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The role and interaction of occupational risk factors and generalised susceptibility to osteoarthritis of the knee: A case control investigation.

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Abstract

Objective

Knee osteoarthritis (OA) is common and is a major contributor to morbidity in the community. This project is designed to examine constitutional and lifestyle factors that may act to modify the risk of developing structural knee osteoarthritis. In particular, the hypothesis that specific occupational physical activities act as risk factors for structural knee OA has been investigated.

Method

A community based case control study of knee OA was carried out in which 304 men and women with painful, radiographically confirmed knee OA were compared with 445 age and sex matched controls who were pain free and had normal radiographs. Subjects were identified from a postal questionnaire. A structured questionnaire based interview was carried out in the subject's home. Information collected established the systemic factors i.e. obesity, hormones, diet and smoking and local mechanical factors i.e. occupational loading, leisure and sport activities which may act to increase the risk of knee OA.

Results

After adjustment for body mass index (BMI), the risk of knee OA was significantly elevated in subjects whose main job entailed more than one hour per day squatting (Odds Ratio (OR) 1.97, 95% CI 1.14 – 3.41) kneeling (OR 2.06, 95% CI 1.25 – 3.40) or regular heavy lifting (OR 2.72, 95% CI 1.61 – 4.61). The increase in risk associated with regular knee flexion was more marked in subjects whose main job also entailed regular lifting (OR 3.28, 95% CI 1.77 – 6.08). There was significant evidence of interaction between regular stair climbing and heavy lifting (OR 7.11 95% CI 2.28 – 22.20).

Conclusions

This study confirms earlier findings that prolonged or repeated knee bending is a risk factor for knee OA. Furthermore there is risk associated with regular heavy lifting. Risk is higher in jobs that entail both knee bending and heavy lifting.

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1. Introduction

1.1 Knee Osteoarthritis

Osteoarthritis is a condition of synovial joints characterised by: cartilage loss; bony growth (sclerosis and osteophytes); muscle weakness and ligamentous and meniscal damage.

In the developed world osteoarthritis is set to become the fourth highest impact condition in women and the 8th most important in men (23).

Knee Osteoarthritis ultimately affects more than one in three individuals and causes considerable morbidity. By 65 years, 30% of men and 40% of women have radiographic evidence of knee OA (27).

1.2 Risk factors for Knee Osteoarthritis

Previously thought of as an inevitable part of ageing (16;28), more recent studies have indicated that there are two components to the disease aetiology which should be separated (8;17;25). Firstly, constitutional factors which may increase susceptibility to the development of this condition (3) and secondly local mechanical factors that act to increase the likelihood of specific joint damage (22).

Possible factors that fall within the category of constitutional risk factors include:

- Ageing
- Genetic/Familial predisposition
- Gender
- Smoking
- Diet

Local factors, which may act to increase the likelihood of joint damage, particularly in individuals at greater risk through systemic factors identified above, include:

- Occupational Loading
- Occupational and leisure time activities and sports activities that increase the likelihood of joint injury
- Obesity
- Leisure time and sports activities that involve abnormal joint loading
- Reduced muscle strength

1.2.1 Age

The strongest risk factor for structural knee osteoarthritis is age (9); with severe radiographic OA uncommon in persons < 45 years of age (27).

1.2.2 Gender

Except in those under the age of 55 years, OA is more common in women and tends to be more severe in terms of both radiographic change and symptoms.(1;14;27).

1.2.3 Weight

The prevalence and incidence of knee osteoarthritis is strongly associated with weight. Estimates of risk from obesity vary but the consistent picture emerges that overweight people are more at risk of knee osteoarthritis than non-overweight controls (13). Those with a Body Mass Index (BMI) of >30 have a much higher risk of OA than those with moderate obesity. (BMI >25 and <30) (13). Weight at 37 years predicts the risk of subsequent radiographic knee osteoarthritis better than current weight, suggesting that obesity is a cause rather than effect of knee osteoarthritis (12). Not only does being overweight increase the risk of developing osteoarthritis but once it has developed then the loss of function and sedentary lifestyle may predispose the individual to further weight gain.

