken from the 2001 census [29], to determine the number of people $>50$ years of age with disabling OA in England and the number of people $>50$ years of age with disabling OA in an average population of 100,000 served by a general practice health care commissioning group.

Results

After 605 exclusions before mailing, there were 26,100 adults $>50$ years of age in the eligible mailed population [54.3% female; mean age 66.0 (s.d. 10.7) years]. A total of 18,474 individuals returned their HS questionnaire. The imputation process was performed on missing items of data in these 18,474 individuals [55.8% female; mean age 66.2 (s.d. 10.2) years]. The weighted logistic regression analysis then extrapolated the results of the imputed analysis of the 18,474 HS questionnaire responders to the full initial eligible target population of 26,100 persons. Using these combined techniques, prevalence estimates were almost identical in the baseline responder population and the total baseline eligible mailed population, hence the latter data are presented.

Prevalence estimates

Prevalence estimates at the level of the joint region in the total baseline eligible mailed population, overall and by age group, are presented in Table 1. Prevalence estimates were highest for knees and hands, twice as high for each chronic joint pain as for chronic interfering pain and higher in females than males for all four joint regions. Estimates generally increased with age, particularly for chronic, interfering pain.

Prevalence estimates for OA in the person are shown in Table 2. Approximately half of this population had OA in at least one of the four joint regions [prevalence 53.23% (95% CI 52.3, 54.1)], which was more than twice the prevalence of disabling OA in the person [21.87% (21.2, 22.5)]. The proportional difference between OA and disabling OA estimates decreased as the extent of OA increased, indicating that the more joint regions that were involved, the more likely that person reported pain interference. Estimates of OA and disabling OA for persons reporting pain in all four joint regions were therefore quite close [OA: 4.15% (3.8, 4.5) and disabling OA: 3.27% (3.0, 3.6)].

The prevalence of OA in the person was higher in females than males and generally increased with age (Tables 2 and 3, Fig. 1A and B). Almost 25% of females $>50$ years of age have disabling OA, increasing to 39% in females $>85$ years of age. The proportion of persons with OA increases with age regardless of the presence of disability or the number of sites affected. At any age $>50$ years, the prevalence of OA is greater for persons reporting multiple region involvement than for those with single-region pain only.

Estimated numbers, using the English population and commissioning groups as an example

Applying the prevalence estimates to population data suggests 3,510,378 persons $>50$ years of age have disabling OA in England. In a typical unit of population of

**Table 1** Prevalence estimates for OA in the joint region: overall and by gender

| Joint region | Hand | Hip | Knee | Foot |
|--------------|------|-----|------|------|
|              | OA   | Disabling OA | OA   | Disabling OA | OA   | Disabling OA | OA   | Disabling OA |
| Overall      | 26.54 (25.8, 27.3) | 12.56 (12.0, 13.1) | 19.16 (18.5, 19.8) | 10.77 (10.3, 11.3) | 30.65 (29.9, 31.4) | 14.91 (14.3, 15.5) | 23.15 (22.4, 23.9) | 11.65 (11.1, 12.2) |
| Gender       |      |               |      |               |      |               |      |               |
| Female       | 30.53 (29.5, 31.5) | 14.66 (13.9, 15.4) | 21.84 (21.0, 22.7) | 12.49 (11.8, 13.2) | 33.06 (32.0, 34.1) | 16.47 (15.7, 17.3) | 26.67 (25.7, 27.7) | 13.52 (12.8, 14.3) |
| Male         | 21.79 (20.8, 22.8) | 10.06 (9.4, 10.8) | 15.96 (15.0, 17.0) | 8.72 (8.1, 9.4) | 27.77 (26.7, 28.9) | 13.03 (12.3, 13.9) | 18.96 (18.0, 20.0) | 9.42 (8.7, 10.2) |

Values within brackets are 95% confidence intervals.
100,000 people for health services commissioning in England, slightly more than 7000 persons ≥50 years of age are estimated to have disabling OA (Table 3).

**Discussion**

This article concerns the clinical syndrome of OA and presents a practical approach to defining the person with OA and the person with disabling OA for population needs assessment. These definitions are not intended to replace clinical diagnosis of individual patients in everyday practice, but we argue that they do provide a useful approach to classifying persons for epidemiological and planning purposes. Their application in a self-administered population survey shows that most people with OA have pain in more than one joint region and proportionately more women than men have OA. Although joint pain generally increases with age, the sharpest increase occurs among people who have pain that interferes—39% of persons ≥85 years of age compared with 15% of persons age 50–54 years. However, these figures also mean that OA is not an inevitable consequence of ageing and prevention is a plausible target for health care.

