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Radiographic knee osteoarthritis in floorlayers and carpenters

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Objectives The aim of the present study was to examine the relationship between knee-straining work and radiological findings of knee osteoarthritis and to study the relation between radiological findings and self-reported knee complaints and clinical signs of knee osteoarthritis.

Methods The material consisted of 133 floorlayers, 506 carpenters, and 327 compositors, 26—72 years of age, who had completed a questionnaire and reported no previous knee trauma. A stratified sample of these questionnaire respondents, 50 floorlayers, 51 carpenters, and 49 compositors, were radiologically examined for knee osteoarthritis by 2 radiologists. The X-ray films were independently assessed by 2 radiologists and blinded with respect to knee complaints, trade, and age.

Results The radiological investigation showed estimated prevalences of knee-osteoarthritis (grades 2—4) for 14% of the floorlayers, 8% of the carpenters, and 6% of the compositors (not significantly different). For the subjects ≥ 50 years of age the estimated prevalences of the combination of radiological grades 2—4 for knee osteoarthritis and knee complaints during the last 12 months were 29% [95% confidence interval (95% CI) 17—44%], 9% (95% CI 1—26%), and 1% (95% CI 1—10%) for the floorlayers, carpenters, and compositors, respectively. Radiological grades 2—4 were mainly found for subjects above the age of 50 years, subjects with knee complaints, and floorlayers. Radiological knee osteoarthritis was positively associated with self-reported knee complaints and with clinical signs of intraarticular and retropatellar crepitation.

Conclusions The data suggest that work in which a considerable amount of time is spent in knee-straining positions may be a risk factor for the development of knee osteoarthritis above the age of 50 years.

Key terms clinical examination, compositors, knee osteoarthritis, knee-straining work, questionnaire, radiological investigation, self-reported knee complaints.

Previous studies have shown an increased frequency of radiological knee osteoarthritis among miners (1, 2), pipefitters, and welders (3), possibly related to kneeling or squatting. However, the amount of knee-straining work in these trades was poorly described. A study of floorlayers, including a quantitative description of knee-straining work, was negative, but this study included only subjects below 50 years of age (4).

The purpose of the present study was to examine the relation between knee-straining work and knee complaints, physical findings indicating knee disorders, and radiological knee osteoarthritis. Knee-straining work was defined as work in kneeling, knee-supporting (weight-bearing on the knees), or squatting work positions. The study was a cross-sectional study of male floorlayers, carpenters, and compositors between 26 and 72 years of

age. The results concerning the amount of knee-straining work in the 3 trades, knee complaints, and physical findings have been published separately (5). Video recordings of representative work tasks showed that the floorlayers had knee-straining work in 56% of their workhours, and the corresponding figure for carpenters was approximately 25%. Compositors had no knee-straining work (5).

Subjects and methods

The study material consisted of 133 floorlayers, 506 carpenters, and 327 compositors who had completed a questionnaire on aspects of their work, knee complaints,

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previous knee trauma, medical conditions, height, weight, smoking, and participation in sports. The subjects with a previous knee trauma (eg, meniscal lesions and ligament ruptures) and those with diseases such as rheumatoid arthritis and gout were excluded. The clinical study included 295 subjects, selected at random with variable sample fractions from 9 strata defined by the 3 trades and the following 3 categories of knee complaints: never, previously but not within the last 12 months, within the last 12 months. A sample of subjects participating in the clinical study was further invited to participate in the radiological examination. These subjects were invited at random from the 9 strata, aiming at a total of 50 subjects for each trade and in such a way that approximately 2/3 within each trade were selected from subjects who had had knee complaints within the last 12 months. Clinical findings were not considered in the selection of the subjects. The study material is presented in table 1.

Table 1. Results of the radiological examinations by sampled strata (trade and knee complaints during the last 12 months), age, and selected combined strata. (95% CI = 95% confidence interval)

