Association of overweight, trauma and workload with coxarthrosis

A health survey of 7,217 persons

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In a population sample health survey, body mass, previous trauma and physical stress were studied for associations with coxarthrosis. A sample of 8,000 persons representative of the Finnish population aged 30 or over was invited for examination, and 90 percent participated. On the basis of a standardized clinical examination, a physician diagnosed coxarthrosis in 6 percent of the women and 4 percent of the men. The prevalence rose with age. In persons with a past traumatic lower-limb injury, the odds ratio of unilateral coxarthrosis was 2.1 and of bilateral coxarthrosis 1.5, as adjusted for sex, age and other determinants using logistic regression. The sum index reflecting self-reported features of physical stress in present or previous occupations was directly proportional to the prevalence of coxarthrosis. Body mass index (kg/m^2) was closely associated with bilateral coxarthrosis; the adjusted odds ratio (95 percent confidence intervals) for indices > 35, compared to those < 25, was 2.8 (1.4–5.7). In terms of the population attributable fraction, prior trauma, physical stress and body mass were estimated to explain 59 percent of the prevalence of coxarthrosis.

The potential for primary prevention may be great, but longitudinal population studies are necessary to elucidate causal significance of the risk factors.

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Overweight, repetitive occupational load, and traumatic injuries are factors that strongly determine the risk of developing arthrosis in knee and hand joints (Felson 1988). Studies on the association of these factors with the occurrence of coxarthrosis have given conflicting results. There was a close association between relative weight and the prevalence of coxarthrosis in one study (Vingård 1991a), a slight association in two studies (Kraus et al. 1978, Hartz et al. 1986), and no association in one study (Saville and Dickson 1968). The prevalence of coxarthrosis appears to be increased among farmers (Typpö 1985, Thelin 1990, Croft et al. 1992) and in men doing heavy work (Vingård et al. 1991), but in one study this disease was reported to be equally distributed between occupational groups (Lindberg and Danielsson 1984). Although major injury is a principal cause of arthrosis in the knee, traumatic damage to the ligaments and cartilage of the hip is rare. The contribution of trauma to the incidence of coxarthrosis would therefore be expected to be small (Felson 1988).

A study of the risk determinants of unilateral and bilateral knee arthrosis separately from each other has proved useful (Davis et al. 1989). So far, such an approach has not been used in studies on determinants of coxarthrosis. We report the associations of overweight, previous injury and occupational physical stress with the prevalence of coxarthrosis in a sample representative of the Finnish adult population. Special emphasis was put on establishing whether unilateral and bilateral coxarthrosis are determined by the same or different factors.

Study population and methods

Population

The study population was a stratified 2-stage cluster sample drawn from the population register to represent Finnish adults aged 30 years or over (Aromaa et al. 1989). In the first stage, 40 representative areas were selected. In the second stage, a systematic sample of inhabitants was drawn from each area. The sample consisted of 8,000 persons (3,637 men and 4,363 women) from 69 municipalities.

Screening phase

The data were collected from 1977 to 1980. The examinations were carried out by the Mobile Clinic of the Social Insurance Institution in 2 phases: a screening phase and a diagnostic (clinical) phase. A total of 7,217 persons (90 percent of the sample) participated in the screening phase. The distributions of sex, age and level of education among the participants corresponded closely to those of the whole Finnish population (Aromaa et al. 1989).

The methods used for studying musculoskeletal diseases and the basic results have been described elsewhere (Sievers et al. 1985, Aromaa et al. 1989, Mäkelä et al. 1991). With the invitation to attend the Mobile Clinic, the subjects received a basic questionnaire inquiring about previous diseases, hospitalizations, operations, and medications. The health examination began with a review of the basic questionnaire by a nurse interviewer, who also performed a specific structured interview for the musculoskeletal system. The interview included the question: *During the past month, have you had difficulty in walking or have you had to limp due to a hip complaint or defect?* To screen for musculoskeletal impairment, a standard joint function test was carried out by specially trained nurses unaware of the interview results. The test included 10 items: walking on even ground; walking on tip-toes; walking upstairs; squatting; elevation of the arms; extension of the elbow joints; flexion of the elbow joints; volar flexion of the wrists; flexion of the fingers; and opponens movement of the thumbs. Information about all disability pensions due to musculoskeletal diseases was obtained from the registers of the Social Insurance Institution.

