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The High Prevalence of Knee Osteoarthritis in A Rural Chinese Population: The Wuchuan Osteoarthritis Study

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Abstract

Objective—To estimate the prevalence of radiographic and symptomatic knee osteoarthritis (OA) in a remote rural region of northern China and compare these with those reported in Beijing and data from the Framingham (Massachusetts, USA) cohort.

Methods—A population-based cross-sectional survey was conducted among 1030 residents of Wuchuan County, Inner Mongolia, aged 50 years and over. Survey participants, mostly farmers reporting heavy physical occupational activity, completed an interviewer-based questionnaire and obtained bilateral weight-bearing posterior-anterior semi-flexed knee radiographs.

Results—While the overall prevalence of radiographic knee OA was similar to that demonstrated in the Beijing OA study, men in Wuchuan had about double the prevalence of severe radiographic [prevalence ratio (PR) 2.5, 95% CI 1.6 to 3.8] and symptomatic knee OA (PR 1.9, 95% CI 1.3 to 2.9). Women in Wuchuan also had a higher prevalence of both severe radiographic (PR 1.4, 95% CI 1.0 to 2.0) and symptomatic knee OA (PR 1.6, 95% CI 1.2 to 2.1) compared with their Beijing counterparts. The prevalence of bilateral OA and lateral compartment disease were two to three times higher in both Chinese cohorts compared with estimates from the Framingham OA Study.

Conclusions—The prevalence of symptomatic knee OA in rural areas of China is much higher than reported from urban regions of China or in the Framingham cohort. The higher representation of bilateral and lateral compartment disease in China suggests a unique phenotype to OA. The findings will be useful to guide the distribution of future health care resources and preventive strategies.

Keywords

Osteoarthritis knee; disease prevalence; rural China; physical activity

Musculoskeletal conditions are the most common cause of severe chronic pain and physical disability among older people directly affecting the health of millions worldwide [1]. Knee pain from osteoarthritis (OA) is the most frequently reported peripheral joint complaint [1–4]. Most large population-based observational studies evaluating musculoskeletal disease prevalence have been conducted in North America or Europe, with scant information from

less developed regions of the world. However, it has been estimated that by 2050, almost four-fifths of the world's older population (65 years and over) will be living in these regions [5].

In 1981, the WHO launched a program of increased research into the causes and consequences of rheumatic diseases. During the past 25 years, this COPCORD (Community Oriented Programme for the Control of Rheumatic Diseases) initiative has completed several small community based surveys in the Asia-Pacific region reporting that current knee pain was present in 5–13% of adult populations (16 years and over) [6-9].

Other small community-based Asian studies have reported knee pain rates ranging from 2% in Pakistanis [10] to 15-18% in Omani men and women [11] and 39% in a suburban village in Beijing [12]. The wide range of knee pain prevalence found may be attributed to differences in genetic, environmental, psychosocial or cultural factors. However, differences in methods of prevalence ascertainment or the specific questions used to solicit information on knee symptoms were not clearly described or standardized in most of these surveys, limiting the validity of comparisons.

A recent population-based survey conducted in central Beijing [13] provided initial evidence that radiographic or symptomatic knee OA prevalence or disease presentation observed in North America or Europe may not be directly extrapolated to less developed regions of the world. The Beijing OA study, which used the same survey questionnaire and radiographic protocol as the Framingham OA Study (USA), found that the prevalence of radiographic and symptomatic knee OA was higher in older women living in Beijing compared with age-matched Caucasian women in Framingham, and very similar when comparing men.

Rural-urban differences exist for most chronic diseases due to varying social, environmental and occupational influences. Therefore, the prevalence of knee OA found in Beijing may not be applicable to the majority of people in China (and most developing countries) who live in rural communities. The aim of the Wuchuan OA Study was to determine the prevalence of radiographic and symptomatic knee OA among older people in a remote rural region of northern China. To allow valid comparisons with the Beijing OA Study and the Framingham cohort, the same survey instruments evaluating knee pain and comparable radiographic protocols were used.