Complaints during the last 12 months	Questionnaire respondents total (N)	Sample for X-ray (N)	Knee osteoarthritis grades 2—4		
			N	%	95% CI
No					
Floorlayers					
<50 years	33	5	-	0	0—48
≥50 years	29	13	1	8	3—28
All	62	18	1	4 ^a	2—23
Carpenters					
<50 years	196	10	1	10	1—43
≥50 years	95	5	-	0	0—51
All	291	15	1	7 ^a	0—31
Compositors					
<50 years	120	9	-	0	0—32
≥50 years	158	10	1	10	1—43
All	278	19	1	6 ^a	0—25
Yes					
Floorlayers					
<50 years	46	21	-	0	0—11
≥50 years	25	11	7	64	40—84
All	71	32	7	22 ^a	13—35
Carpenters					
<50 years	154	18	1	6	1—26
≥50 years	61	18	4	22	10—43
All	215	36	5	10 ^a	4—25
Compositors					
<50 years	18	13	1	8	6—22
≥50 years	30	17	1	6	3—20
All	48	30	2	7 ^a	4—15
Total					
Floorlayers	133	50	8	14 ^b	8—24
Carpenters	506	51	6	8 ^b	3—18
Compositors	326	49	3	6 ^b	2—16

^a Estimate based on the 2 age strata, the sample fractions being taken into consideration.
^b Estimate based on 4 strata (2 age and 2 complaint strata), the sample fractions being taken into consideration.

X-rays of the anteroposterior and lateral positions of the knees were taken while the subject was lying down. The X-rays were assessed independently by 2 medical specialists in radiology (IB, VL) and were made without knowledge of the subject's trade, age, or reported knee complaints. In case of disagreement on the grade, a final joint assessment was made. The assessments were carried out according to the criteria defined by Kellgren & Lawrence (6), which categorize knee osteoarthritis by severity as follows: grade 0 = no changes, grade 1 = doubtful narrowing of joint space and possible osteophytic lipping, grade 2 = definite osteophytes and possible narrowing of joint space, grade 3 = moderate multiple osteophytes, definite narrowing of joint space and some sclerosis and possible deformity of bone ends, grade 4 = large osteophytes, marked narrowing of joint space, severe sclerosis, and definite deformity of bone ends.

Reproducibility of the radiological assessment

The agreement between the assessments of knee osteoarthritis by the 2 radiologists is shown in table 2. The kappa-coefficient was 0.52 [95% confidence interval (95% CI) 0.43—0.61] if all grades were considered and 0.61 (95% CI 0.44—0.78) if the grades were dichotomized as grades 0—1 and 2—4.

Analysis

The grades of knee osteoarthritis were dichotomized by merging grades 0 and 1 and grades 2 through 4. There were only 3 subjects with knee osteoarthritis of grades 2—4 among the subjects who never had knee complaints or not within the last 12 months, and these 2 complaint groups were also merged. Each of the resulting 6 strata (3 trades combined with 2 self-reported complaint categories) were further subdivided into 2 age groups, <50 years and ≥50 years.

The population prevalence of knee osteoarthritis in a specific stratum was estimated by the proportion of subjects with knee osteoarthritis in the sample. When strata were combined, the estimation of the population

Table 2. Agreement between the radiologists' assessment (grades 0—4) of knee osteoarthritis (N=300 knees).^a

Radiologist 2	Radiologist 1				
	0	1	2	3	4
0	178	37	2	-	-
1	11	42	5	-	-
2	1	8	7	1	-
3	-	1	2	2	-
4	-	-	-	2	1

^a Agreement 230/300=77%; kappa=0.52 (95% confidence interval 0.43—0.61).

prevalence in the combined group (eg, trade) must consider the various sampling fractions of the specific strata. The following notation is used: N_i is the number of subjects in the i 'th stratum in population N , n_i is the number of subjects in the sample in the i 'th stratum, and x_i is the number of subjects with knee osteoarthritis of grades 2-4 in the i 'th stratum. For combined strata, the estimated prevalence $[E(p)]$ in the population is as follows:

$$E(p) = \sum v_i E(p_i),$$

where $v_i = N_i/N$ and $E(p_i) = x_i/n_i$.

The 95% confidence intervals for the estimated prevalences were calculated using the hypergeometric distribution. For combined strata, we can only be certain of a significant difference for 2 prevalence estimates if the 95% confidence intervals do not overlap. The significance of differences between prevalences in 2 specific strata was assessed by Fisher's exact test.

Results

The prevalences of knee osteoarthritis of grades 2-4 for all the specific strata and certain combined strata are shown in table 1.

Altogether 17 subjects (8 floorlayers, 6 carpenters, and 3 compositors) were ranked as radiological grades 2-4. Four of the 8 floorlayers but no carpenters or compositors were grades 3-4. Among the subjects below the age of 50 years, 3 subjects (2 carpenters, 1 compositor) were ranked grade 2, and none were grade 3 or 4. Among the subjects without knee complaints within the last 12 months, 3 were ranked grade 2, and none were grade 3 or 4. Thus grades 2-4 of knee osteoarthritis were mainly found among symptomatic subjects above the age of 50 years.