We explored the validity of our survey estimates. There were missing data in the returned questionnaires. We investigated this by using imputation based on a range

**Table 2** Prevalence estimates for OA in the person: overall and by gender and age group

| Definition of OA | 1-4 regions | 2-4 regions | 3-4 regions | All 4 regions |
|------------------|-------------|-------------|-------------|--------------|
| OA               | 53.23       | 28.75       | 13.37       | 4.15         |
| Disabling OA     | 21.87       | 15.73       | 9.02        | 3.27         |
| Female           | (52.3, 54.1)| (21.2, 22.5)| (12.8, 14.0)| (3.8, 4.5)   |
|                  | (23.5, 49.9)| (12.1, 16.3)| (8.6, 9.5)  | (3.0, 3.6)   |
| OA               | 57.39       | 32.95       | 16.35       | 5.41         |
| Disabling OA     | 23.85       | 18.07       | 10.99       | 4.23         |
| Male             | (56.3, 58.5)| (31.9, 34.0)| (15.5, 17.3)| (4.9, 5.9)   |
|                  | (23.0, 24.7)| (17.3, 18.9)| (10.3, 11.7)| (3.8, 4.7)   |
| OA               | 48.28       | 23.74       | 9.82        | 2.65         |
| Disabling OA     | 19.51       | 12.98       | 6.67        | 2.13         |
| Male             | (47.0, 49.6)| (22.7, 24.8)| (9.1, 10.6)| (2.3, 3.1)   |
|                  | (18.6, 20.4)| (12.2, 13.7)| (6.1, 7.3)  | (1.8, 2.5)   |

| Age group, years | Overall 50-54 | 52.90 | 21.76 | 13.37 | 4.15 |
|                 | (51.8, 53.9)  | (19.8, 23.6) | (12.8, 14.3) | (3.8, 4.4) |
|                 | Female 50-54  | 57.39 | 23.85 | 16.35 | 5.41 |
|                 | (56.3, 58.5)  | (31.9, 34.0) | (15.5, 17.3) | (4.9, 5.9) |
|                 | Male 50-54    | 52.90 | 21.76 | 13.37 | 4.15 |
|                 | (51.8, 53.9)  | (19.8, 23.6) | (12.8, 14.3) | (3.8, 4.4) |

**Table 3** Population estimates for disabling OA in the person: England and an average-sized commissioning group

| Population data for prevalence of disabling OA |
|-----------------------------------------------|
| England (n = 49,138,831)                        |
| Average-sized commissioning group (n = 100,000)   |
| Overall                                       | 3,510,378 | 7,144 |
| Gender                                        |           |      |
| Female                                       | 2,096,555 | 4,267 |
| Male                                         | 1,413,823 | 2,877 |
| Age group, years                             |           |      |
| 50–54                                        | 514,610   | 1,047 |
| 55–59                                        | 465,233   | 946  |
| 60–64                                        | 477,294   | 971  |
| 65–69                                        | 447,165   | 910  |
| 70–74                                        | 448,241   | 912  |
| 75–79                                        | 431,142   | 877  |
| 80–84                                        | 353,914   | 720  |
| ≥85                                          | 372,869   | 759  |
of survey information. There was also a 29% non-response to the survey. We adjusted for this by applying weighted estimates from the responder population to the age, gender and GP practice structure of the target surveyed population. Changes in estimates following these combined approaches were minimal.

The definition of clinical OA in populations
An important concern to address is our use of self-reported joint pain and interference with daily life in an older population as the basis for defining OA.

Estimates of the global burden of disease and local population-based health care needs assessments related to OA have traditionally focused on radiographic definitions of OA at specific joint sites [30, 31]. Although this is reasonable for aetiological studies (e.g. what causes structural OA in the hip and how might it be prevented) and in helping treatment decisions in some individual patients (e.g. the need for an X-ray prior to knee replacement surgery), this is insufficient for even targeted assessments of health care needs at a population level (e.g. how many people have hip OA sufficiently severe for joint replacement), since decisions related to a structurally focused

Fig. 1 Prevalence estimates for definitions of disabling clinical OA in the person.