Diagnostic phase

The subjects with a disease history, symptoms or findings suggestive of musculoskeletal diseases were asked to participate in the diagnostic (clinical) phase, on the average, 3 1/2 months after the screening examination. There were 3,775 persons (52 percent of those examined) who met at least 1 of the screening criteria, and 3,434 (91 percent) participated. Physical examinations were carried out according to a standardized written protocol by specially trained physicians, applying uniform diagnostic criteria (Sievers et al. 1985, Mäkelä et al. 1991). Tenderness and mobility of the hip joints were tested regardless of the screening results calling for the examination. Physicians took medical histories, including the evolution of musculoskeletal symptoms and previous medical examinations and diagnoses. Physicians also investigated all documents (prescriptions, health records, radiographs and physician's certificates) that the subjects had been asked to bring along.

Immediately after the examination, the physicians made their final diagnoses on the basis of disease histories, documents, symptoms and clinical findings. Coxarthrosis was diagnosed if there was either a convincingly documented history or definite findings in the physical status of one or both hips. The physician was instructed to record this diagnosis, even in subjects with less definite abnormalities in the physical status or less convincingly documented disease histories, if the subject gave a typical symptom history of coxarthrosis.

Data on risk determinants

The basic questionnaire included the participants' present and previous occupations involving exposure to (a) lifting or carrying heavy objects, (b) stooped, twisted or otherwise awkward work posture, (c) vibration of the whole body or use of vibrating equipment, (d) a continuously repeated series of movements, and (e) working speed determined by a machine. An exposure was considered to be present if the subject reported it either in the last or the present occupation or in the previous occupation of longest duration (if not the last one). The total number of these factors was designated "the sum index of physical stress at work".

The basic questionnaire also inquired about permanent traumatic injuries and previous hospitalizations and operations. Reported hospitalizations or operations due to fracture, crush or distension in the region of the pelvis or a lower extremity or reported permanent lower-limb injuries were jointly designated "previous injuries to lower limb".

Standing height and weight were measured at the screening examination in light indoor clothing without shoes. Body mass index (weight/height^2, kg/m^2) was used as a measure of relative weight.

Statistics

The kappa statistics (Fleiss 1981) were used to estimate the reliability of dichotomous measurements, and the intraclass correlation coefficient R (Winer 1971) to estimate the reliability of measurements on interval scales. Systematic differences between prevalences were tested by McNemar's test (Fleiss 1981).

Differences in the prevalence of coxarthrosis between subgroups or between levels of suspected risk determinants were analyzed with a logistic regression model (Cox 1970). Relative risks were estimated as adjusted odds ratios. The 95 percent confidence intervals of odds ratios and the likelihood ratio statistics

Table 1. The population sample, participation in the screening and diagnostic examinations, and diagnoses of unilateral and bilateral coxarthrosis by sex and age

	Women						Men					
	30–44	45–54	55–64	65–74	75–	Total	30–44	45–54	55–64	65–74	75–	Total
Sample	1,452	883	821	760	447	4,363	1,447	840	659	490	201	3,637
Participated in screening examination	1,373	828	745	642	307	3,895	1,343	781	603	436	159	3,322
Screening positive for musculoskeletal diseases	479	485	528	455	251	2,198	417	396	387	267	110	1,577
Participated in diagnostic examination	454	449	492	413	208	2,016	379	359	351	239	93	1,421
Diagnosis of unilateral coxarthrosis	6	14	25	35	27	107	4	9	22	31	8	74
Diagnosis of bilateral coxarthrosis	4	9	34	40	38	125	0	6	18	21	18	63

(chi-square values expressed as *P*-values) were based on logistic models.