Knee osteoarthritis and trade

The prevalence estimates of radiological knee osteoarthritis of grades 2-4 for the 3 trades are shown in table 1. The prevalence estimates were 14%, 8%, and 6% for the floorlayers, carpenters, and compositors, respectively, but with considerable overlap of the confidence intervals. For the subjects ≥ 50 years of age the estimated prevalences (2 complaint strata combined) were 34% (95% CI 20-50%), 9% (95% CI 2-26%), and 9% (95% CI 3-28%) for the respective trades. These results were derived by merging the strata specified in table 1.

For subjects ≥ 50 years of age, the estimated prevalences of the combination of radiological knee osteoarthritis grades 2-4 and knee complaints during the last 12 months were 29% (95% CI 17-44%), 9% (95% CI

1-26%), and 1% (95% CI 1-10%) for the floorlayers, carpenters, and compositors, respectively. The figures can be derived by combining strata for subjects ≥ 50 years of age in table 1. [For example, for floorlayers 7 subjects out of the 11 in the X-rayed sample of 25 symptomatic subjects ≥ 50 years of age had knee osteoarthritis, grades 2-4; thus the estimated frequency was $(7/11) \times 25$ among a total of 54 subjects ≥ 50 years of age (29%).]

Knee osteoarthritis and age

Among the subjects < 50 years of age there were only 3 cases with radiological knee osteoarthritis among 76 subjects examined (3.9%), as compared with 14 cases among 74 subjects ≥ 50 years of age (19%). The prevalence of knee osteoarthritis for floorlayers ≥ 50 years of age (34%, 95% CI 20-50%) was significantly different from that of floorlayers < 50 years of age (0%, 95% CI 0-10%). For carpenters and compositors, the differences between the prevalences of the 2 age groups were not significantly different, but the numbers were small. These results are based on 2 complaint strata and can be derived from table 1.

Knee osteoarthritis and complaints

The relation between knee complaints during the last 12 months and radiological knee osteoarthritis is shown in table 1. For symptomatic subjects ≥ 50 years of age, the prevalence of knee osteoarthritis was 64%, 22%, and 6% for the floorlayers, carpenters, and compositors, respectively. The difference in the prevalence between the floorlayers and compositors was significant ($P=0.002$, Fisher's exact test). The difference between the floorlayers and carpenters was "borderline" significant ($P=0.05$). The difference between the carpenters and compositors was not significant ($P=0.34$). For subjects < 50 years of age the numbers were small, and there were no significant differences in the prevalence of knee osteoarthritis among the subjects with and subjects without knee complaints for any of the 3 trades.

Knee osteoarthritis and clinical findings

Table 3 shows the frequencies of knee osteoarthritis among the subjects with and without clinical signs of intraarticular crepitation, retropatellar crepitation, and pain by knee bending. For both of the 2 clinical investigators a significant positive association was found between radiological knee osteoarthritis grades 2-4 and intraarticular crepitation in the physical examination (prevalence rate ratios 4.3 and 5.1). A similar association was found for retropatellar crepitation, significant however only for 1 of the investigators (prevalence rate ratios 2.1 and 3.2). The associations for pain by knee bending were not significant (prevalence rate ratios 2.6 and 2.5).

Table 3. Knee osteoarthritis among the subjects with and without clinical signs of intraarticular and retropatellar crepitation, pain by kneeling 10 times, by investigator.

	Total (N)	Radiological knee osteoarthritis, grades 2—4		
		N	%	P-value
Intraarticular crepitation				
Investigator 1				
No	129	10	7.8	0.003
Yes	21	7	33.3	
Investigator 2				
No	132	10	7.6	0.001
Yes	18	7	38.9	
Retropatellar crepitation				
Investigator 1				
No	119	11	9.2	0.12
Yes	31	6	19.4	
Investigator 2				
No	123	10	8.1	0.02
Yes	27	7	25.9	
Pain by knee bending 10 times				
Investigator 1				
No	129	12	9.3	0.07
Yes	21	5	23.8	
Investigator 2				
No	138	14	10.1	0.14
Yes	12	3	25.0	

Discussion

Radiological knee osteoarthritis, grades 2—4, was mainly found among the subjects ≥ 50 years of age, among the subjects with knee complaints within the last 12 months, and among the floorlayers.