Methods

The target population for this cross-sectional survey was people aged 50 years and over living in rural communities in Northern China. Five communities were randomly selected from a total of eight rural communities in Wuchuan County, Inner Mongolia. This location was considered representative of rural communities in Northern China and allowed feasible access to a hospital-based radiography facility.

Within these five randomly selected communities, a compact segment sampling method [14,15] was used to identify clusters, each containing 6-8 villages. Clusters were then selected with a probability proportional to the population size at the last census. Next a sketch map was drawn of each selected cluster, showing the dwellings. The selected clusters were then each split into a small number of segments, such that the number of dwellings per segment was always roughly the same. One segment was then chosen at random from each cluster and all households in the segment were included in the survey. Specific ethnic groups were not targeted or excluded. The study was approved by the Peking University Health Science Center Ethics Committee and informed consent was obtained by all study participants.

Participants

Trained health professionals administered the survey questionnaires as it was anticipated many study participants would be illiterate. All interviewers, clinical examiners and X-ray technicians were trained under the supervision of the study chief investigators (XK, JL and JC).

The trained interviewers went door-to-door to enumerate and interview all men and women, mostly farmers aged 50 years or older within the selected households who were self-described residents of Wuchuan County. People who self-reported rheumatoid arthritis, cerebrovascular disease or a history of lower limb surgery were excluded from further participation. Participants with self-reported cerebrovascular disease were excluded as lower limb disability, usually associated with stroke, may confound future analyses of associations between knee OA and disability.

Participants were interviewed at their homes or work place. The survey questionnaire focused on joint symptoms and possible risk factors for knee OA. At the end of the interview, all study participants were invited to one central examination site at Wuchuan Hospital for a clinical examination and knee radiographs on the same day. Transportation to the hospital was provided.

Clinical examination and knee radiograph

Height was measured with a wall-mounted stadiometer, using the average of two measurements taken. Body weight was assessed using a balance beam scale with 0.1kg precision. A posterior-anterior weight-bearing semi-flexed metatarso-phalangeal (MTP) view radiograph was taken of both knees strictly according to a validated acquisition protocol [16]. Radiographs were read by the study chief investigator (XK) using the OARSI atlas and Kellgren and Lawrence grades (0-4) were also assigned. Each knee was also graded at four sites (lateral femur, medial femur, lateral tibia, medial tibia) for individual radiographic features.

To ensure measurement reliability and comparability of reading with the Beijing OA Study, the chief investigator (XK) was sent to Boston University to undergo training using radiographs from the Beijing OA Study. Prior to evaluating radiographs from the Wuchuan OA Study, a batch of radiographs from the Beijing OA Study was re-assessed by XK. Preliminary reading of batches of randomly selected OA and non-OA films continued until XK reached a high level of inter-rater agreement using the readings from the primary reader of the Beijing OA study as gold standard (Dr Piran Aliabadi, an academically based musculoskeletal radiologist). For each batch (approximately 50 radiographs), four previously read knee radiographs from the Wuchuan OA Study were fed back to the reader to test intra-rater reliability. For Kellgren and Lawrence grading, the weighted kappa for inter-rater reliability was 0.80 (95% confidence interval (CI) 0.72 to 0.88) and the intra-rater reliability was 0.92 (95% CI 0.86 to 0.99). The small number of disagreements did not occur in any particular direction, suggesting no likelihood of bias in estimates.

We used the same definitions to define cases of radiographic and symptomatic knee OA as used in the Beijing and Framingham studies [4,13]. Radiographic knee OA was defined as having a Kellgren and Lawrence grade ≥ 2 in one or both knees. Similarly, severe radiographic knee OA was defined as having a Kellgren and Lawrence grade ≥ 3 in one or both knees. Symptomatic knee OA was defined as having at least one knee with both a Kellgren and Lawrence grade ≥ 2 and a positive response to the question 'In the past 12 months, have you had knee pain lasting most days of at least a month?'. We defined medial and lateral radiographic OA, respectively, if a knee had a Kellgren and Lawrence grade ≥ 2 and medial or lateral joint space narrowing score ≥ 1 .

