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Coxarthrosis and physical work load

by Eva Vingård, MD,¹ Christer Hogstedt, MD,^{1,2} Lars Alfredsson, PhD,¹ Evy Fellenius, RN²
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VINGÅRD E, HOGSTEDT C, ALFREDSSON L, FELLENIUS E, GOLDIE I, KÖSTER M. Coxarthrosis and physical work load. *Scand J Work Environ Health* 1991;17:104-9. A case-referent study was performed on the possible relationship between physical work loads and an increased risk of developing coxarthrosis. The cases were 239 male recipients of a hip prosthesis as a result of severe idiopathic coxarthrosis; the referents were 302 men randomly selected from the general population. The work load was assessed through an interview and a self-administered questionnaire on the men's specific work periods. Men highly exposed to dynamic or static work loads had an increased relative risk of 2.42 (95 % confidence interval 1.45-4.04) for developing coxarthrosis when compared with men with low exposure. Men with high exposure to heavy lifting between the ages of 30 and 49 years had the highest relative risk, 3.31 (95 % confidence interval 1.97-5.57). Long-time exposure to physical work loads seems to be a risk factor for severe coxarthrosis among men.

Key terms: dynamic work load, hip, lifting, occupation, osteoarthritis, static work load.

Osteoarthritis is the most common articular disorder affecting man. It can be divided into an idiopathic (or primary) form, for which a specific etiology has not yet been found, and a secondary form in which the process starts in a joint as a sequence of anatomic abnormality, trauma, or developmental or congenital disease (1-5).

Investigations of coxarthrosis (ie, osteoarthritis of the hip joint) and occupational physical work load are rare. Only investigations concerning occupational groups, not individual assessments of physical work load, have been performed. Coxarthrosis has been found to be more common among farmers than among reference groups in studies from France (6), Sweden (7), and Finland (8). Lindberg and his co-workers (9) found a higher but not statistically significant excess of coxarthrosis when investigating the prevalence of coxarthrosis among blue-collar shipyard workers using a random sample of men from the general population in the same region as a reference group. In a cohort study from Sweden (10) different blue-collar occupations were classified as highly or lowly exposed to forces acting on the hip, and the frequencies of the outcomes were compared. Male farmers, construction workers, firefighters, and some food processing workers were shown to have an excess risk of hospitalization due to osteoarthritis of the hip.

Experimental studies on animals have shown that compression of a joint, especially in extreme positions, with or without oscillating and repetitive impulsive load, increases the osteoarthrotic changes in exposed joints (11-14). From these studies and epidemiologic investigations of some athletes (15-16), it is possible to suggest the following two major hypotheses concerning the contribution of physical load to the osteoarthrotic process: (i) dynamic forces from instant stress on the joint may result in microfractures of the cartilage and subchondral bone when the shock-absorbing capacity is exceeded and (ii) static compression hampers the movements of the joint and results in difficulties to eliminate metabolites and receive nourishment as the cartilage has neither blood vessels nor lymphatic drainage.

The objective of this case-referent study was to investigate whether long-term exposure to specific work postures and loads increases the risk of developing coxarthrosis.

Subjects and methods

Subjects

The study population comprised all Swedish men who were between the ages of 50 and 70 years and lived in the referral areas of four large hospitals in Stockholm. Information was collected from October 1984 to June 1988. The cases were those men in the study population who received a first-time prosthesis of the hip joint as a result of idiopathic osteoarthritis. The orthopedic clinics involved were contacted each week; they delivered the names and addresses of new patients. The referents were randomly selected from the study population on four different occasions during the study period. Men in both groups with malformations, sequelae

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Table 1. Distribution of the cases and referents by age, their educational background, and their smoking habits.

	Age group				Educational background ^a						Smoking habits			
	50–59 years		60–70 years		Elementary school		Secondary school		University		No information (%)	Non-smokers (%)	Ex-smokers (%)	Smokers (%)
	N	%	N	%	50–59 years (%)	60–70 years (%)	50–59 years (%)	60–70 years (%)	50–59 years (%)	60–70 years (%)				
Cases	53	21	194	79	38	45	48	45	14	10	1	36	36	27
Referents	75	23	247	77	34	38	50	47	16	15	—	34	38	28

^a Given by age group.

after poliomyelitis, rickets, or trauma to the trunk or lower extremities were excluded. Information regarding the occurrence of these disorders was obtained from the files of the hospital or through personal interviews.

An introductory letter was sent to all the subjects. A few days later they were contacted by telephone. Those interested in participating were interviewed about health status, smoking habits, education, sports activities, and occupational career. Information was also obtained about weight and height.

On the basis of information obtained in the telephone interview, each subjects' occupational career was divided into different periods with similar work tasks. For each such period the study participants were asked to complete a questionnaire about the specific physical work load in that type of work. The questionnaires were sent to the homes of the participants, and reminders followed after three, and then another two, weeks if the questionnaires were not returned.