Floorlayers ≥ 50 years of age had an increased prevalence of radiological knee osteoarthritis grades 2—4, compared with the other 2 trades. The differences, however, were not significant as judged by the 95% confidence intervals. This test for statistical significance, however, is conservative. The prevalence of radiological knee osteoarthritis among the carpenters, all and for the subgroup ≥ 50 years of age, was similar to that of the compositors. These results indicate that knee-straining work during most hours of a workday for many years may be a risk factor for the development of knee osteoarthritis. Although the numbers are small, this interpretation is supported by the finding that all cases of knee osteoarthritis grades 3—4 were found among floorlayers ≥ 50 years of age (4 out of 7 cases with knee osteoarthritis grades 2—4). Furthermore, for the subjects ≥ 50 years of age, the combination of complaints and radiological knee osteoarthritis was significantly higher among the floorlayers than among the compositors. For the subjects ≥ 50 years of age, there was a remarkably stronger association between radiological knee osteoarthritis and knee complaints for the floorlayers than for the other 2 trades.

An explanation for the differences between the trades could be that in more knee-straining work a similar degree of osteoarthritis produces more pain.

Subjects who participated in the radiological examination were selected at random from those who participated in the clinical examination, stratified by trade and complaint status. None of those invited to participate in the radiological examination declined. Therefore, if differential selection should explain the results, this selection would have to work at the level of agreement to participate in the clinical examination or completing the questionnaire. The questionnaire response rates were 85%, 79%, and 78% for the floorlayers, carpenters, and compositors, respectively (5). Among the subjects without knee complaints within the last 12 months, 56% of the floorlayers, 56% of the carpenters, and 50% of the compositors agreed to participate in the clinical examination (including those with previous knee trauma or rheumatic disease). The similar figures for those with knee complaints were 66%, 69%, and 70%. These differences are small, and differential selection cannot explain the results.

We have found only 1 radiological study of knee osteoarthritis among floorlayers (4), and no studies of knee osteoarthritis among carpenters. Kivimäki et al (4) found no difference in the frequency of severe knee osteoarthritis among 25-to-49-year-old floorlayers compared with painters, a finding in accordance with our results. Studies from the 1950s showed an increased prevalence of radiological knee osteoarthritis in miners when they were compared with different reference groups without kneeling or squatting work (1, 7). These findings were supported in a more recent German study (2) of 50-year-old miners compared with 50-year-old referents without knee-straining work. Kneeling, squatting, or crawling work positions were also associated with an increased prevalence of radiological knee osteoarthritis in an American population study of more than 4000 subjects over 55 years of age (8).

A few other studies have found a positive association between knee-straining work and a diagnosis of knee osteoarthritis based on a combination of X-ray findings, a physical examination and symptoms for pipefitters (3, 9) and welders and shipbuilders (3).

Subjects with knee-straining tasks often have heavy physical work, and vice versa. Some studies indicate that heavy physical work is a risk factor for knee osteoarthritis (10—14), but they do not separate the possible effects of heavy physical work from the effects of knee-straining work positions.

We found an increased frequency of knee osteoarthritis among floorlayers but not among carpenters. We consider the work of the 2 groups to be fairly similar with respect to physical load and lifting, and we have shown that floorlayers have more knee-straining work than

carpenters. In our study, therefore, knee-straining work positions rather than physical work load seem to be the more important risk factor. This assumption is supported by the results of a study by Enderlein et al (3).

The radiological interrater agreement on the degree of knee osteoarthritis was moderately good, with a kappa coefficient of 0.52, considering all grades, and 0.61 for grades 2–4 versus grades 0–1.

Kellgren & Lawrence (1) had 4 radiologists assessing radiological findings from miners, heavy manual workers, and office workers. These 4 investigators found 2, 3, 5, and 6 cases of severe knee osteoarthritis among the miners, 0, 0, 1, and 1 among the heavy manual workers, and none among the office workers. Their results do not suggest better interrater agreement than in our study. Intrarater agreement is naturally higher than interrater agreement. Thus Felson et al (15) found an intrarater agreement of 0.85 using the same criteria. McAlindon et al (16) found an intrarater agreement of 1.00 and 0.69 for medial and lateral compartment osteoarthritis, respectively, using dichotomized data. It was not clear, however, if they dichotomized at grade 2 or 3.

The radiographs in our study were made with the subjects lying down. Compared with radiographs made in the standing position our results may underestimate the prevalence of knee osteoarthritis. Underestimation may also have resulted from not having assessed patellofemoral osteoarthritis (16, 17). Underestimation may have lowered the power of our study, but should not change the pattern of relationships between knee osteoarthritis and other factors.

