*Original article*

Scand J Work Environ Health 2000;26(1):20-25

doi:10.5271/sjweh.505

**Primary osteoarthrosis of the knee in men and women as a result of lifelong physical load from work**

by Sandmark H, Hogstedt C, Vingård E

The following article refers to this text: 2002;28(1):25-32

**Key terms:** overweight; physically demanding job; population study; prosthetic knee surgery

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/10744173



Print ISSN: 0355-3140 Electronic ISSN: 1795-990X Copyright (c) Scandinavian Journal of Work, Environment & Health

Scand J Work Environ Health 2000;26(1):20—25

# Primary osteoarthrosis of the knee in men and women as a result of lifelong physical load from work

by Hélène Sandmark, PhD,[1,2] Christer Hogstedt, MD,[1,2,3] Eva Vingård, MD[1,2,3]

Sandmark H, Hogstedt C, Vingård E. Primary osteoarthrosis of the knee in men and women as a result of lifelong physical load from work. *Scand J Work Environ Health* 2000;26(1):20—25.

**Objectives** This study investigated the effect of lifelong physical load from work on the development of knee osteoarthrosis (OA) leading to prosthetic surgery among men and women.

**Methods** In a population-based case-referent study, men and women (N=625) who had had prosthetic surgery due to primary tibiofemoral OA were compared with referents (N=548) as to job titles and exposure to physical load in occupational work, housework, and leisure-time activities from 15 to 50 years of age.

**Results** Male forestry and construction workers, and both male and female farmers ran the highest risk of knee OA. The men had considerably higher exposure to lifting at work, and also to jumps and vibration, than the women. Among the men there was an association between lifting at work [odds ratio (OR) 3.0, 95% confidence interval (95% CI) 1.6—5.5], squatting or knee bending (OR 2.9, 95% CI 1.7—4.9), kneeling (OR 2.1, 95% CI 1.4—3.3), and jumping (OR 2.7, 95% CI 1.7—4.1) with knee OA. Exposure to physically demanding tasks at home, such as taking care of an elderly or handicapped person, was associated with knee OA among the women (OR 2.2, 95% CI 1.3—3.6).

**Conclusions** Working as a farmer or as a construction worker could be associated with the development of knee OA and lead to prosthetic surgery. Men and women differ in the quality and quantity of reported physical load and also in the strength of the risk estimates. A reduction of high physical load at work and at home could probably lower the risk of knee OA later in life.

**Key terms** overweight, physically demanding jobs, population study, prosthetic knee surgery.

The etiology of osteoarthrosis (OA) of the knee is multifactorial. The association of knee OA with increasing age, obesity, previous knee injury, and meniscectomy has been established, and for men workload factors have also been discussed (1—11). However, there is little evidence for an association between knee OA and physical load exposure among women, probably due to moderate occupational exposure, which limits the use of job titles and calls for complementary data collection regarding exposure.

The classification of tibiofemoral OA as the outcome variable in epidemiologic studies has often been based on radiographic findings, with or without symptoms in the subjects. Only one earlier study has investigated the risk factors for severe knee OA leading to prosthetic surgery (8).

The objective of our study was to investigate the effect of lifelong physical load from occupational work, housework, and leisure-time activities on the development of primary knee OA leading to prosthetic surgery among men and women and to determine which jobs may be hazardous in this respect.

## Subjects and methods

### Study population and design

The relationship between physical load factors in occupational work, housework, and leisure-time activities and the development of knee OA leading to knee prosthetic surgery was studied in a population-based case-referent study.

The study base comprised all men and women born between 1921 and 1938 and living in 14 counties in

1 Department of Occupational Health, Karolinska Hospital, Stockholm, Sweden.
2 Department of Public Health Sciences, Division of Occupational Health, Karolinska Institute, Stockholm, Sweden.
3 Department for Work and Health, National Institute for Working Life, Solna, Sweden.

Reprint requests to: Dr Hélène Sandmark, Department of Occupational Health, Karolinska Hospital, SE-171 76 Stockholm, Sweden. [E-mail: helene.sandmark@knv.ki.se]

Sweden between 1991 and 1995. The cases had undergone prosthetic knee replacement during the period 1991—1993 because of clinically significant primary tibiofemoral osteoarthrosis and were between the ages of 55 and 70 years at the time of the surgery. They were identified through the nationwide Swedish Knee Arthroplasty Register, which is a register system of knee arthroplasties performed at orthopedic units in Swedish hospitals (12). The register is annually updated by reports from the units. During the study there were 72 units in Sweden in which knee prosthetic surgery was carried out, and 67 of them reported regularly to the register. The aggregated information in the register has continuously been reported and evaluated and found to be in agreement with the hospital discharge registers (12).