Adjusted prevalence rates of coxarthrosis were estimated using a general linear model (Searle 1971). The population-attributable fraction for previous traumatic injury, physical stress at work and body mass index was adjusted for age and sex according to Miettinen (1974).

Quality control

The quality of the data was controlled in 3 ways (Aromaa et al. 1989). A random sample of those who participated in the screening phase was invited to the diagnostic phase to find out how many disorders were missed by the screening procedure. The repeatability of the diagnostic decisions made by the physicians was assessed at an interval of 1 year with a set of 40 authentic subject documents, selected so as to have a high prevalence of musculoskeletal and other disorders. In addition, an intensive musculoskeletal examination of a sub-sample of the study subjects was performed about 1 year after the diagnostic phase to investigate the consistency of the diagnoses over time. The sample of this examination (302 subjects) included mostly persons with at least 1 musculoskeletal disorder in the diagnostic phase. In the intensive examination, radiographs of the hip joints were taken from all subjects with a disease history, symptoms or physical status suggestive of coxarthrosis.

A diagnosis of coxarthrosis was made in 39 of the 740 subjects examined to validate the screening procedure. All of them were screening-positive, indicating complete sensitivity of the screening.

In the re-evaluation of the 40 subject documents, the diagnostic threshold was essentially unchanged after 1 year for all of the physicians. The kappa varied from 0.54 to 0.84 (crude agreement 88–95 percent), with an overall kappa of 0.76 (crude agreement 93 percent). Thus, the repeatability of the diagnostic criteria was good.

In the sub-sample of 302 subjects, the prevalence of coxarthrosis was 11 percent in the diagnostic phase and 8.0 percent in the intensive examination, including hip radiographs. The kappa for agreement between the 2 examinations was 0.44 (crude agreement 90 percent), and McNemar's test indicated no systematic difference (*P* 0.14).

As part of the diagnostic phase, random samples (n 339–1,327) of the subjects were re-examined to assess the reliability of background information. The intraclass correlation coefficient *R* for the sum index of physical stress at work was 0.66. Kappa for the repeatability of the most frequent impairments found by the joint function test (8 items with prevalences > 2.0 percent) ranged between 0.60 and 0.76 (crude agreement 95–99 percent).

Results

In the standardized clinical examination, coxarthrosis was diagnosed in 6.0 percent of the women and 4.1 percent of the men. The disease was bilateral in 54 percent of the women and in 46 percent of the men. The prevalence of coxarthrosis rose with age (Table 1).

Body mass index (kg/m^2) was directly proportional to the prevalence of bilateral coxarthrosis, and this association was independent of age, sex, previous injury and physical stress at work. Body mass was clearly less closely associated with the prevalence of unilateral coxarthrosis (Table 2).

8 percent of all participants had traumatic lower-limb injury, and they had an increased prevalence of

Table 2. Odds ratios, based on logistic regression, adjusted for all the factors listed in this table, for determinants of unilateral, bilateral and either type of coxarthrosis

		Unilateral coxarthrosis			Bilateral coxarthrosis			Either coxarthrosis		
Determinant	N	n	Odds ratio	95% CI[a]	n	Odds ratio	95% CI[a]	n	Odds ratio	95% CI[a]
Body mass index										
<25.0	3305	57	1.0		55	1.0		112	1.0	
25.0–29.9	2815	84	1.5	1.1–2.2	73	1.4	1.0–2.0	157	1.5	1.1–1.9
30.0–34.9	909	35	1.6	1.0–2.5	49	2.3	1.5–3.5	84	2.0	1.5–2.7
>35.0	188	5	1.2	0.5–3.0	11	2.8	1.4–5.7	16	2.0	1.1–3.5
P for trend			0.05			0.00001			0.000005	
Injury to lower limb										
No	6658	149	1.0		162	1.0		311	1.0	
Yes	559	32	2.1	1.4–3.1	26	1.5	0.9–2.3	58	1.9	1.4–2.6
P for heterogeneity			0.0003			0.08			0.0002	
Sum index of physical stress at work										
0	2497	39	1.0		32	1.0		71	1.0	
1	1455	30	1.1	0.7–1.8	32	1.4	0.8–2.3	62	1.2	0.9–1.8
2	1940	65	1.5	1.0–2.3	82	2.2	1.5–3.4	147	1.9	1.4–2.6
3	887	33	2.4	1.4–3.8	29	2.8	1.6–4.7	62	2.7	1.8–3.9
4–5	448	14	2.3	1.2–4.3	13	2.9	1.5–5.8	27	2.7	1.7–4.4
P for trend			0.0001			0.000008			<0.000001	
Sex										
Men	3322	74	1.0		63	1.0		137	1.0	
Women	3895	107	1.2	0.9–1.6	125	1.4	1.0–1.9	232	1.3	1.0–1.7
P for heterogeneity			0.36			0.04			0.02	
Age[b]	7217	181	1.7	1.6–1.8	188	2.0	1.8–2.1	369	1.9	1.8–2.0
P for trend			<0.000001			<0.000001			<0.000001	