Statistical Analysis

Survey participants were divided into three age groups: 50-59; 60-69; 70 years and over. The age specific prevalence was calculated separately for men and women. For comparisons between the Wuchuan OA study, the Beijing OA Study and the Framingham cohort, we needed to limit the analysis to subjects aged between 59 to 84 years, the overlapping age range of the three cohorts. When comparing prevalence of radiographic and symptomatic knee OA in the Wuchuan OA study with that found in the Beijing OA Study, subjects were categorized into four age groups: 59-64, 65-69, 70-74 and 75-84 years. We calculated the age standardized prevalence ratios and 95% confidence intervals [17] for subjects in the Wuchuan OA Study compared with subjects in the Beijing OA Study using the age-distribution in the Wuchuan cohort as the standard. R-2.6.1, a statistical program developed by the R Foundation for Statistical Computing, Austria, [18] was used for statistical analysis for this paper.

Results

A total of 1165 individuals reporting to be aged 50 years and older were identified in 762 randomly selected households in Wuchuan County, Inner Mongolia (Figure 1). Of these, 27 subjects were excluded from further study participation [rheumatoid arthritis (n=7), cerebrovascular disease (n=11) or a history of lower limb surgery (n=9)]. The remaining 1138 residents were approached, and 1030 (91%) consented to participate in the study and completed the home interview during the months of October and November 2005. People declining to consent were mostly older compared with the study participants [mean(sd) 64±7 versus 58±8 years, respectively]. Only four consenting participants did not attend the radiographic examination.

The characteristics of the participants are presented in Table 1. At the time of data analysis, it was discovered that 24 men and 26 women were actually younger than 50 years (48 or 49 years). We retained these 50 (7%) participants in the 50 to 59 year age category. Under this classification, about 65% of men and 73% of women were aged 50 to 59 years.

The mean body mass index (BMI) was 22 kg.m⁻², with only 63 (6%) participants considered to be obese (BMI ≥ 28) and 219 (21%) considered overweight (BMI ≥ 24, but less than 28) according to specific Asian population criteria [19]. About one quarter of men and half of the women had not received any formal education. Almost all participants were farmers or had been engaged in farming as their main occupation (91%), with the remaining 9% reporting businessman or shopkeeper as their main occupation. 85% of all participants still working at the time of the survey (Table 1). Most participants (91%) reported that the occupation they held longest involved 'heavy physical work'.

As shown in Table 2, prevalence of either radiographic or symptomatic knee OA increased markedly between the fifth and sixth decades for both men and women, with further increases in the seventh decade for men. Compared with men, women in Wuchuan had a much higher prevalence of both radiographic prevalence ratio (PR) of 2.2 [95% confidence interval (CI) 1.6 to 3.0] and symptomatic (PR 2.4, 95% CI 1.7 to 3.5) knee OA.

While the overall prevalence of radiographic knee OA in Wuchuan County was similar to that reported in the Beijing OA study (Table 3), both men and women from the rural Wuchuan community showed a higher prevalence of both symptomatic knee OA and severe radiographic disease (Kellgren and Lawrence grades ≥ 3) compared with their Beijing counterparts. Men in Wuchuan had approximately double the prevalence of both severe radiographic disease (PR 2.5, 95% CI 1.6 to 3.8) and symptomatic knee OA (PR 1.9, 95% CI 1.3 to 2.9) compared with men in the Beijing cohort. Women in Wuchuan also had a

higher prevalence of both severe radiographic disease (PR 1.4, 95% CI 1.0 to 2.0) and symptomatic knee OA (PR 1.6, 95% CI 1.2 to 2.1) compared with their counterparts in the Beijing cohort. Similar to the findings from the Beijing OA study, bilateral radiographic knee OA was more common than unilateral in both men and women (Table 3).