The referents were men and women randomly selected from the study base, through the central population register in Sweden, and age in 5-year intervals and gender was taken into account.

Both cases and referents were excluded if they reported earlier trauma or surgery to the knee or the surrounding tissues, rheumatoid arthritis, or systemic disease involving the joints, such as poliomyelitis or rachitis, or had any musculoskeletal malformation. The cases who had symptoms of the knee before 50 years of age were excluded since physical load exposure provokes pain and would affect exposure to the different physical load variables and thus dilute the risk estimate. The referents who reported OA of the knee or had experienced severe pain or dysfunction of the knee were excluded.

In all, 369 male and 380 female cases were invited to participate in the study. The participation rate was 88% and 79%, respectively. Among the referents, 330 men and 370 women were contacted, of whom 80% and 77%, respectively, participated in the entire study (table 1).

### Procedure

The subjects were invited to participate in the study through an introductory letter, and shortly thereafter they were contacted by professional interviewers for a telephone interview with questions on occupational history and whether they had ever had trauma to the knees.

After the interview a postal questionnaire was sent to the subjects for more-detailed information on specific physical loads from occupation and housework, sports activities, general health status, height, weight at different ages in adult life, smoking habits, medication, and, among the women, the use of hormones.

For the specific physical load exposure each subject's reported periods of study, work, and housework were the base. For each period, questions were asked about the frequency and duration of positions or about movements that could be considered physically demanding, especially to the lower extremities. The subjects could fill out between 1 and 10 questionnaires, depending on how many periods with different jobs or studies they had had during their lifetime.

All information was obtained after the surgery and the period between the knee prosthetic surgery and the interview varied between 1 and 4 years. The subjects were aged 56—74 years at the time of the survey.

### Exposure classification

For the variables kneeling, standing, and sitting the exposure was reported in hours per day spent in these different positions. The duration of exposure (hours per day) to whole-body vibration during work, for example, driving a car or truck during work, was also asked for. Stairs climbed every day (number per day), squatting and knee bending (number per day), and jumps (number per day) were asked for. Lifting burdens at work was estimated by the subjects with regard to frequency and weight and then summed up in kilograms for the same period as the rest of the variables. Lifting in housework and during leisure time was estimated only by the summed up frequency. The cumulative duration and frequency of these variables during work and housework were then summed for the period 15 to 50 years of age of each subject's life.

Exposure was classified into the 3 classes of no or low exposure, medium exposure, and high exposure on the basis of the referents' values. The lower quartile was considered as low exposure, and the upper quartile as high exposure. The 50% in between were considered medium exposure.

All the reported occupational titles were classified according to the Nordic Standard Occupational Classification (13). The subjects were identified who had worked in certain occupations[4] considered to involve the highest physical load on the knees according to a score which had been developed and used in previous studies (14). Ten years of exposure to the occupations with high

**Table 1.** Participation in the study.

| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Cases | | Referents | | Cases | | Referents | |
| | N | % | N | % | N | % | N | % |
| Invited subjects | 369 | . | 330 | . | 380 | . | 370 | . |
| Only telephone interview | 33 | . | 40 | . | 58 | . | 25 | . |
| Refusals | 8 | . | 20 | . | 10 | . | 51 | . |
| Too ill to answer questions | 3 | . | 6 | . | 12 | . | 10 | . |
| Participation in entire study | 325 | 88 | 264 | 80 | 300 | 79 | 284 | 77 |

4 Livestock workers, garbage collectors, forestry workers, horticultural workers, farmers, metal workers, carpet layers, saw mill workers, miners and quarrymen, plumbers and pipefitters, concrete workers, construction carpenters, materials handling workers, deck and engine room crew on ships, delivery men.

physical load was the criterion for being exposed, and the subjects who had never had any of these physically demanding jobs were considered unexposed. The analysis was made for all jobs with high physical load taken together, as well as for each of the jobs in which there were enough subjects for separate calculations. The subjects who had exposure in any of the physically demanding occupations for a period of less than 10 years were excluded from this analysis.