The contacts with the hospitals, the telephone calls, and the interviews were performed by the same nurse during the entire investigation.

Men who undergo surgery and are on sick leave may recall exposure more thoroughly than men from the general population, many of whom are still working. To investigate this possible recall bias, we also interviewed patients who were treated for a first episode of myocardial infarction in the same hospitals as the coxarthrosis cases. The same procedures were used.

The case group consisted of 253 men. Five could not be reached by telephone, one did not want to participate, and 14 did not return their questionnaires but answered the questions in the telephone interview. Therefore 233 cases (92 %) participated in the whole study and 247 (98 %) in parts of the study. Thirty-eight percent had bilateral coxarthrosis.

The reference group consisted of 392 men. Thirty-eight could not be reached by telephone, 32 did not want to participate, and 20 did not return their questionnaires but answered the questions in the telephone interview. Therefore 302 referents (77 %) participated in the whole study and 322 (82 %) in parts of the study. The myocardial infarction group comprised 345 men. Five of them could not be reached by telephone, and five did not want to participate.

The age distribution, educational level, and smoking habits were very similar for the cases and the refer-

Table 2. Self-reported medically treated hypertension and diabetes among cases and referents in different age groups.

	Hypertension		Diabetes	
	50–59 years (%)	60–70 years (%)	50–59 years (%)	60–70 years (%)
Cases	19	16	3	8
Referents	7	21	2	4

ents (table 1). Treated hypertension was more common among the cases in the 50- to 59-year age group. Diabetes mellitus was equally distributed (table 2).

Exposure classification

In the questionnaires the study subjects were asked how many hours per week were spent in different work positions (eg, standing, sitting, walking, biking, and stair climbing); how many hours per week were spent driving a vehicle; how many hours per week were spent in a twisted position; and how many kilograms were lifted per week. Some other related questions were also asked.

Biomechanical investigations of hip-joint load have been performed under laboratory conditions but not in relation to specific job tasks. The available figures are shown in table 3. Everyday activities like sitting, walking without burdens, standing, and biking were classified as normal. Walking with burdens and stair climbing were classified as dynamic exposure, and working in a twisted locked position was classified as static exposure. These work tasks were quantified in hours per week.

The number of lifted kilograms, the number of times the person lifted heavy burdens (>40 kg), and the number of jumps between different levels are other ways of quantifying dynamic exposure. This information was analyzed separately.

Information regarding exposure was collected from the start of the occupational career to the year of the diagnosis for the cases and to the year of the interview for the referents. Exposure was then aggregated for the men's worklife up to 49 years of age. In an attempt to determine whether there were any differences between the loads affecting the joint in earlier versus later years, another aggregation into two periods was per-

Table 3. Biomechanic measurements of forces acting on the hip joint in different postures.

Reference	Position	Force
Frankel & Nordin (17)	Standing (relaxed with no muscular force)	0.33 · body weight
Inman (18)	Standing on one leg	2.4–2.6 · body weight
Rydell (19, 20)	Walking	1.6–3.3 · body weight
Paul (21)	Walking	2.3–5.8 · body weight
Seireg & Arvikar (22)	Walking	5.4 · body weight (maximum)
Crowninshield (23)	Walking	3.3–5.0 · body weight
Paul (21)	Fast walking	7.0 · body weight (maximum)
Crowninshield (23)	Stair climbing	5.0–7.0 · body weight
Németh (24)	Lifting 12.5 kg	2.6–3.2 · body weight
Ericsson (25)	Biking	Less than walking

Table 4. Ranges of the different work-load exposures during the different age periods.

Level of exposure	Static + dynamic (h)	Only static (h)	Only dynamic (h)	Lifted tons	Number of lifts of >40 kg	Number of jumps
Low						
≤29 years	0—999	0—480	0—719	0—74	0—999	0—840
30–49 years	0—1 238	0—576	0—999	0—66	0—750	0—450
≤49 years	0—1 499	0—1 174	0—1 151	0—137	0—1 187	0—1 019
Medium						
≤29 years	1 000—9 674	481—4 311	720—6 999	75—1 699	1 000—16 463	841—3 999
30–49 years	1 239—10 264	577—6 067	1 000—7 294	67—1 247	751—17 640	451—8 084
≤49 years	1 500—17 659	1 175—16 079	1 152—15 909	138—3 006	1 188—25 199	1 020—7 919
High						
≤29 years	9 675—49 788	4 312—32 220	7 000—34 425	1 700—45 546	16 464—480 000	4 000—16 920
30–49 years	10 265—50 880	6 068—49 776	7 295—36 965	1 248—60 000	17 641—772 800	8 085—25 200
≤49 years	17 660—95 868	16 080—76 032	15 910—59 880	3 007—94 003	25 200—930 600	7 920—38 880

formed. The two periods were ≤29 years of age and 30–49 years of age.