We found a positive association between radiological knee osteoarthritis and clinical findings of intraarticular and retropatellar crepitation. The association was similar for the 2 clinical investigators even though the interrater reliability of the findings was only low to moderate (5). Similar data from epidemiologic studies are sparse. However, Wickström et al (18) also reported a positive relation between physical examination signs and radiological knee osteoarthritis in their study of concrete reinforcement workers.

We found an increased frequency of knee osteoarthritis for floorlayers ≥ 50 years of age but not for floorlayers < 50 years of age. This finding is in agreement with the findings of an American population study (8) and a study by Kivimäki et al (4) of floorlayers. In future epidemiologic studies it is recommended that more sensitive methods be used or developed to detect early stages of osteoarthritis in younger populations to know more precisely when they appear.

In conclusion, our data suggest that work in which a considerable amount of time is spent in knee-straining positions may be a risk factor for developing radiologically determined knee osteoarthritis above the age of 50 years.

Radiological knee osteoarthritis was positively associated with self-reported knee complaints and with clinical signs of intraarticular crepitation.

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References

1. Kellgren JH, Lawrence JS. Rheumatism in miners. Part II: X-ray study. *Br J Ind Med* 1952;9:197–207.
2. Greinemann H. Argumente gegen die Anerkennung von Kniegelenkarthrosen nach Berufsbelastung als Berufskrankheit. *Unfallchirurgie* 1988;91:374–80.
3. Enderlein G, Kasch J. Modellierung von Dosis-Wirkungsbeziehungen für expositionsabhängige Veränderungen am Bewegungsapparat. *Z Gesamte Hyg* 1989;35(4):215–8.
4. Kivimäki J, Riihimäki H, Hänninen K. Knee-disorders in carpet and floor layers and painters. *Scand J Work Environ Health* 1992;18:310–6.
5. Jensen LK, Petersen IP, Eenberg W, Bergmann I, Løgager V, Sinding J, et al. Knæbelastning og knælidelser blandt gulvlæggere og tømrere [Knee-strain and knee-disorders among floorlayers and carpenters]. Copenhagen: The Danish Working Environment Foundation, 1996. Abstract in English.
6. Kellgren JH, Lawrence JS. Atlas of standard radiographs, vol 2: the epidemiology of chronic rheumatism. Oxford: Blackwells Scientific Publications, 1963.
7. Lawrence JS. Rheumatism in miners, part III: occupational factors. *Br J Ind Med* 1955;12:249–61.
8. Anderson J, Felson DT. Factors associated with osteoarthritis and the knee in the first national health and nutrition examination survey (HANES I). *Am J Epidemiol* 1988;128(1):179–89.
9. Von Nauwald G. Untersuchungen zur Häufigkeit professioneller kniegelenkerkrankungen bei älteren Rohrschlossern im Hochseeschiffbau. *Beitr Orthop Traumatol* 1986;33:124–8.
10. Jensen LK, Eenberg W. Occupation as a risk factor for knee disorders [review]. *Scand J Work Environ Health* 1996; 22:165–75.
11. Vingård E, Alfredsson L, Goldie I, Hogstedt C. Occupation and osteoarthritis of the hip and knee: a register-based cohort study. *Int J Epidemiol* 1991;20(4):1025–31.
12. Kohatsu ND, Schurman DJ. Risk factors for the development of osteoarthritis of the knee. *Clin Orthop* 1990;261:242–6.
13. Vingård E, Alfredsson L, Evy F, Christer H. Disability pensions due to musculo-skeletal disorders among men in heavy occupations: a case-control study. *Scand J Soc Med* 1992; 20:31–6.
14. Lindberg H, Montgomery F. Heavy labor and the occurrence of gonarthrosis. *Clin Orthop* 1987;214:235–6.
15. Felson DT, Naimark A, Anderson J, Kazis L, Castelli W, Meenan RF. The prevalence of knee osteoarthritis in the elderly: the Framingham Osteoarthritis Study. *Arthritis Rheum*

- 1987;30:914—8.
16. McAlindon TE, Snow S, Cooper C, Dieppe PA. Radiographic patterns of osteoarthritis of the knee joint in the community: the importance of the patellofemoral joint. *Ann Rheum Dis* 1992;51:844—9.
17. Jacobsen LTH. Definition of osteoarthritis in the knee and hand. *Ann Rheum Dis* 1996;55:556—8.
18. 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.

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