The number of years in physically demanding tasks, outside work during adult life, was also asked. These tasks consisted of taking care of an elderly or handicapped person at home or any other kind of physically demanding activity in housework or during leisure time.

### Statistical analysis

The odds ratios for high and medium exposure, compared with no or low exposure, were calculated for the physical load variables of work, housework, and leisure-time activities. The odds ratios were interpreted as estimates of the incidence rate ratios, since the design was that of a population-based case-referent study (15). The different variables were studied using multivariate logistic regression with 1 physical load variable included at a time, and also with models of several physical load variables included. The appropriateness of the model, the "goodness-of-fit", was tested by the Hosmer & Lemeshow test (16). The variables age (2 classes), body mass index at the age of 40 years (3 classes), smoking (nonsmokers, light smokers, and smokers), and sports activities (3 classes for men and 2 classes for women) were included in all the analyses to adjust for potential confounding.

## Results

The men and women who had had occupational titles considered to involve heavy physical load on the knees for at least 10 years had an increased risk of developing knee OA when compared with those who had never had any of these titles. Male forestry and construction workers and both male and female farmers ran the highest risk (table 2).

The male subjects had considerably higher exposure, especially to lifting at work, and a higher exposure to jumps and vibration than the female subjects (table 3).

Lifting at work, squatting or knee bending, kneeling, and jumping were strongly associated with knee OA for the men. Lifting at work seems to be a substantial risk

**Table 2.** Odds ratios (OR) with their 95% confidence intervals (95% CI) for the development of osteoarthritis of the knee among those who had worked for a total of at least 10 years in ≥1 jobs considered to entail high physical demands on the knees (14) in comparison with subjects who had never had any such jobs. For those who worked for at least 10 years in 1 of these jobs, separate odds ratios were calculated. The odds ratios have been controlled for potential confounding from age, body mass index, sports, smoking, and, for the women, hormone substitution.

| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Cases (N) | Referents (N) | OR | 95% CI | Cases (N) | Referents (N) | OR | 95% CI |
| Unexposed to heavy jobs | 116 | 162 | . | . | 250 | 238 | . | . |
| ≥10 years in heavy jobs | 137 | 74 | 2.5 | 1.7—3.6 | 77 | 29 | 2.5 | 1.6—3.9 |
| Farm workers | 24 | 22 | 1.4 | 0.8—2.6 | 83 | 49 | 1.4 | 0.8—2.6 |
| Farmers | 70 | 28 | 3.2 | 2.0—5.2 | 59 | 23 | 2.4 | 1.4—4.1 |
| Construction workers[a] | 23 | 11 | 3.1 | 1.5—6.4 | - | - | . | . |
| Forestry workers | 23 | 12 | 2.1 | 1.0—4.6 | - | - | . | . |

[a] Plumbers and pipefitters, concrete workers, construction carpenters.

**Table 3.** Lifelong sum of physical load exposure during work and leisure time among the female and male referents. All the numbers have been rounded to the nearest thousand.

| Group | Standing (hours) | Sitting (hours) | Lifts at home (N) | Lifts at work (kg) | Squatting or knee bending (N) | Kneeling (minutes) | Climbing stairs (number of steps) | Vibration (hours) | Jumps (N) |
|---|---|---|---|---|---|---|---|---|---|
| Men | | | | | | | | | |
| No or low exposure | 2—51 | <0.5—26 | 0 | 0—107 | 0 | 0 | <0.5—103 | 0 | 0 |
| Medium exposure | 51—96 | 26.5—65 | <0.5—32 | 114—5891 | <0.5—70 | 1—160 | 105—1432 | <0.5—17 | <0.5—29 |
| High exposure | 96—213 | 66—136 | 36—172 | 5907—94248 | 70—312 | 162—1434 | 1461—205900 | 18—90 | 31—259 |
| Women | | | | | | | | | |
| No or low exposure | <0.5—58 | 2—27 | 0—25 | 0—4 | 0—2 | 0 | <0.5—166 | 0 | 0 |
| Medium exposure | 58—94 | 27.5—56 | 26—50 | 5—438 | 3—58 | 2—166 | 170—2494 | 1—34[a] | <0.5—68[a] |
| High exposure | 94—200 | 56—135 | 51—168 | 440—24075 | 59—236 | 170—1264 | 2557—165543 | . | - |

[a] There were few exposed subjects, and it was not possible to have more than 2 classes.

factor, as the risk estimate was 3-fold for the highly exposed men and even medium exposure demonstrated a significant positive association (table 4). Medium exposure to the remaining physical load variables did increase the point estimates for the men, although not significantly.