(A) Females by age group. (B) Males by age group.
treatment such as joint replacement are informed by the
degree of interference with daily life as well as by the
severity of radiographic change [10]. Hence the focus in
recent studies has shifted towards pain and disability at
specific joint sites, with or without radiographic measures,
i.e. towards clinical OA as the condition of interest [9, 10].
Further justification for using a symptom definition for
population purposes is provided by recent work [32] which,
by carefully adjusting for confounding, has identified
a much closer association between the severity of
radiographic features of OA at the knee and pain in that
joint compared with previous reports.
This then leaves the final argument for the choice of
joint pain to represent clinical OA in population studies
resting on the assumption that OA is the most common
cause of pain in this age group. There is evidence to sup-
port this assumption. In a clinical assessment substudy of
NorSTOP (including X-rays), the proportion of persons with
chronic hand pain and pain interference who had definite
radiographic hand OA was 81%, and the equivalent figure
for the knee was 78%, whereas the number of people with
a joint disease other than OA in their medical record was
16 out of >800 persons with knee pain [33] and 28 out of
>600 persons with hand pain [34].
Our conclusion is that evidence from a range of sources
suggests that the phenotype of self-reported joint pain
and pain that interferes in persons >50 years of age suf-
ciently reflects other recognized OA phenotypes (radio-
graphic change, use of the label of OA in primary care) to
be acceptable as the basis for population measures of the
person with OA. As with many public health measures,
this definition is crude, and a degree of misclassification
has to be accepted, but it fits a particular purpose of
estimating population burden. It may be less appropriate
for assessing or evaluating the individual patient.

The definition of OA in the whole person
Regardless of how OA itself is defined, prevalence esti-
mates of OA in specific joints do not provide a clear basis
for informing health and social care needs and preventive
services for all persons with OA since, as confirmed here,
most people with OA have problems at more than one
joint site and core treatment for OA (pain relief, exercise,
weight reduction, self-management) is similar regardless
of the joint location [4]. A recent systematic review high-
lighted that measuring OA in the population has largely
relied on a recalled diagnosis of arthritis or OA from a
health professional [9]. It found variability of prevalence
estimates arose from different measures of the problem
(recalled diagnosis, radiographic, symptom-based), and
the accompanying editorial [7] called for more attention
on the person with OA. However, for specific questions
about health care needs, different definitions and analyses
may be needed [31]. A specific example would be the
estimation of the number of persons requiring a joint
replacement or the potential costs of joint replacement
surgery, where the approach proposed here would not
be appropriate on its own and would need supplementation
to provide estimates at a joint-specific level and include information on radiographic severity.
One potential concern is that our definition of the
person with OA includes the foot. Textbook definitions
focus on the hand, knee and hips as major OA sites, but
accept that any synovial joint may be affected by radio-
graphic and clinical syndromes. The frequency of OA in
joints other than the foot, however, is low compared with
the hand, knee and hip, whereas the proportion of foot
pain in older people that could be OA is unclear. To inves-
tigate this we recalculated disabling OA prevalence in the
person excluding the foot. This figure was 20.78% (95% CI 20.2, 21.4), very similar to the prevalence including the
foot (21.87%; Table 2). This means the foot does not add
to the definition of disabling OA in the person. However,
inclusion of the foot does contribute to grading of the
number of joint regions involved and we retained it in
the definition of the person with OA.
Our figures for disabling OA in the person are a little
lower than estimates based on the ACR criteria using
combined self-report, radiographic and clinical assess-
ment data [35, 36]. These studies either did not estimate
prevalence in the person or did so by adding up preva-
ience figures for individual joints, which inevitably results
in overestimates.
Primary care data sets with clinician diagnostic labels
provide an alternative resource for estimating population
prevalence of the person with OA. Our estimates for dis-
abling OA are rather lower than the 10-year period preva-
lence of diagnosed OA reported from an analysis of
persons with OA in a primary care clinical database [37],
which may reflect the contrast between currently trouble-
some OA and OA intermittently troublesome over a
period. However, these contrasting approaches to deter-
mining the population prevalence of disabling OA—self-
report vs clinical consultation history—do seem to provide
compatible and comparable estimates of OA in the
person.