The men were classified by exposure to dynamic and static forces. Three exposure groups were defined on the basis of the loads in the reference group. Those unexposed and the 5 % less exposed were considered to have low exposure. The rest of the exposed group was divided into two equally large groups, classified as the medium-exposure group and the high-exposure group (table 4).

Information on potential confounding factors

In an evaluation of the extent to which the association between physical work load and coxarthrosis was influenced by other factors, a stratified analysis was performed. In this analysis, age was categorized into three groups (49–59, 60–64, and 65–70 years) and smoking habits into two groups (current smokers and nonsmokers).

The men's sports activities were well documented. The cases and referents reported how many hours they had performed different sports during different age periods. The exposure from sports activities was quantified as low, medium, and high for each sport activity and for the total amount of hours in sports in the same way as for exposure from work load. Sports activities were more common in the earlier years, and the analyses were stratified according to the total hours

of sports activities up to 29 years of age in the three different exposure classes of low, medium, and high. Body mass index was calculated for each person in the study, and the analysis was made with the subjects stratified into three groups, those with a low, normal, and high body mass index. The relationship between sports activities and coxarthrosis will be reported separately, as will the relationship between the body mass index and coxarthrosis.

Statistical methods

The incidence density ratios (relative risks) were estimated from the odds ratios. Potential confounding from age, body mass index, smoking habits, and sports activities were controlled through stratified analysis with the use of the method proposed by Mantel & Haenszel (26). Ninety-five percent confidence intervals were calculated for the relative risks by the test-based method (27).

Results

The relative risks of developing severe coxarthrosis associated with different work loads in different age periods are shown in tables 5 and 6. Men with high exposures until the age of 49 years had an adjusted relative risk of 2.42 [95% confidence interval (95 % CI) 1.45–4.04] for developing coxarthrosis in a compar-

ison with the men with low exposure. The corresponding relative risk for those with medium exposure was 1.82 (95 % CI 1.02–3.24). When the different exposure periods were compared, those exposed between 30–49 years of age had the highest relative risks. Dynamic exposure seems to give the highest pressure on the hip joint according to the biomechanical model. The total number of lifted tons during life might be a measurement of the dynamic pressure. The relative risk for those with high exposure up to the age of 49 years was 1.84 (95 % CI 1.12–3.03), and for those with medium exposure it was 1.58 (95 % CI 0.93–2.66). The subgroup with the highest dynamic load was probably that with frequent exposure to the lifting of burdens over 40 kg. The relative risk for the men with high exposure in the period between 30 and 49 years of age was 3.31 (95 % CI 1.97–5.57).

Discussion

Mechanical stress may contribute to the multifactorial etiology of coxarthrosis. This study demonstrated an increased risk of developing severe coxarthrosis for those with medium and high exposure to physical work loads.

Selection bias

The men with coxarthrosis in this study had undergone surgery and were still on sick leave, while many of the referents were working. Only one person in the case group did not want to collaborate. The corresponding number for the reference group was 32 (8 %). Lack of time was the most common explanation for refusal to participate. For those who did not return their questionnaires, the occupational history was known, and it did not differ substantially from those of the men participating in the whole study.

A selection bias might have occurred if persons in certain occupations had moved to another geographic area after receiving their diagnosis of coxarthrosis (eg, for better availability to surgery). All health care, including surgery, is free of charge in Sweden, and everyone living in a certain geographic area in Stockholm is referred to a specific hospital. There was only one private hospital in Stockholm performing hip prosthesis surgery during this period, and very few men used that expensive possibility.

Another selection bias could have appeared if men in heavy jobs received surgery earlier than men in sedentary jobs. In this study, the subjects were divided into three age groups. The relative risks were somewhat higher in the middle age group (60–64 years of age) and about the same in the youngest and oldest age groups. None of the three groups had an under-risk, which might have been expected in the oldest age group if the true relative risk is assumed to be equal to one. In a cohort study comparing blue-collar workers in heavy and sedentary jobs in Sweden (10), the

Table 5. Relative risk^a (RR) and 95 % confidence interval (95 % CI) for developing coxarthrosis from medium or high exposure before the age of 49 years as compared with low exposure of different types.

Exposure	Medium exposure		High exposure	
	RR	95 % CI	RR	95 % CI
Static + dynamic	1.82	1.02–3.24	2.42	1.45–4.04
Only static	1.21	0.64–2.31	2.92	1.69–5.05
Only dynamic	1.92	1.11–3.32	2.17	1.27–3.73
Lifted tons	1.58	0.93–2.66	1.84	1.12–3.03
Number of lifts (>40 kg)	1.38	0.81–2.36	2.40	1.50–3.83
Number of jumps	1.83	1.06–3.14	1.52	0.91–2.53

^a Relative risks adjusted for age, body mass index, smoking, and sports activities up to the age of 29 years.