Exposure to physically demanding tasks at home, such as nursing and taking care of an elderly or handicapped person, was significantly associated with knee OA among the women, and it seemed to be the strongest risk factor for women among the physical load variables that were investigated in this study (table 5). For the men exposure to this kind of task was not associated with knee OA (table 4).

Among the women high exposure to lifts at work and a standing posture were positively associated, while kneeling, climbing stairs, and lifting at home had point estimates in excess of unity but wide confidence intervals.

Many of the subjects who reported kneeling also reported squatting or knee bending. Consequently these 2 variables could not simultaneously be included in the multivariate model. The model is therefore demonstrated 3 times, with each of the variables and with a new variable, which consisted of those who had high exposure to at least 1 of the 2 variables (high-exposure group) and those who had low-to-medium exposure (low-exposure group). In all 3 variations of the model, lifting and carrying and jumping seemed to be the strongest independent risk factors for the men, as compared with physically demanding tasks at home among the women. Squatting or knee bending and kneeling, when taken together in the new variable, showed increased risk among the men (tables 6 and 7).

## Discussion

Our study shows that having had occupations involving high physical demands for 10 years or more is associated with an increased risk of knee OA leading to prosthetic surgery among men and women. Among men some physical load variables, such as lifting, squatting or knee bending, kneeling, and jumping, demonstrated evidence of a positive association with knee OA and also indicated a dose-response association. Furthermore, we found differences between men and women regarding the activity in which the physical load exposure had been obtained, in the quantity of exposure, and in the strength of the risk estimates. Among the women we found a positive association with physically demanding activities at home, such as taking care of elderly relatives or handicapped children.

In Sweden, all citizens have free hospital care, which includes surgery, such as knee replacement. No selection should have occurred due to not being able to afford prosthetic surgery.

The participation rate in our study was high, especially among the male cases. There were subjects who participated only in the telephone interview, but did not want to continue with the questionnaires. The information obtained by the interview did not differ between the groups, and there was no evidence that selection because of the distribution of risk factors occurred.

As we did not include subjects with earlier trauma or injury to the knee and the surrounding tissues, we

**Table 4.** Relationship between knee osteoarthritis in men and different physical load variables. The multivariate logistic regression analyses included 1 physical load variable at a time. Comparisons are between the medium or high exposure class and the no or low exposure class. The odds ratios (OR) and 95% confidence intervals (95% CI) are shown. The odds ratios have been adjusted for age, body mass index, smoking, and sports.[a]

| Physical load variable | Medium exposure | | | High exposure | | |
|---|---|---|---|---|---|---|
| | Exposed cases (N) | OR | 95% CI | Exposed cases (N) | OR | 95% CI |
| Standing (hours) | 144 | 1.5 | 0.9—2.4 | 78 | 1.7 | 1.0—2.9 |
| Sitting (hours) | 161 | 1.0 | 0.7—1.6 | 41 | 0.7 | 0.4—1.2 |
| Lifts at home (number) | 123 | 0.9 | 0.6—1.5 | 77 | 1.0 | 0.6—1.7 |
| Lifts at work (kilograms) | 147 | 2.5 | 1.5—4.4 | 8 | 3.0 | 1.6—5.5 |
| Squatting or knee bending (number) | 93 | 1.3 | 0.8—2.2 | 126 | 2.9 | 1.7—4.9 |
| Kneeling (minutes) | 77 | 1.4 | 0.9—2.2 | 103 | 2.1 | 1.4—3.3 |
| Climbing stairs (number of steps) | 139 | 1.2 | 0.8—1.9 | 76 | 1.2 | 0.7—2.1 |
| Vibrations (hours) | 47 | 1.0 | 0.6—1.7 | 86 | 1.3 | 0.9—2.1 |
| Jumps (number) | 52 | 1.4 | 0.9—2.4 | 118 | 2.7 | 1.7—4.1 |

[a] Physically demanding tasks at home >1 year (yes;no): 44 exposed cases, OR 0.9 (95% CI 0.4—2.1).