1.2.4 Occupation

Occupations associated with repetitive use and/or heavy lifting have been associated with site specific osteoarthritis (5). Occupational knee bending is associated with knee osteoarthritis in both men and women (3;5;11).

A recent case control population based study in the UK interviewed 109 men and women with symptomatic radiological knee OA and 218 age and sex matched controls. Highest risks were found in subjects whose occupation involved more than 30 minutes squatting per day (odds ratio 7, CI 1.8-26.4) or kneeling (odds ratio 3.4, CI 1.3-9.1) (7). However the numbers exposed were small.

Although risks were found in the HANES I (3) and Framingham studies (11), job title was relied on as an index of presumed workplace activity, rather than directly assessing exposure to particular types of repetitive movements.

1.2.5 Sport and Leisure Activities

Levels of activity have been suggested to have an influence on osteoarthritis of the knee.

Long term weight-bearing sports activity e.g. running, football, tennis and weight lifting have been associated with greater risk of knee osteoarthritis (21;26) but whether this is true in the absence of sports-related injury is unclear (15). Low impact activities do not appear to increase the risk of osteoarthritis nor do recreational levels of sport (22). Indeed the regular use of a normal joint may help to maintain healthy joint function (4).

1.2.6 Oestrogen use

The gender difference in prevalence of knee OA, even allowing for the effect of obesity, has led to the search for a possible hormonal explanation (9). At present there has been no clear relationship found between oestrogen use and OA (12).

1.2.7 Smoking

This is negatively associated with structural change (3;12) but may increase symptom reporting (18).

2 Method

2.1 Department of Health Randomised Control Trial

85% (1017) of cases and controls for this project have been identified through a randomised control trial funded by a grant from The Department of Health which identified subjects with knee pain and those without in two GP practices in Nottingham.

An initial postal questionnaire (Appendix 1) was sent in 1996 to approximately 10,000 patients aged 45 years and over (no upper age limit) from two General Practice lists: The Torkard Hill Medical Centre, Hucknall, Nottingham; and Arnold Health Centre, Arnold, Nottingham (in the North East of the city and in the North West of the city respectively). In order to recruit further cases for this study a further 1200 questionnaires were sent in January 1999 to registered patients of the Arnold practice not initially surveyed.

Of the 787 subjects recruited into the randomised control trial 704 agreed to have their knees x-rayed at The City Hospital, Nottingham (89%).

A further 15% (183) of cases and controls were identified through a previous study looking at knee pain (24). In this study identical questionnaires were sent to 4000 patients from Stenhouse Medical Centre, Arnold, Nottingham and Calverton Health Centre, Calverton, Nottingham (a mining village to the North of Nottingham).

2.2 Radiographic assessment

2.2.1 Radiographic definitions of knee OA

Radiographic definitions of knee osteoarthritis have largely been developed based on the production of standardised atlases (19;20). In this study we have chosen to use the grading system provided by Kellgren and Lawrence (Table 1).

Table 1 Kellgren and Lawrence grading scheme for osteoarthritis

Grade	X-Ray criteria
0	Normal
1	Doubtful narrowing of joint space, possibly osteophyte
2	Definate osteophytes, absent or questionable narrowing of space
3	Moderate osteophytes, definite narrowing, sclerosis, possible deformity
4	Large osteophytes, marked narrowing, severe sclerosis, definite deformity

2.2.2 X-ray criteria

Volunteers attending for assessments and interviewed controls were invited to attend the Nottingham City Hospital Radiography department for anteroposterior weight bearing and sky line radiographs (standardised to 30° flexion) of their knees. All radiographs were assessed by Dr Sheila O'Reilly using the Altman atlas of standardised radiographs (2).

X-rays were graded for osteophyte (0-3) and joint space narrowing (0-3) in the medial tibiofemoral, lateral tibiofemoral and patellofemoral compartments. Definite osteoarthritis (Kellgren and Lawrence Grade 2) was defined as ≥ grade 1 osteophyte in the tibiofemoral compartments or ≥ grade 2 osteophyte in the patellofemoral compartment.