Conclusion
In summary, we propose that the definition and approach
developed here provides an appropriate basis for estimat-
ing the number and distribution of persons with OA in
local, regional and national populations, and for compari-
son between such populations. Three dimensions, easily
captured by self-complete questions, identify subgroups
of increasing severity—chronicity and pain interference
provide the core definitions of disabling OA, and the
number of joint regions is a simple measure of ‘how
much OA have you got?’, which has associations with
other measures of societal and personal impacts of
OA [38].
Research on interventions for persons with co-morbid
chronic diseases has highlighted the need to balance
condition-specific management (e.g. diabetic control,
joint replacements, heart failure therapy) with interven-
tions common to many different chronic conditions
(e.g. weight reduction, physical activity, positive cogni-
tions, anti-depression therapies) [39, 40]. A focus on the

www.rheumatology.oxfordjournals.org
person with OA will help to integrate these two approaches.

### Rheumatology key messages

- There is a need for more attention on people with OA.
- Twenty per cent of people reported disabling OA, which was higher in females and those of older age.
- An estimated 3.5 million persons have disabling OA in the UK.

### Acknowledgements

We thank the administrative and health informatics staff at the Arthritis Research UK Primary Care Centre and the doctors, staff and patients of the eight participating general practices.

### Funding

This work was supported through a programme grant from the Medical Research Council (grant G9900220) and NHS service support costs from the North Staffordshire Primary Care R&D Consortium. The funder of the study had no role in study design, data collection, data analysis, data interpretation or writing of the report. P.C. is a National Institute for Health Research (NIHR) senior investigator.

### Disclosure statement

The authors have declared no conflicts of interest.

### References

1. Woolf AD, Pfleger B. Burden of major musculoskeletal conditions. Bull WHO 2003;81:64-66.
2. Jordan K. Musculoskeletal matters. 2009. http://www.keele.ac.uk/media/keeleuniversity/ri/primarycare/bulletins/MusculoskeletalMatters1.pdf (18 January 2012, date last accessed).
3. Jagger C, Matthews R, Spiers N et al. Compression or expansion of disability? Forecasting future disability levels under changing patterns of diseases. Wansell Social Care Review Research Report. Leicester Nuffield Research Unit, University of Leicester, 2006.
4. Conaghan PG, Dickson J, Grant RL et al. Care and management of osteoarthritis in adults: summary of NICE guidance. BMJ 2008;336:502-3.
5. Bijlsma JW, Berenbaum F, Lafeber FP. Osteoarthritis: an update with relevance for clinical practice. Lancet 2011; 377:2115-26.
6. Yusuf E, Kortekaas MC, Watt I et al. Do knee abnormalities visualised on MRI explain knee pain in knee osteoarthritis? A systematic review. Ann Rheum Dis 2011;70:60-7.
7. Issa SN, Sharma L. Epidemiology of osteoarthritis: an update. Curr Rheumatol Rep 2006;8:7-15.
8. Wilkie R, Peat G, Thomas E et al. Factors associated with restricted mobility outside the home in community-dwelling adults ages fifty years and older with knee pain: an example of use of the International Classification of Functioning to investigate participation restriction. Arthritis Rheum 2007;57:1381-9.
9. Pereira D, Peleteiro B, Araujo J et al. The effect of osteoarthritis definition on prevalence and incidence estimates: a systematic review. Osteoarthritis Cartilage 2011;19:1270-85.
10. Gosses L, Paternotte S, Bingham CO III et al. OARSI/OMERACT initiative to define states of severity and indication for joint replacement in hip and knee osteoarthritis. An OMERACT 10 special interest group. J Rheumatol 2011;38:1765-9.
11. Nelson AE, Jordan JM. Defining osteoarthritis: a moving target. Osteoarthritis Cartilage 2012;20:1-3.
12. Croft P, Jordan K, Jinks C. ‘Pain elsewhere’ and the impact of knee pain in older people. Arthritis Rheum 2005; 52:2350-4.
13. Thomas E, Wilkie R, Peat G et al. The North Staffordshire Osteoarthritis Project—NorStOP: prospective, 3-year study of the epidemiology and management of clinical osteoarthritis in a general population of older adults. BMC Musculoskeletal Disorders 2004;5:2.
14. Thomas E, Peat G, Harris L et al. The prevalence of pain and pain interference in a general population of older adults: cross-sectional findings from the North Staffordshire Osteoarthritis Project (NorStOP). Pain 2004;110:361-8.
15. Office for National Statistics. Standard Occupational Classification 2000, Vol. 2. The Coding Index. London: The Stationery Office, 2000.
16. Office for National Statistics. The National Statistics Socio-Economic Classification user manual, version 1. London: The Stationery Office, 2002.
17. Ware JE Jr, Kosinski M, Keller SD. A 12-item short form health survey: construction of scales and preliminary tests of reliability and validity. Med Care 1996;34:220-33.
18. Zigmund AS, Snith R. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67:361-70.
19. Blyth FM, March LM, Brabice AJM et al. Chronic pain in Australia: a prevalence study. Pain 2001;89:127-34.
20. Scudds RJ, O’ostbye T. Pain and pain-related interference with function in older Canadians: the Canadian study of health and aging. Disabil Rehabil 2001;23: 654-64.
21. Hoffman DL, Dukes EM. The health status burden of people with fibromyalgia: a review of studies that assessed health status with the SF-36 or the SF-12. Int J Clin Pract 2008;62:115-26.
22. Häuser W, Schmutzer G, Claes H et al. Prevalence and predictors of pain in several body regions. Results of a representative German population survey. Schmerz 2009; 23:461-70.
23. Schmader KE, Johnson GR, Saddier P et al. Effect of a zoster vaccine on herpes zoster-related interference with functional status and health-related quality-of-life measures in older adults. J Am Geriatr Soc 2010;58:1634-41.
24. Bellamy N, Campbell J, Harjou B et al. Dimensionality and clinical importance of pain and disability in hand osteoarthritis: development of the Australian/Canadian (AUSCAN) osteoarthritis hand index. Osteoarthritis Cartilage 2002;10:855-62.
25 Bellamy N. WOMAC osteoarthritis index. A user’s guide. London, Ontario: London Health Services Centre, McMaster University, 1996.