**Table 5.** Relationship between knee osteoarthritis in women and different physical load variables. The multivariate logistic regression analyses included 1 physical load variable at a time. Comparisons are between the medium or high exposure class and the no or low exposure class. The odds ratios (OR) and 95% confidence intervals (95% CI) are shown. The odds ratios have been adjusted for age, body mass index, and smoking.[a]

| Physical load variable | Medium exposure | | | High exposure | | |
|---|---|---|---|---|---|---|
| | Exposed cases (N) | OR | 95% CI | Exposed cases (N) | OR | 95% CI |
| Standing (hours) | 128 | 1.2 | 0.7—1.9 | 94 | 1.6 | 1.0—2.8 |
| Sitting (hours) | 143 | 1.1 | 0.7—1.7 | 64 | 0.9 | 0.5—1.5 |
| Lifts at home (number) | 146 | 1.3 | 0.8—2.1 | 87 | 1.4 | 0.8—2.5 |
| Lifts at work (kilogram) | 126 | 1.2 | 0.7—1.9 | 91 | 1.7 | 1.0—2.9 |
| Squatting or knee bending (number) | 152 | 1.2 | 0.7—1.9 | 61 | 1.1 | 0.6—1.9 |
| Kneeling (minutes) | 100 | 1.5 | 1.0—2.3 | 86 | 1.5 | 0.9—2.4 |
| Climbing stairs (number of steps) | 166 | 1.7 | 1.1—2.5 | 65 | 1.4 | 0.8—2.3 |

[a] Physically demanding tasks at home >1 year (yes;no): 100 exposed cases, OR 2.2 (95% CI 1.3—3.6).

**Table 6.** Multivariate logistic regression analysis of the relationship between knee osteoarthritis in men and the different physical load variables. Comparisons are between the highly exposure class and the no or low expsoure class. The odds ratios (OR) and 95% confidence intervals (95% CI) are shown. The odds ratios have been adjusted for age, body mass index, and smoking. The model is demonstrated in 3 different ways due to the covariation between the variables kneeling and squatting or knee bending.

| | OR | 95% CI[a] | OR | 95% CI[b] | OR | 95% CI[c] |
|---|---|---|---|---|---|---|
| Standing | 1.3 | 0.7—2.3 | 1.1 | 0.6—2.1 | 1.1 | 0.6—2.1 |
| Climbing stairs | 1.0 | 0.5—1.6 | 0.8 | 0.5—1.5 | 0.9 | 0.5—1.6 |
| Lifts at work | 1.9 | 0.9—3.8 | 1.6 | 0.8—3.1 | 1.6 | 0.8—3.3 |
| Jumps | 2.0 | 1.2—3.3 | 2.0 | 1.2—3.2 | 2.0 | 1.2—3.2 |
| Kneeling | 1.6 | 1.0—2.6 | . | . | . | . |
| Squatting or knee bending | . | . | 2.0 | 1.1—3.6 | . | . |
| Kneeling or squatting or knee bending | . | . | 1.8 | 1.2—2.8 | . | . |

[a] Hosmer & Lemeshow test P=0.45. [b] Hosmer & Lemeshow test P=0.60. [c] Hosmer & Lemeshow test P=0.47.

**Table 7.** Multivariate logistic regression analysis of the relationship between knee osteoarthritis in women and the different physical load variables. Comparisons are between the high exposure class and the no or low exposure class. The odds ratios (OR) and 95% confidence intervals (95% CI) are shown. The odd ratios have been adjusted for age, body mass index, and smoking. The model is demonstrated in 3 ways due to the covariation between the variables kneeling and squatting or knee-bending.

| | OR | 95% CI[a] | OR | 95% CI[b] | OR | 95% CI[c] |
|---|---|---|---|---|---|---|
| Standing | 1.2 | 0.6—2.2 | 1.2 | 0.7—2.3 | 1.2 | 0.7—2.3 |
| Climbing stairs | 1.2 | 0.6—2.2 | 1.3 | 0.7—2.3 | 1.3 | 0.7—2.3 |
| Lifts at work | 1.3 | 0.7—2.3 | 1.4 | 0.8—2.6 | 1.4 | 0.8—2.5 |
| Jumps | 1.3 | 0.8—2.4 | 1.5 | 0.8—2.6 | 1.4 | 0.8—2.5 |
| Physical demanding tasks at home | 1.7 | 1.0—2.9 | 1.8 | 1.0—3.1 | 1.8 | 1.0—3.1 |
| Kneeling | 1.2 | 0.7—2.0 | . | . | . | . |
| Squatting or knee bending | . | . | 0.6 | 0.3—1.2 | . | . |
| Kneeling or squatting or knee bending | . | . | . | . | 0.8 | 0.5—1.2 |

[a] Hosmer & Lemeshow test P=0.47. [b] Hosmer & Lemeshow test P=0.21. [c] Hosmer & Lemeshow test P=0.72.

carefully checked this exclusion criterion. About 15% of the referents reported this condition, which was a somewhat higher rate than we expected. This problem resulted in a lower frequency of referents than of cases, especially among the men.