Intraobserver reproducibility was assessed on 40 films and found to be high (Kappa > 0.7).

2.3 Sample Size

A sample size of 400 cases and 800 controls (two per case, matched by age, gender and practice) was chosen to achieve a 90% power of detecting an odds ratio of 1.5 or more at the 5% significance level.

2.4 Ethical approval and funding

This study was approved by Local Research Ethics Committee and was funded by The Health and Safety Executive and The British Occupational Health Research Foundation.

2.5 Subject Recruitment

Cases were recruited from the 3 sources as detailed above.
Controls were matched to cases by age, gender and GP practice to within three years for 98.5%. Due to a shortfall of 2nd controls from Dr O'Reilly's study 1% of controls were selected within five years and 0.5% were unmatched by age (these controls were therefore excluded from matched analysis). Two controls were selected per case and were randomly chosen from responders to the postal questionnaire that did not describe current knee pain.

2.6 Inclusion Criteria

To determine the presence of knee pain the following question was asked in the randomised control trial's postal questionnaire (Appendix 1):
"Have you ever had pain in or around the knee on most days for at least a month? If so, have you experienced any pain during the last year?" To be designated knee pain positive, subjects must answer 'yes' to both parts.
A case is defined as a subject aged 45+ with knee pain and radiographic evidence of osteoarthritis greater or equal to Kellgren and Lawrence grade 2 in at least one compartment (patello-femoral, medial or lateral tibio-femoral compartments) of at least one knee.
A knee pain negative, x-ray negative control is defined as a responder to the postal questionnaire reporting no current knee pain and with an x-ray demonstrating less than grade 2 change on the x-ray.

2.7 Exclusion Criteria

These were solely incapacity to participate fully in the interview.

2.8 Questionnaire Design

The questionnaire (Appendix 2) was interviewer administered and was developed using components related to:

1) Basic demographic details including weight and height
2) Occupational history, tasks encountered at work and work related knee injuries
3) Exercise / leisure time physical activities and related knee injuries
4) Diet - past and present
5) Hormone Levels for females
6) Smoking
7) Drug History

The interview was conducted in the subject's home and lasted an average of 45 minutes. There were a total of 4 interviewers over the duration of the study who were fully trained and monitored for consistency of approach.

2.9 Data entry and statistical methods

All data were entered by three data entry clerks using Access 97. There were regular data checks for consistency.

Risk factors have been assessed for their individual contribution using a univariate approach. Significant factors, either from known a-priori knowledge or from a statistical point of view were then been used to model the collected data to investigate for confounding and possible effect modifications. The approach in general has followed the line identified in the analysis by Cooper and Coggin on which this present study is based (7). Odds ratios for the various risk factors were calculated by conditional logistic regression (using the EGRET package) where the cases and controls were matched by age, gender and practice, and unconditional logistic regression (using SPSS version 6.1.3) where the subjects were unmatched.

3 Results

3.1 Recruitment

3.1.1 Cases

The target for recruitment was 400 cases. In fact, less eligible cases were identified than expected. This is mainly because of the use of a more modern x-ray grading system.

Of the 749 x-rays taken for the RCT 44% were eligible to become cases in this study i.e. knee pain positive combined with radiographic evidence of osteoarthritis greater or equal to Kellgren and Lawrence grade 2 (Table 2). The refusal rate was 8%.

363 cases were interviewed.

Table 2 Recruitment of eligible cases

	D of H cases	Dr O'Reilly's cases
X-rays taken	752	242
X-ray eligible	331 (44%)	84 (35%)
Refused	26 (8%)	7 (8%)
No contact/moved/died	3 (1%)	16 (19%)
Interviewed	302	61

3.1.2 Controls

10 controls were initially identified per case. 34% of selected controls were unable to be interviewed for the reasons shown in Table 3. This therefore meant in some cases that several controls were contacted before one was interviewed.