Both Chinese cohorts demonstrated a two to three fold higher prevalence of medial tibio-femoral compartment disease compared with the lateral compartment. In contrast, the Framingham OA Study reported a five to eight fold higher prevalence of medial compared to lateral compartment disease (Table 4).

Discussion

While the overall prevalence of radiographic knee OA in Wuchuan was similar to that reported in Beijing, the prevalence of both symptomatic knee OA and severe radiographic disease in these rural farming communities in Wuchuan was much more common than that reported in the urban-based Beijing OA Study. Similar to findings from other parts of the world, knee OA was more prevalent among women compared with men and increased with age.

The Wuchuan OA Study also confirmed two other unexpected findings from the Beijing OA Study. Unilateral and bilateral disease is fairly evenly represented in the Framingham OA Study [4], but bilateral disease was two to three times more prevalent than unilateral disease among participants in each of the two Chinese studies. This finding was unexpected as bilateral disease has been associated with obesity in developed countries [20]. In fact, participants in the rural Wuchuan OA study had an even lower mean BMI (22-23 kg.m⁻²) than participants in the Beijing OA Study (25-26 kg.m⁻²). In addition, the ratio of medial tibio-femoral compartment versus lateral tibio-femoral compartment disease was similar in both Chinese cohorts (approximately 2.8 to 1). This finding is in sharp contrast to the Framingham OA Study and other surveys from developed regions of the world, where knee OA mostly presents in the medial tibio-femoral compartment compared with the lateral tibio-femoral compartment (approximately 6.3 to 1). Both findings of OA phenotype proportions support the hypothesis of markedly different risk profiles for the development of knee OA between these regions of the world. Further research will be required to explore whether genetic or environmental factors, or a combination of both, are mostly implicated. For example, there may be more valgus alignment in lower limbs in China and this may account for the increased predilection for lateral compartment disease in China.

The strongest risk factors identified to date for incident radiographic and symptomatic knee OA in developed countries include aging, female gender, obesity, knee joint injury, knee surgery or employment in an occupation requiring heavy physical work [21]. Specifically, knee OA has been associated with occupations involving knee bending, squatting, kneeling and heavy lifting with obesity adding considerably to the risk [21-23]. The comparisons between the Chinese cohorts have been stratified for age and gender. Furthermore, obesity is almost negligible and only 5% and 7% of participants in the Beijing and Wuchuan cohorts, respectively, reported having injured their knee in the past 'sufficiently to limit walking for at least a week'. Similar to the Beijing OA Study, the majority of the Wuchuan OA Study participants were Han Chinese. Therefore, the much higher prevalence of symptomatic knee OA and severe radiographic disease in this rural community compared with the urban Beijing cohort is likely to be mostly attributable to a lifetime of heavy physical work associated with their farming occupation. About 91% participants (men and women) in the Wuchuan OA Study reported to have been engaged in farming for most of their adult lives, with almost all (91%) reporting that the job they had held the longest involved 'heavy

physical work'. In contrast, only 34-39% of women and men in the Beijing OA Study reported that the job they held the longest involved 'moderate to heavy labor'.

Symptomatic knee OA was twice as prevalent in the rural Wuchuan cohort as in Beijing. The increased likelihood of developing chronic knee pain with increasing severity of radiological changes in the knee joint is well established. While the overall prevalence of radiographic OA was similar in Wuchuan and Beijing, the percentage of those with radiographic OA who had knee pain was much higher in Wuchuan. We ascribe this, in part, to the greater severity of radiographic disease in Wuchuan but also believe that greater physical demands on persons in the rural Wuchuan environment is likely to produce more knee pain in those who already have OA. We should note that, unlike recent studies in North America, no one in Wuchuan was excluded because they had had a knee replacement despite the high prevalence of severe radiographic disease that was symptomatic. Of further interest is that only one participant in the Beijing OA cohort had a knee replacement and only eight subjects in the Framingham cohort (1983-1985) had either bilateral or unilateral knee replacements. These small numbers of excluded participants would not influence prevalence comparisons.