26 Garrow AP, Papageorgiou AC, Silman AJ et al. Development and validation of a questionnaire to assess disabling foot pain. Pain 2000;85:107–13.

27 White IR, Royston P, Wood AM. Multiple imputation using chain equations: issues and guidance for practice. Stat Med 2011;30:377–99.

28 Rubin DB. Multiple imputation for nonresponse in surveys. New York: Wiley, 1987.

29 Office for National Statistics. Census: Standard Area Statistics in 2001: England and Wales. https://www.nomisweb.co.uk/home/census2001.asp (18 January 2012, date last accessed).

30 Quintana JM, Arostegui I, Escobar A et al. Prevalence of knee and hip osteoarthritis and the appropriateness of joint replacement in an older population. Arch Intern Med 2008;168:1576–84.

31 Murray CJ, Lopez AD. The global burden of disease. Cambridge, MA: Harvard University Press, 1996.

32 Neogi T, Felson D, Niu J et al. Association between radiographic features of knee osteoarthritis and pain: results from two cohort studies. BMJ 2009;21:339.

33 Duncan RC, Hay EM, Saklatvala J et al. Prevalence of radiographic osteoarthritis—it all depends on your point of view. Rheumatology 2006;45:757–60.

34 Marshall M, van der Windt D, Nichollis E et al. Radiographic hand osteoarthritis: patterns and associations with hand pain and function in a community-dwelling sample. Osteoarthr Cartil 2009;17:1440–7.

35 Andrianakos AA, Kontelis LK, Karamitsos DG et al. Prevalence of symptomatic knee, hand, and hip osteoarthritis in Greece. The ESORDIG study. J Rheumatol 2006;33:2507–13.

36 Salaffi F, De Angelis R, Grassi W et al. 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.

37 Kopec JA, Rahman MM, Sayre EC et al. Trends in physician-diagnosed osteoarthritis incidence in an administrative database in British Columbia, Canada, 1996–1997 through 2003–2004. Arthritis Rheum 2008;59:929–34.

38 Kamaleri Y, Natvig B, Ihlebaek CM et al. Number of pain sites is associated with demographic, lifestyle, and health-related factors in the general population. Eur J Pain 2008;12:742–8.

39 Lin EH, Katon W, Von Korff M et al. Effect of improving depression care on pain and functional outcomes among older adults with arthritis: a randomized controlled trial. JAMA 2003;290:2428–9.

40 Katon WJ, Lin EH, Von Korff M et al. Collaborative care for patients with depression and chronic illnesses. N Engl J Med 2010;363:2611–20.