Table 3 Recruitment of eligible controls

	D of H controls	Dr O'Reilly's controls
Contacted	1033	111*
Refused	237 (23%)	11 (10%)
No contact/moved/died	118 (11%)	
Interviewed	678	100
No of 1st controls	458 (68%)	89 (89%)
No of 2nd	138 (20%)	9 (9%)
No of 3rd	51 (8%)	1 (1%)
No of 4th	23 (3%)	1 (1%)
No of 5th – 8th	8 (1%)	

* 22 2nd controls could not be randomised from this group as there was a shortfall of eligible patients.

3.1.3 Control X-rays

All controls were asked to have their knees x-rayed at The City Hospital, Nottingham within a month of interview. 23% of controls refused x-rays (Table 4). Of the 602 x-rays taken 18% showed evidence of knee OA greater than or equal to grade 2.

Table 4 X-ray results

Controls Interviewed	X-rays taken	X-rays no OA	X-rays OA
778	602 (77%)	496 (82%)	106 (18%)

3.1.4 Matched cases and controls

Due to the number of controls who either refused an x-ray or had an x-ray taken with evidence of knee OA the number of matched sets was reduced (Table 5).

Table 5 Matched case numbers

Cases	Number
Cases with age unmatched controls*	5
Cases with no eligible controls	54
Cases with 1 eligible control	163
Cases with 2 eligible controls	141

** i.e. > 3 years*

Matched analysis was therefore based on cases with at least one eligible control i.e. 304 and 445 controls. Unmatched analysis included 363 cases (all eligible cases) and 496 controls (all controls whose x-ray showed no evidence of knee OA).

3.2 Demographic Details

3.2.1 Comparison of cases and controls

Table 6 shows demographic variables in cases and controls. Age and sex distributions were almost identical in cases and controls due to matching on these variables. Body Mass Index was significantly greater in cases at all ages. As age increased the gap between the BMI of the cases and controls widened.

Table 6 Comparison of demographic variables in cases and controls

Factor		Cases N=304	Controls N=445
Age	Mean	66	66
	Median	66	67
	IQ range	60 - 72	61 – 72
Sex (female:male ratio)		1.6:1	1.6:1
BMI Present age	Mean	28.37	25.12
	Median	27.48	24.80
	IQ range	25.41 – 30.53	22.57 – 27.32
BMI age 18	Mean	22.22	21.15
	Median	21.80	21.06
	IQ range	20.25 – 23.32	19.43 – 22.53
BMI 30's	Mean	24.78	22.46
	Median	23.84	22.13
	IQ range	22.28 – 26.05	20.59 – 23.93
BMI 60's (where applicable)	Mean	27.52	24.62
	Median	26.70	24.19
	IQ range	24.45 – 29.62	22.22 – 26.63

3.3 Occupational Activity

The mean (SD) age at onset of knee pain was 50.5 (14.9).

Table 7 shows the job type of the longest held occupation before the onset of symptoms. Job type is defined in Appendix 3.

The chi-square test is significant (p=0.001) indicating that differences in job type do exist between cases and controls. Inspection of the table reveals that cases are more likely to fall into groups 5 (skilled manual trades e.g. plumber, electrician, miner and carpenter) and 6 (health care workers e.g. nursery/auxiliary nurse and care assistant). Cases are less likely to fall into groups 1, 2 and 4.

Table 7 Job type of main job (longest job before disease onset)

Job Type	Cases		Controls	
	N	(%)	N	(%)
1 (Managers & Administrators)	10	3.3	38	8.6
2 (Professional Occupations)	12	3.9	36	8.1
3 (Associate Professional)	20	6.6	22	5.0
4 (Clerical & Secretarial Occupations)	68	22.4	129	29.1
5 (Craft and Related Occupations)	94	30.9	111	25
6 (Personal and Protective Service occupations)	32	10.5	27	6.1
7 (Sales Occupations)	22	7.2	25	5.6
8 (Plant and Machine Operatives)	32	10.5	35	7.9
9 (Other Occupations)	14	4.6	21	4.7

Table 8 shows the associations between knee osteoarthritis and reported occupational activities after adjusting for body mass index. (Table of missing values see appendix 4). In defining the main job we considered only paid employment. For cases, the main job was defined as the occupation which had been held longest up to date of interview before the onset of symptoms. For controls it was the longest job up to date of interview before the onset of the matched cases symptoms.

