Lifestyle factors and hip arthrosis

A case referent study of body mass index, smoking and hormone therapy in 503 Swedish women

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We investigated in a case-referent study the relationship between arthrosis of the hip in women and lifestyle factors such as body mass index (BMI), smoking and hormone therapy.

The study comprised all women of ages 50–70 years, living in 5 counties and 5 towns in Sweden 1991–1994. The cases (n 230) were women with total hip replacements (THR) because of primary arthrosis, and the referents (n 273) were randomly selected women from the study base, without hip problems. All women were interviewed about height, weight, smoking habits, hormone therapy, sports activities, occupational history, home work, etc, to the age of 50.

The relative risk of developing hip arthrosis leading to a THR after the age of 50 was associated with an increased BMI. The highest value, 2.9 (CI 1.3–6.5), was reported in those with BMI ≥ 25 at the age of 40. The preventive value of weight loss seems substantial. There was a greater risk of 1.5 (CI 1.0–2.2) for smokers than for non-smokers. Use of contraceptive pills meant an increase in the relative risk for THR, unlike estrogen substitution which was associated with a lower risk than in unexposed persons.

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Opinions differ as regards the association between hip or knee arthrosis and body weight (Kraus et al. 1978, Vingård 1991, Heliövaara et al. 1993, Tepper and Hochberg 1993), smoking (Felson et al. 1989, Hart and Spector 1993, Samanta et al. 1993) and hormone therapy (Hannan et al. 1990, Samanta et al. 1993). We investigated the relationship between body mass index, smoking, hormone therapy and hip arthrosis in women.

Subjects and methods

Study base

The study comprised all women of ages 50–70 years, living in 5 counties in western Sweden (Halland, Göteborg and Bohus, Älvsborg, Skaraborg and Värmland) and in the referral areas of 5 hospitals (Gävle, Linköping, Norrköping, Malmö and Huddinge) during the period 1991–1994. The relationship between physical workload and hip arthrosis was studied by case-referent methods.

Identification of cases

Sweden has a National Register of total hip replacements (THR). All orthopedic departments report to the Register. The database in the Register is validated in several different ways and annually aggregated data are fed back to the member clinics (Malchau et al. 1993). From the general database, several subsets of patients can be defined. One of them, used in this study, includes women with primary arthrosis of the hip from certain well-defined geographic regions in Sweden. Preoperatively all patients have been examined clinically and radiographically according to a well-defined protocol, and only patients with the diagnosis "primary arthrosis of the hip" are included (Malchau et al. 1996).

Referents were randomly selected from the study base by means of local population registers, matched for age (1-year interval), county or hospital referral area, respectively. Referents with known hip disorders were excluded.

Methods

All the women were contacted by letter and telephone and interviewed by the same experienced nurse about health status, height, weight at the age of 20, 30, 40, and 50, medication, especially hormones, present and earlier smoking habits, education, number of children in the family, occupational history, home work, and sports activities to the age of 50. For detailed informa-

tion about workload at home and at work, questionnaires were used. BMI values less than 20 were considered low and BMI values 25 or more as high. Those in-between were considered as medium. Smoking habits were divided into present or earlier smokers and non-smokers. Women who had used contraceptive pills more than 1 year before the age of 50 were considered as exposed. Estrogen substitution more than 1 year before or after the age of 50 was considered as exposure.

255 cases and 334 referents were included in the study. 3 cases and 14 controls refused to participate, 6 cases and 8 controls could not be reached by telephone and 4 cases and 14 controls were too ill to answer. 242 cases (95%) and 298 controls (89%) agreed to participate. 12 of the cases and 25 of the controls never returned their questionnaires on workload at their job and at home. Finally, the investigated group consisted of 230 women (90% participation rate) with a hip replacement and 273 women (82% participation rate) without hip problems. 26% of the women had a left-sided, 35% had a right-sided and 39% had a bilateral hip arthrosis. The mean time-lapse between the first symptom and diagnosis was 5 (0–24) years, the mean time between the first visit to a doctor and diagnosis was 2 (0–14) years and the mean time between diagnosis and operation 6 (0–18) years.

Statistics

The relationships between BMI at different ages, smoking, hormone therapy and hip arthrosis were estimated by calculating the odds ratio for highly exposed and medium-exposed, respectively, compared to the low or non-exposed. The odds ratio was interpreted as an estimate of the incidence rate ratio (RR) since the design was that of a population-based case-referent study (Miettinen 1976). The influence on RRs from potential confounding factors was considered by means of stratified analysis. Adjusted estimates of relative risk were calculated according to Mantel and Haenszel (1959), together with 95% confidence intervals, according to the method proposed by Greenland and Robins (1985b). In all analyses, confounding due to age, geographical area, number of children, total hours of sports activities and physical load at work to the age of 50 (high, medium or low for both load variables) was considered. When the effect of BMI was analyzed, smoking and hormone therapy were also considered as potential confounders. When smoking was analyzed, BMI at the age of 40 and hormone therapy were analyzed as confounders and when hormone therapy was analyzed, BMI at the age of 40 and smoking were adjusted for.