Table 6. Relative risk^a (RR) and the 95 % confidence interval (95 % CI) for developing coxarthrosis from medium or high exposure of different types during the age period of ≤29 years and 30–49 years as compared with low exposure during the same age periods.

Exposure	Medium exposure		High exposure	
	RR	95 % CI	RR	95 % CI
Static + dynamic				
≤29 years	1.74	1.06–2.87	1.97	1.22–3.18
30–49 years	2.25	1.35–3.76	2.87	1.79–4.62
Only static				
≤29 years	1.91	1.06–3.44	2.29	1.38–3.81
30–49 years	1.13	0.68–1.86	2.12	1.32–3.41
Only dynamic				
≤29 years	2.09	1.27–3.48	1.83	1.09–3.06
30–49 years	1.50	0.90–2.49	2.36	1.46–3.82
Lifted tons				
≤29 years	1.73	1.06–2.83	1.95	1.23–3.09
30–49 years	1.63	0.98–2.73	2.74	1.70–4.43
Number of lifts (>40 kg)				
≤29 years	1.73	1.06–2.82	2.35	1.47–3.74
30–49 years	1.60	0.81–3.15	3.31	1.97–5.57
Number of jumps				
≤29 years	1.80	1.06–3.04	1.39	0.85–2.26
30–49 years	1.92	1.07–3.46	1.38	0.77–2.46

^a Relative risks adjusted for age, body mass index, smoking, and sports activities up to the age of 29 years.

relative risk for hospitalization due to coxarthrosis was more elevated for persons born in 1905–1924 (ie, most of them retired) than for those born in 1925–1945. These results contradict a job-selective indication for surgery in Sweden.

The potential selective forces were limited and probably did not cause any substantial underestimation or overestimation of the risks.

Misclassification

Only persons with coxarthrosis severe enough to warrant a hip prosthesis were included as cases in this study. Patients were excluded if any evidence of secondary osteoarthritis was gathered in the interview or medical records. The borderline between idiopathic and secondary coxarthrosis is diffuse, and a non-differential misclassification of diagnosis might have occurred.

The interviewing nurse normally had contact with all the participating wards at the four hospitals every week, and therefore it is assumed that there were extremely few missing cases of coxarthrosis.

Exposure information was obtained from self-administered questionnaires, specified for each period with similar work tasks, from the beginning of the occupational career to the day of the interview or diagnosis. Each participant completed one to eight forms. A differential bias could have been introduced if the cases had recalled exposures more thoroughly than the referents. However, the amount of time that elapses between the exposure and the recall is probably a more important indicator of the accuracy of recall. In this study similar exposure interviews were made for men who had had a first myocardial infarction and were supposed to recall exposure very thoroughly too. The differences in self-reported physical work load between the men with myocardial infarction and the men from the general population were very small. The relative risk of hospitalization due to a myocardial infarction for men with medium exposure of both dynamic and static character was 1.05 (95 % CI 0.69–1.60), and for those with high exposure it was 1.24 (95 % CI 0.82–1.87), when the comparison involved men with low exposure.

It is obviously very difficult to remember physical work loads with precision, especially many years after exposure. The information used in this study was the physical load until 49 years of age. Nondifferential misclassification due to memory deficiencies might have occurred that diminished the relative risk estimate towards unity in the high-exposure groups.

High exposure before the age of 30 years was associated with slightly lower risks than between 30–49 years of age. When the effect of high exposure between 30–49 years of age was analyzed, confounding from both high, medium, and low exposure before the age of 30 years was controlled for and vice versa. This procedure did not substantially change the relative risks. It seems biologically possible that at younger ages the hips could be better protected from bone and cartilage damage by strong muscles than later in life. Another explanation could be that nondifferential misclassification is more pronounced in the most distant time period.

Exposure from everyday activities like sitting, walking, standing, and biking was not considered as special exposure and was not analyzed. Sustained sitting or standing could be a static exposure, but, with our retrospective approach, it was impossible to divide between "normal" sitting and standing and more fixed static positions that could be harmful to the joint. Some persons, now classified as having low exposure, probably in this respect had medium or high static loads, and the impact on the relative risks depends on whether or not the misclassified persons belonged to the case or reference group.

Confounding factors

Age, body mass index, smoking habits, and sports activities were considered potential confounding factors and were controlled for in the analyses. No substantial confounding was indicated in any of the analyzed relationships. Present knowledge indicates that there is no reason to consider other factors for potential confounding.

Concluding remarks

Long-time exposure of men to both static and dynamic physical work loads seems to be a risk factor for clinically severe coxarthrosis.

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