Several characteristics of the Wuchuan OA Study should be noted. Firstly, a rigorous sampling strategy was utilised and the response rate was excellent (91%). In this farming community, the most common reason for declining participation was 'lack of time'. In Wuchuan, this phrase is often used to avoid saying 'no' and it says very little about the actual cause, although this phrase was mostly used in the younger age group who were still working. Among participants aged less than 65 years, 93% reported to be 'working now' compared with 54% of the older participants.

The radiographic and symptomatic knee OA criteria were standardized to those used in the Beijing OA Study and the Framingham OA Study (Kellgren and Lawrence grade ≥ 2 , knee pain of most days of one month during the past year). Furthermore, the study chief investigator (XK) was trained in radiographic measurement on scored radiographs from the Beijing OA study.

A possible study limitation is the use of semi-flexed knee radiographs in the Wuchuan OA Study, as opposed to the traditional fully extended knee radiographs mostly used by the Beijing OA Study. This decision was made as the semi-flexed radiograph provides a better measurement of the functional joint space width compared with the fully extended knee radiograph and has demonstrated superior long term test retest measurement reliability [16]. We should note, however, that the last 700 subjects in the Beijing OA Study had knee films obtained using the same semi-flexed method as used here and prevalence estimates using this approach versus the fully extended approach, also obtained in these subjects, was the same. Therefore, the semi-flexed protocol should not change the radiographic prevalence estimates reported.

It should also be noted that the knee OA prevalence estimates presented for these cohorts are conservative, as radiographs did not include the patello-femoral joint. Furthermore the prevalence demonstrated in this survey can only be generalized to similar farming communities in Northern China, not to the population of Inner Mongolia in general. Participants in the Wuchuan OA Study were almost exclusively Han Chinese, while this ethnic group makes up only 79% of the Inner Mongolian population, Mongolians accounting for most of the remaining 21%. The lifestyles of these two ethnic groups is very different, therefore the prevalence of knee OA may also be very dissimilar.

In conclusion, we found a high prevalence of symptomatic and severe radiographic knee OA among older people in a rural farming region of northern China when compared with their

ethnic peers living in Beijing. The findings of the Wuchuan survey suggest that having an occupation requiring heavy physical work is associated with knee OA, even in the absence of obesity. The actual magnitude of the rural-urban differential for this important chronic musculoskeletal disease in other regions of China or other developing Asian countries would need to be confirmed in further studies. Interestingly, unilateral versus bilateral disease and medial compartment versus lateral compartment disease presentation demonstrated marked similarities between the two Chinese cohorts which were, however, in marked contrast to the disease presentation demonstrated in the Framingham OA Study. In a similar fashion to other population based surveys evaluating disease prevalence across geographic regions in the world, our study has generated hypotheses to important modifiable risk factors for OA, factors that have likely not yet been fully recognized in this specific population and worthy of further exploration in prospective studies. Heavy physical work, for example, is a risk factor that may be modifiable by access to more sophisticated farming equipment and possibly by changes in work postures and repetitive movements achieved through self-management education programs.

Given the high prevalence of symptomatic knee OA in Wuchuan, we suggest that knee OA represents a major public health concern in rural China. It is more prevalent there than in other reported population surveys. With the availability of knee replacements severely limited and occupational demands persisting into middle and older years, knee OA may be a major source of disability among Chinese adults in rural areas, where most Chinese still live.