Risk was elevated in subjects whose main job entailed more than one hour per day of squatting (OR 1.97, 95% CI 1.14 – 3.41) or kneeling (OR 2.06, 95% CI 1.25 – 3.40). There were no significant associations with any other occupational activities. There is a suggestion that those whose main job entailed more than two hours sitting a day were protected from knee osteoarthritis but this is not significant.

Table 8 Associations between knee osteoarthritis and reported occupational activities in main job (longest job before disease onset) after adjusting for BMI

Occupational Activity	Numbers Exposed				Odds Ratios	95% Confidence Interval
	Cases		Controls			
	N	(%)	N	(%)		
Sitting (> 2 hrs/ day)	155	51.0	237	53.3	0.82	0.58 – 1.14
Standing (> 2 hrs/ day)	194	63.8	282	63.4	1.07	0.75 – 1.54
Squatting (> 1 hr/ day)	45	14.8	43	9.7	1.97	1.14 – 3.41
Kneeling (> 1 hr/ day)	56	18.4	48	10.8	2.06	1.25 – 3.40
Getting up from kneeling or squatting (>30 times)	44	14.5	52	11.7	1.38	0.83 – 2.28
Driving (> 4 hrs/ day)	18	5.9	17	3.8	1.25	0.59 – 2.65
Walking (> 2 miles/ day)	116	38.2	165	37.1	1.04	0.73 – 1.47
Climbing stairs (>30 flights/ day)	35	11.5	52	11.7	1.15	0.67 – 1.98

Table 9 shows the cumulative index for all jobs held for greater than 2 years before diagnosis defined by number of exposure years. The risk of knee osteoarthritis was significantly elevated in subjects who had been exposed to regular squatting (OR 2.45 95% CI 1.19 – 5.05), kneeling (OR 2.49 95% CI 1.28 – 4.85) or climbing stairs (OR 2.40 95% CI 1.03 – 5.59) for more than 20 years. Of these three exposures, only the odds ratios for squatting suggested an obvious dose-response effect.

The protective effect of sitting at work appeared to increase with years of exposure. Exposure of 10 years or less had an odds ratio close to unity, but by 20 years this reduced to 0.65, and further exposure showed a significant protective effect (OR 0.53, 95% CI 0.32 – 0.87).

Analysis of cumulative exposure to standing at work produced a significant, positive association with knee osteoarthritis for 3-10 years of exposure (OR 1.48, 95% CI 1.01 – 2.16). This risk increased slightly with further exposure, but lost significance. Some exposures presented an erratic response to increased dose, such as getting up from kneeling or squatting, which gave a significant odds ratio of 2.73 for 11-20 years but fell to a non-significant 1.87 for greater than 20 years exposure. Odds ratios for driving and walking presented no real pattern and remained non-significant at all levels of exposure.

Analysis of trend revealed significant risks associated with all knee flexion activities and a protective effect of sitting at work.

Table 9 Cumulative index for all reported occupational activities after adjusting for BMI