In epidemiologic studies using retrospective exposure assessments, validity and reliability can be discussed. The exposure asked for in our study was between the ages of 15 to 50 years. This retrospective assessment involved a certain degree of nondifferential misclassification due to memory difficulties, giving a dilution of the true risk for the highly exposed and an over- or underestimation of the risk for the medium exposed. When detailed scales are used in questionnaires, they should be pooled into fewer and wider classes to obtain greater precision (17). In the analyses we used only 3 classes of exposure, and this procedure should have diminished the problems of potential misclassification. If cases and referents recalled their exposures differently, differential misclassification could have occurred. Such misclassification can result in an over- or underestimation of the true OR. However, we compared individual cases and referents who had had similar jobs, considered as low-exposure jobs, and their assessments of the loads in that job did not differ substantially. This finding indicates that differential misclassification is a minor problem which did not interfere much with the validity of the exposure assessments in our study.

Factors associated with an increased risk of knee OA, which also could be confounders, such as obesity, smoking, and age, were adjusted for in all the analyses. Other potential confounders, such as sports activities, were also included, both in the multivariate analyses and in the analysis of a single occupational exposure at a time. None of these exposures were found to be confounders.

In many studies using job titles as a proxy for occupational load, few women have been properly classified. Nonoccupational exposure has not been investigated in studies on knee OA before, but results similar to those of our study have been seen in a study on hip OA (18). Women have not had the same amount of occupational load during their lifetime, but usually they have had much more load from housework than men have. In our study, we assessed the amount of housework in a detailed way to get a full picture of the total load, in both occupational and nonoccupational work. Therefore we could identify physically demanding activities, such as taking care of an elderly or handicapped person at home, as strongly associated with knee OA among women. This exposure was somewhat more complex than several other physical load variables in the study. It certainly involved lifting, carrying, squatting or knee bending, and kneeling.

The results from our study suggesting that repetitive knee use, impact loading, and heavy lifting are associated with knee OA are very much in accordance with those of earlier studies on risk factors. In the Framingham study (4), which is a population-based cohort study, knee bending and physically demanding jobs, including lifting and carrying, were found to be risk factors for radiographic knee OA, both for men and for women. However, the exposure to occupational physical load in this study was indirectly assessed from job titles and not by monitoring or questioning the subjects. Also in the NHANES I survey, which was a cross-sectional study, the exposure was estimated indirectly through job titles without individual exposure assessment. An increased risk of radiographic knee OA was found for those who had had occupational exposure considered to involve much knee bending. In the same study it was found that exposure to high physical demands in jobs increased the risk for women and also for men, although the association was weaker (2).

However, in a study of Bagge and his co-workers (19), no associations were reported between heavy work load and knee bending and knee OA among men and women. In a case-referent study by Cooper et al (6), of 109 men and women with knee OA, knee bending, kneeling, squatting, and climbing stairs, but not lifting as an independent variable, were identified as risk factors for radiographic knee OA with knee pain. The most evident risk factor was exposure to prolonged or repetitive squatting or knee bending. In a study of 50 men and women who had undergone total knee arthroplasty due to knee OA, the results showed that heavy work, obesity, and earlier knee injury were risk factors (8). In these 2 studies the data were not analyzed separately for men and women. In a prospective longitudinal register-based study on occupational titles, men working as farmers, as construction workers or as mail carriers and women working as cleaners had an increased relative risk of being hospitalized because of knee OA (5). A systematic review of evidence-based risk factors for OA of the knee concluded that there is a strong positive relationship between work-related knee bending exposure and knee OA. (20).

In conclusion, the physical load exposure, which we approximated in the variables used, contributes to knee OA among men and women. The results indicate an exposure-response association between physical load and knee OA, at least for men. Positive associations of physical exposure from work and housework, as well as from leisure time, have been shown, and it was found that men and women differ in the quality and quantity of reported physical load. The risk estimates were, with a few exceptions, higher for the men. Certain occupations, especially farming among men and women and construction work among men involve risk factors for the development of knee OA. Preventive measures are motivated for jobs with high risk, and also a reduction of high physical load at home could lower the risk of knee OA.