[a]95 percent confidence interval.
[b]Continuous variable, odds ratio per ten years of age.

Table 3. Prevalence of coxarthrosis by number of determinants

Number of determinants[a]	Number of subjects examined	Number of subjects with coxarthrosis	Adjusted[b] prevalence (%)	Population attributable fraction (%)	
0	1215	18	2.9		
1	3057	129	4.4	18.6	
2	2701	182	6.0	30.8	58.5
3	244	40	15.4	9.1	

[a] Body mass index 25.0 kg/m^2 or more; sum index of physical stress at work 1 or more; history of lower-limb injury.
[b] Based on general linear model; adjusted for sex and age.

unilateral, but not bilateral, coxarthrosis, as adjusted for sex, age and other determinants.

There was a graded positive relationship between the sum index of physical stress at work and the prevalence of both unilateral and bilateral coxarthrosis. The adjusted odds ratio of coxarthrosis was almost 3-fold in those with 3 or more occupational stress features when compared with those who reported no stress features.

The interactions of sex, age, body mass index, previous injury and physical stress at work were analyzed by entering their first-degree interaction terms as explanatory variables into the logistic regression models. None of these terms was found to carry independent explanatory significance. That the influences of the 3 determinants under study were cumulative is seen in the graded relationship between their number and the prevalence of coxarthrosis (Table 3). The combined fraction of the prevalence of coxarthrosis attributable to prior traumatic injury, physical stress at work and body mass index > 25 kg/m^2 was estimated to be 59 percent.

Discussion

The most critical limitation of this study is its cross-sectional design. Although we assessed the occurrence of previous traumatic injuries and work-related physical stress retrospectively, and the body weight is likely to reflect earlier weight in long-term studies (Rissanen et al. 1988, Kuczmarski 1992), the temporal relation of these risk determinants to the development of coxarthrosis cannot be demonstrated.

The diagnosis of coxarthrosis in the present study was based on standardized clinical examinations carried out by specially trained physicians who applied fixed diagnostic criteria, taking into account medical histories, symptom histories and the physical status of the hip joints. A combination of symptoms and physical status has been reported to be rather sensitive, but not specific in detecting radiographic coxarthrosis. Moreover, radiographic changes, pain and restricted movement of the hip joint correlate only moderately with each other (Altman 1991). The review of previous medical documents, in addition to the self-reported disease history, was likely to improve the diagnostic accuracy in the clinical phase of our study. Nevertheless, this study focused on the prevalence of symptomatic hips. Our results may therefore differ from those of other studies that have based their diagnoses solely on radiographs.

A number of population-based radiographic prevalence surveys have been performed for coxarthrosis, but the samples have been small (Felson 1988). The prevalence rates differ markedly even between populations in industrialized countries, probably due to differences in sample selection or radiographic criteria. The prevalence in this study was about the average compared with the rates reported previously (Felson 1988). This is in line with our finding that there was no systematic difference in the diagnostic threshold between the diagnostic phase and the intensive examination making use of hip radiography.