Occupational Activity	Numbers Exposed				Odds Ratios	95% Confidence Interval	Test for trend
	Cases		Controls				
	N	(%)	N	(%)			
Squatting:							0.005
3 – 10 years	22	7.2	28	6.3	1.29	0.67 – 2.47	
11 – 20 years	15	4.9	17	3.8	2.07	0.93 – 4.61	
> 20 years	27	8.9	21	4.7	2.45	1.19 – 5.05	
Kneeling:							<0.001
3 – 10 years	26	8.6	26	5.8	1.71	0.88 – 3.33	
11 – 20 years	20	6.6	18	4.0	2.46	1.14 – 5.33	
> 20 years	30	9.9	27	6.1	2.49	1.28 – 4.85	
Climbing stairs							0.023
3 – 10 years	29	9.5	30	6.7	1.81	1.01 – 3.24	
11 – 20 years	16	5.3	20	4.5	1.17	0.53 – 2.59	
> 20 years	18	5.9	19	4.3	2.40	1.03 – 5.59	
Sitting							0.006
3 – 10 years	84	27.6	99	22.2	0.98	0.64 - 1.50	
11 – 20 years	49	16.1	81	18.2	0.65	0.41 - 1.04	
> 20 years	52	17.1	110	24.7	0.53	0.32 - 0.87	
Standing							0.055
3 – 10 years	123	40.5	164	36.9	1.48	1.01 - 2.16	
11 – 20 years	29	9.5	37	8.3	1.60	0.87 - 2.97	
> 20 years	9	3.0	16	3.6	1.59	0.57 - 4.43	
Getting up from kneeling or squatting							0.015
3 – 10 years	21	6.9	34	7.6	0.93	0.50 - 1.74	
11 – 20 years	22	7.2	15	3.4	2.73	1.24 - 5.99	
> 20 years	25	8.2	27	6.1	1.87	0.93 - 3.74	
Driving							0.707
3 – 10 years	11	3.6	14	3.1	1.18	0.47 - 2.93	
11 – 20 years	8	2.6	13	2.9	0.86	0.33 - 2.24	
> 20 years	9	3.0	8	1.8	1.41	0.48 - 4.08	
Walking							0.712
3 – 10 years	48	15.8	90	20.2	0.93	0.60 - 1.46	
11 – 20 years	40	13.2	56	12.6	0.91	0.54 - 1.56	
> 20 years	67	22.0	86	19.3	1.16	0.72 - 1.89	

Table 10 shows the associations between knee osteoarthritis and reported weight lifting. The groups who regularly lifted weights from 10kgs to 1cwt a day were more than twice as likely to have knee osteoarthritis.

Table 10 Associations between knee osteoarthritis and reported weight lifting in main job (longest job before disease onset) after adjusting for BMI

Occupational Activity	Numbers Exposed				Odds Ratios	95% Confidence Interval
	Cases		Controls			
	N	(%)	N	(%)		
Lifting weights over 10 kg in an average working day:						
< once a week	4	1.3	10	2.2	0.63	0.16 - 2.47
1-10 times per week	27	8.9	46	10.3	1.23	0.68 - 2.25
> 10 times per week	102	33.6	90	20.2	2.18	1.45 - 3.30
Lifting weights over 25 kg in an average working day:						
< once a week	5	1.6	15	3.4	0.64	0.20 – 2.12
1-10 times per week	20	6.6	22	4.9	1.71	0.81 – 3.59
> 10 times per week	57	18.8	42	9.4	2.72	1.61 – 4.61
Lifting weights over 1 cwt in an average working day:						
< once a week	9	3.0	7	1.6	2.24	0.74 – 6.77
1-10 times per week	14	4.6	11	2.5	2.18	0.88 – 5.39
> 10 times per week	21	6.9	14	3.1	2.71	1.24 – 5.90

A summary of the occupations that involved kneeling, squatting and regular heavy lifting in main job before disease onset have been added as an appendix (Appendix 5).

Stepwise conditional logistic regression modelling led to a final model containing significant terms for body mass index and heavy lifting (OR 2.76 95% CI 1.64 – 4.66) only. All of the knee flexion variables were found to be non-significant using the likelihood ratio test, and therefore were excluded from this model.

The influence of heavy lifting on the risk of knee osteoarthritis in subjects according to their exposure to squatting, kneeling or climbing stairs has been examined (Table 11A). When compared with those not exposed to any of these activities, the group who regularly (at least ten times a week) lifted over 25kg at work, as well as having to kneel, squat or climb stairs, were more than three times as likely to have knee osteoarthritis (OR 3.28 95% CI 1.77 – 6.08). This odds ratio is much greater than that for regular knee flexion without lifting (1.03).