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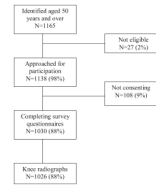


Figure 1.
Wuchuan OA Study Flow Chart

Table 1
Characteristics of the Wuchuan County study participants

	Men (n = 505)	Women (n = 520)
Age,		
50-59* years	65%	73%
60-69 years	22%	17%
70+ years	13%	10%
Biometrics		
	mean (sd)	mean (sd)
Height (cm)	166.2 (6.3)	155.2 (6.1)
Weight (kg)	59.7 (8.9)	56.2 (9.5)
Body mass index (kg.m ⁻¹)	21.6 (2.7)	23.3 (3.5)
Years of education		
0 years	23%	51%
1-6 years	38%	37%
7-9 years	33%	11%
>10 years	6%	2%
Main occupation farming		
94%		88%
Still working		
90%		81%

* Includes 50 participants aged 48 and 49 at the time of survey.

Table 2
Prevalence of tibio-femoral knee OA in Wuchuan County, Inner Mongolia

Age	Men			Women		
	N	Radiographic n (%)	Symptomatic n (%)	N	Radiographic n (%)	Symptomatic n (%)
50-59*	327	13 (4%)	9 (3%)	381	48 (13%)	33 (9%)
60-69	111	18 (16%)	14 (13%)	90	36 (40%)	26 (29%)
70+	67	22 (33%)	12 (18%)	49	18 (37%)	15 (31%)
All	505	53 (10%)	35 (7%)	520	102 (20%)	74 (14%)

* Includes 50 participants aged 48 and 49 at the time of survey.

Table 3
Comparison of crude/age adjusted prevalence and age standardized prevalence ratio of knee OA among rural (Wuchuan) and urban (Beijing) Chinese participants aged 59 to 84 years

	Crude prevalence, %		Age standardized prevalence, %		Age standardized prevalence ratio (95% confidence interval)
	Wuchuan	Beijing	Wuchuan	Beijing	
Men	N=196	n=995	n=197	N=995	
Radiographic OA	20%	22%	20%	20%	1.00 (0.74 to 1.34)
Unilateral	9%	9%	9%	8%	1.06 (0.64 to 1.74)
Bilateral	12%	13%	12%	12%	0.96 (0.63 to 1.44)
Severe radiographic OA	14%	6%	14%	6%	2.48 (1.62 to 3.78)
Symptomatic OA	13%	7%	13%	7%	1.91 (1.25 to 2.91)
Women	n=158	n=1491	n=161	n=1491	
Radiographic OA	36%	42%	36%	41%	0.88 (0.70 to 1.09)
Unilateral	12%	12%	12%	11%	1.05 (0.67 to 1.65)
Bilateral	24%	30%	24%	30%	0.81 (0.61 to 1.08)
Severe radiographic OA	21%	15%	21%	15%	1.42 (1.03 to 1.97)
Symptomatic OA	27%	18%	27%	18%	1.55 (1.17 to 2.05)

Radiographic OA; Kellgren Lawrence grade ≥ 2

Severe Radiographic OA; = Kellgren Lawrence grade ≥ 3

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Table 4
Comparison of the prevalence of medial and lateral knee OA among rural (Wuchuan) and urban (Beijing) Chinese participants aged 59 to 84 years and the Framingham (USA) OA Study

	Wuchuan Knees (%)	Beijing Knees (%)	Framingham Knees (%)
Women			
Medial OA/Total number of knees	66/316 (21%)	590/2977 (20%)	153/1117 (14%)
Lateral OA/Total number of knees	22/316 (7%)	271/2977 (9%)	30/1093 (3%)
Men			
Medial OA/Total number of knees	44/392 (11%)	179/1988 (9%)	93/626 (15%)
Lateral OA/Total number of knees	17/392 (4%)	95/1988 (5%)	12/621 (2%)

Medial and lateral OA were defined as a Kellgren and Lawrence grade ≥ 2 and medial or lateral joint space narrowing score ≥ 1 .

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