Overweight adds to loads on weight-bearing joints. Its contribution to the development of coxarthrosis is therefore a logical assumption. Mechanisms other than mechanical wear-and-tear may also be involved, as besides the knee (Felson 1988, Davis et al. 1989) most of the frequently affected joints show an association between arthrosis and overweight (van Saase et al. 1988). The relationship that we found between body mass index and the prevalence of coxarthrosis was independent of the other determinants and the association was closer for bilateral than for unilateral coxarthrosis. These findings suggest a causal connection. The question, however, remains whether overweight precedes the development of coxarthrosis or vice versa. Only 1 previous study deals with the temporal order of the events. In her retrospective case-control study, Vingård (1991a) found among persons with radiographic coxarthrosis a higher proportion of those reporting prior overweight at the ages of 20, 30, 40, and 50 years compared with controls. In contrast with the results of Vingård (1991a) and those of the present study, 2 other studies have revealed only a slight association between relative weight and coxarthrosis (Kraus et al. 1978, Hartz et al. 1986). One study (Saville and Dickson 1968) found no association at all. Thus, further studies are needed to assess the strength and consistency of the association between overweight and coxarthrosis.

Traumatic injuries can lead to the development of coxarthrosis, but the contribution of major injuries to the prevalence of coxarthrosis has not been assessed in population studies, and most of the current information is anecdotal or has been obtained from retrospective case studies (Wright 1990). Major injuries leading to ligament tears and cartilaginous damage are rare in the hip. Felson (1988) concluded that trauma could be linked to coxarthrosis only in the rare instance of fracture. Our results suggest that the proportion of coxarthrosis secondary to major injury may be substantial. There are, however, 2 possible kinds of bias with opposing effects. First, our study may overestimate the true impact of trauma, because persons with coxarthrosis may have recalled their disabling injuries better than the rest of the population. Secondly, our results may underestimate the contribution of trauma, because only those leading to either persistent disability or hospitalization were considered. Although the direction and extent of the overall bias remain obscure, it seems unlikely that such biases would concentrate on persons who have unilateral coxarthrosis. Our finding that a prior injury to the lower limb was closely associated with unilateral but not bilateral coxarthrosis suggests that coxarthrosis secondary to trauma may be more prevalent than has been previously assumed (Peyron 1979, Felson 1988).

The graded relationship that we found between physical stress and the prevalence of coxarthrosis is compatible with a causal-connection hypothesis. The associations with both unilateral and bilateral coxarthrosis were strong and not confounded by other determinants. The sum index we used relates mainly to previous exposure of long duration, as most subjects with coxarthrosis are in the later phases of or past their occupational career. Previous studies have given conflicting results, and their value, as in the present study, is limited by the cross-sectional or retrospective design. An increased prevalence of radiographic coxarthrosis has been observed among farmers compared

with other occupational groups (Typpö 1985, Thelin 1990, Croft et al. 1992). In a radiographic survey the prevalence of coxarthrosis was higher in Gotland than in Malmö. This was assumed by the authors to result from heavy labor in farming (Forsberg and Nilsson 1992). Lindberg and Danielsson (1984), however, reported no difference in the prevalence of coxarthrosis between shipyard laborers and white-collar workers. The majority of studies on sport activities as a risk determinant have failed to find any association between sports and the risk of coxarthrosis (Puranen et al. 1975, Panush and Brown 1987, Felson 1988). A recent Swedish case-control study, however, revealed an elevated risk of undergoing prosthetic surgery for coxarthrosis in men exposed to high physical loads (Vingård 1991b, Vingård et al. 1991). Thus, various physical loads, including occupational exposure to repetitive movements and minor injuries, may contribute to the development of coxarthrosis. This hypothesis remains to be tested in longitudinal epidemiologic studies in which the potential confounding factors are effectively controlled.

It has been claimed or assumed that a substantial proportion of coxarthrosis is caused by congenital dislocation, Perthes' disease or physiolysis (Harris 1977, Peyron 1979, Felson 1988). Our study suggests that external influences during adult life are more important.

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