Table 11A Interaction between occupations involving heavy lifting and repetitive knee flexion on the risk of knee osteoarthritis

		Kneeling, squatting or stair climbing	
		No	**Yes**
Heavy lifting	**No**	1.00 [n = 533]	1.03 (0.62 – 1.72) [n = 110]
	Yes	1.69 (0.70 – 4.08) [n = 30]	3.28 (1.77 – 6.08) [n = 69]
			*p=0.238

Figures in each cell are odds ratios with 95% confidence intervals in brackets. Square brackets provide number of subjects in each cell. Odds ratios are adjusted for body mass index.
*p: p-value for interaction after adjusting for body mass index and main effects

These activities were also examined independently (Tables 11B – 11D). When examined independently the group who regularly lifted over 25kg at work, as well as having to climb stairs were more than seven times as likely to have knee osteoarthritis than the baseline group (OR 7.11 95% CI 2.28 – 22.20). This interaction was the only one which remained significant after adjusting for the appropriate main effects. The 20 occupations that involved this activity have been classified in Appendix 6.
The odds ratio for stair climbing without regular lifting is 0.73. The interactions between lifting and both kneeling and squatting are less striking. Tables 11E – 11G show odds ratios for all two-way interactions between the three flexion variables (kneeling, squatting and stair climbing). Some evidence of positive interactions between all variables is suggested.

Table 11B Interaction between occupations involving heavy lifting and kneeling on the risk of knee osteoarthritis

		Kneeling	
		No	**Yes**
Heavy lifting	**No**	1.00 [n = 592]	1.99 (0.97 – 4.08) [n=51]
	Yes	3.03 (1.48 – 6.19) [n = 46]	2.79 (1.43 – 5.45) [n = 52]
			*p=0.179

Table 11C Interaction between occupations involving heavy lifting and squatting on the risk of knee osteoarthritis

		Squatting	
		No	**Yes**
Heavy lifting	**No**	1.00 [n=595]	1.91 (0.89 – 4.10) [n = 48]
	Yes	3.01 (1.56 – 5.82) [n = 59]	2.67 (1.28 – 5.58) [n=40]
			*p=0.228

Table 11D Interaction between occupations involving heavy lifting and stair climbing on the risk of knee osteoarthritis

		Stair climbing	
		No	**Yes**
Heavy lifting	**No**	1.00 [n = 578]	0.73 (0.38 – 1.41) [n = 65]
	Yes	1.91 (1.07 – 3.41) [n = 78]	7.11 (2.28 – 22.20) [n = 20]
			*p=0.022

Table 11E Interaction between occupations involving kneeling and squatting on the risk of knee osteoarthritis

		Kneeling	
		No	**Yes**
Squatting	**No**	1.00 [n = 623]	1.47 (0.66 – 3.24) [n=36]
	Yes	1.10 (0.38 – 3.22) [n = 19]	2.55 (1.36 – 4.80) [n = 68]
			*p=0.654

Table 11F Interaction between occupations involving kneeling and stair climbing on the risk of knee osteoarthritis

		Kneeling	
		No	**Yes**
Stair climbing	**No**	1.00 [n = 580]	1.91 (1.09 – 3.37) [n=78]
	Yes	1.05 (0.56 – 1.96) [n = 62]	2.43 (0.92 – 6.39) [n = 25]
			*p=o.858

Table 11G Interaction between occupations involving stair climbing and squatting on the risk of knee osteoarthritis

		Squatting	
		No	**Yes**
Stair climbing	**No**	1.00 [n = 597]	1.80 (0.98 – 3.30) [n=62]
	Yes	1.03 (0.55 – 1.91) [n = 62]	2.35 (0.86 – 6.48) [n = 25]
			*p=0.273

4. Discussion

OA is a chronic degenerative condition for which repetitive use models have often been suggested but for which there has so far been only limited data available. Earlier evidence linking knee osteoarthritis with regular occupational knee flexion comes from two population-based surveys in the USA and a population based case control study in Southampton.