## Acknowledgments

This study was supported by grants from the Swedish Council for Work Life Research. We are grateful to Ms Ebba von Rosen for the data collection and to Patrick Schéele, a statistician, for the computer work.

## References

1. Lindberg H, Montgomery F. Heavy labour and the occurrence of gonarthrosis. Clin Orthop 1987;214:235—6.
2. Anderson JJ, Felson DT. Factors associated with osteoarthritis of the knee in the first National Health and Nutrition Examination Survey (NHanes 1): evidence for an association with overweight, race and physical demands of work. Am J Epidemiol 1988;128:179—89.
3. Lawrence RC, Hochberg MC, Kelsey JL, McDuffie FC, Medsger TA, Felts WR, et al. Estimates of the prevalence of selected arthritic and muskuloskeletal diseases in the United States. J Rheumatol 1989;16:427—41.
4. Felson DT. The epidemiology of knee osteoarhtritis: results from the Framingham study. Semin Arthritis Rheum 1990; 20:42—50.
5. Vingård E, Alfredson L, Goldie I, Hogstedt C. Occupation and osteoarthrosis of the hip and knee. Int J Epidemiol 1991;20:1025—31.
6. Cooper C, McAlindon T, Coggon D, Egger P, Dieppe P. Occupational activity and osteoarthrosis of the knee. Ann Rheum Dis 1994;53:90—3.
7. Cooper C, McAlindon T, Snow S, Vines K, Young P, Kirwan J, et al. Mechanical and constitutional risk factors for symptomatic knee osteoarthritis: differences between medial tibiofemoral and patellofemoral disease. J Rheumatol 1994;21: 307—13.
8. Kohatsu ND, Schurman D. Risk factors for the development of oesteoarthrosis of the knee. Clin Orthop 1990;261:242—6.
9. Partridge REH, Duthie JJR. Rheumatism in dockers and civil servants: a comparison of heavy manual and sedentary workers. Ann Rheum Dis 1968;27:559—67.
10. Kivimäki J, Riihimäki H, Hänninen K. Knee disorders in carpet and floor layers and painters. Scand J Work Environ Health 1992;18:310—6.
11. Wickström G, Hänninen K, Mattsson T, Niskanen T, Riihimäki H, Waris P, et al. Knee degeneration in concrete reinforcement workers. Br J Ind Med 1983;40:216—9.
12. Knutsson K, Lewold S, Robertsson O, Lidgren L. The Swedish knee arthroplasty register: a nation-wide study of 30,003 knees 1976—1992. Acta Orthop Scand 1994;65(4):375—386.
13. Statistics Sweden. Reports on statistical co-ordination: occupations in population and housing census 1985(FoB 85) according to Nordic Standard Occupational Classification (Nordisk yrkesklassificering, NYK) and Swedish Socio-economic Classification (Socioekonomisk indelning, SEI) [alphabetical version]. Stockholm: Statistics Sweden, 1989:5, version 1995.
14. Vingård E, Alfredsson L, Fellenius E, Hogstedt C. Disability pensions due to musculo-skeletal disorders among men in heavy occupations. Scand J Soc Med 1992;20:31—6.
15. Miettinen O S. Estimability and estimation in case-referent studies. Am J Epidemiol 1976;103:226—35.
16. Hosmer DW, Lemeshow. Applied logistic regression. New York (NY): John Wiley & Sons, 1989.
17. Wiktorin C. Occupational physical load in epidemiological studies, development and evaluation of methods [thesis]. Stockholm: Karolinska Institutet, 1995.
18. Vingård E, Alfredsson L, Malchau H. Osteoarthrosis of the hip in women and its relation to physical load at work and in the home. Ann Rheum Dis 1997;76:293—8.
19. Bagge E, Bjelle A, Edén S, Svanborg A. Factors associated with radiographic osteoarthritis: results from the population study of 70-year-old people in Göteborg. J Rheumatol 1991;18:1218—22.
20. Maetzel A, Mäkelä M, Hawker G, Bombardier C. Osteoarthritis of the hip and knee and mechanical occupational exposure – a systematic overview of the evidence. J Rheumatol 1997;24:1599—607.

Received for publication: 19 August 1998