The HANES I study found that osteoarthritis of the knee at ages 55-64 was three times more common in people whose jobs were judged likely to entail knee-bending (3). The Framingham study found the risk of radiographic knee osteoarthritis was highest in subjects whose earlier jobs were likely to have involved bending of the knee (11). However, as earlier discussed, exposure was not monitored directly so the assessment of repetitive exposure occurring at work was limited by poor categorisation with the effect of misclassification and hence dilution of risk.

The Southampton study (7) reinforced these results and furthermore sought a lifetime occupational history with details of specific activities, in contrast to the American investigators who inferred occupational activities indirectly from job title. This study however was limited by a small sample size and did not assess all possible confounders/effect modifiers, in particular non-occupation exposure and or diet. It also only examined the cases main job before disease onset.

All evidence to date suggests that the relation between occupational knee flexion and knee OA is powerful and consistent (6). This study reinforces earlier findings and has also found significant risk associated with regular heavy lifting.

This study reports results taking the above factors into account. The present report is based on occupational analysis only; further work is continuing over the next three months to look at non-occupation exposure, particularly recreational activities, and diet.

Our findings support those of the Southampton study (7). One of the noticeable differences in our study has been the difference in the odds ratios of subjects whose main job entailed regular squatting or kneeling. However this study provides a more accurate estimate with greater numbers and narrower confidence intervals. Our demonstration of a significant overall elevation of risk from heavy lifting is not surprising given the increased numbers.

Jobs that entail frequent stair climbing and regular heavy lifting were shown to associate with a seven-fold increase in the risk of knee OA. Although this is a very significant result the small numbers exposed and wide confidence intervals mean that this result must be looked at with some degree of caution. When the individual jobs were explored (Appendix 6) they were not ones that appeared to involve an obvious combination of lifting whilst stair climbing.

The method used to assess exposure might be susceptible to recall bias. However, it avoids misclassification arising from the inaccuracy of a job title as a marker for occupational activity as in the HANES I and Framingham studies (3;11). We have established a very thorough job history for each subjects entire working life. All jobs have been coded according to a recognised system (10) and there were regular consistency checks amongst the interviewers.

The findings of this study support the hypothesis that prolonged or repetitive bending of the knee and regular heavy lifting is associated with osteoarthritis of the joint. Furthermore, regular heavy lifting augments the risks associated with regular knee flexion.

5. Conclusions

The association between certain occupational physical activities and the risk of knee OA is consistent with earlier findings. Prolonged or repeated knee flexion is a risk factor for knee OA.

Consideration should be given to preventative measures in jobs that involve occupational knee flexion, particularly kneeling and squatting and also regular heavy lifting. Work for long periods involving these physical activities should be avoided, if possible.

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ARTHRITIS IN THE COMMUNITY

This questionnaire has been prepared by the Rheumatology Unit, City Hospital Nottingham and the Department of Public Health Medicine and Epidemiology, Queens Medical Centre.

We want to find out more about the extent of knee pain in the community, in order to find ways of improving the management and care of osteoarthritis. It is therefore of great importance that you help us by filling in this questionnaire. Even if you do not have **knee pain**, please fill it in, as we are still very interested in your responses. We think you will find the questionnaire interesting and it should only take about 15-20 minutes to complete.

Most of the questions require a tick in a box, for the others, clear instructions are given. Much thought has gone into the design of this questionnaire, we are aware a few questions may seem similar - this is intentional and necessary for our research, please fill in **all** of them to the best of your ability.

Please return it in the pre-paid envelope (no stamp required) as soon as possible to the Department of Public Health Medicine and Epidemiology, Queens Medical Centre, Nottingham.

Your answers are strictly confidential.

Please do not pass this questionnaire onto anyone else.

If you have any questions about this work please ring :

Anna Follows, Study Administrator on 0115 9691169 extension 45557.
or
Alex Sutton, Research Assistant on 0115 9249924 extension 42004.

Thank you for your assistance with this important area of research.

A small number of you may, at a later date, be invited to participate in a further study (which would involve an examination and X-Rays of your knees). Even if you would not be willing to help us further please return this questionnaire.

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