Table 1. Relative risk with 95% confidence intervals of women with medium and high BMI to developing severe hip arthrosis compared to women with low BMI at different ages

Age	RR	Exposed cases (%)
Medium BMI		
30	1.7 (1.0–3.1)	52
40	2.3 (1.1–4.9)	54
50	1.2 (0.5–2.8)	43
High BMI		
30	2.1 (1.1–4.1)	23
40	2.9 (1.3–6.5)	33
50	2.1 (0.9–4.6)	48

RR adjusted for age, number of children, sports activities, occupational workload, smoking and hormone therapy

Results

The relative risks of developing hip arthrosis were higher for those with medium (21–24) and high (≥ 25) BMI than for those with low BMI (≤ 20) (Table 1).

Smoking was commoner among the cases (Table 2). The cases had smoked a mean of 12 years and 8 cigarettes/day before the age of 50 compared to 10 years and 6 cigarettes/day for the referents. Heavy smokers were commoner among the cases. The relative risk for smokers and ex-smokers compared to never-smokers developing hip arthrosis was 1.5 (CI 1.0–2.1).

The use of contraceptive pills was somewhat more commoner among the women with THR than in referents and the opposite was true for estrogen use (Table 2). The relative risk of hip arthrosis in women who had taken contraceptives 1 year or more before the

Table 2. Smoking habits and the use of hormones among cases and referents in percent

	Smoking habits before 50		Use of hormones		
	Smokers > 1 yr	Never smokers	Contraceptives before 50	Estrogen before 50	Estrogen after 50
Cases	52	48	35	15	33
Referents	44	56	26	16	42

age of 50 was 1.6 (CI 1.0–2.3). There was no change in relative risk when the calculation included those who had taken contraceptive pills for 5 years or more. In those who had used estrogen therapy 1 year or more before and after the age of 50, the relative risk of THR was 0.7 (CI 0.5–1.0).

Discussion

Our observations indicate an association between high BMI earlier in life and hip arthrosis among women. When comparing BMI earlier in life, the association is clear and the relationship is biologically plausible. In cross-sectional studies, it is not clear if the overweight causes the arthrosis or the arthrosis causes the overweight, due to inactivity. However, BMI at different ages is not an independent factor and most of the women who were overweight early in life were still overweight later on. When analyzing the relative risks for women overweight at the age of 30, 40, and 50 compared to those underweight on all these occasions, the relative risk was 3.0 with a 95% confidence interval of 1.4–6.7.

In earlier studies on overweight and arthrosis of the hip, the outcome is somewhat differently measured and the definitions of increased BMI also vary widely. In the USA, one study with self-reported data on BMI at the age of 40 showed a slight increase in the risk of severe arthrosis of the hip later in life (Kraus et al. 1978). A case control study from Sweden on self-reported data on BMI at age 20, 30, 40, and 50 for men reported a moderate increase in relative risk of developing severe arthrosis of the hip for slightly overweight men compared to slightly underweight ones (Vingård 1991). In a prospective cohort study from Finland, BMI > 35 was closely associated with bilateral arthrosis of the hip compared to BMI < 25 (RR 2.8 CI 1.4–5.7) (Heliövaara et al. 1993). In the cross-sectional NHANES study from the USA, no association was found between increased BMI and arthrosis of the hip (Tepper and Hochberg 1993).

Smoking meant a tendency towards an increased relative risk for hip arthrosis among smokers and ex-smokers, compared to non-smokers. Both in the NHANES-1 and the Framingham studies (Felson et al. 1989), smoking or a factor associated with smoking had a modestly protective effect against arthrosis of the knee. The effect persisted even after adjustments in the analysis for age, sex, weight, knee injury, sports activities, occupational load, as well as coffee and alcohol consumption. In a study from the U.K., there was a similar negative association between nonnodal large joint arthrosis and smoking (Samanta et al. 1993). However, the Chingford population study on women does not support an inverse association between cigarette smoking and arthrosis in the hand and knee (Hart and Spector 1993).

Hormone therapy showed a special pattern, with a slightly increased risk for use of contraceptive pills, but a decreased risk for estrogen substitution. The effects are very moderate. Samanta and coworkers (1993) found no effect of hormone therapy and arthrosis. From the Framingham study, however, conclusions were drawn that estrogen use in women is associated with a slight insignificant protective effect against arthrosis of the knee (Hannan et al. 1990).

Cases of THR due to primary arthrosis of the hip were identified through the National Register of THR managed by one of the authors (HM). The reporting rate to the register is good, according to validation studies performed continuously. In spite of this, some cases might not have been reported to the register. However, it is not very likely that such missed cases were related to exposure status. As regards diagnosis, all patients have undergone a special investigation and then been classified as primary arthrosis. Thus, potential misclassification of diagnosis is probably non-differential with regard to exposure status.

Women with a substantial overweight or heavy smokers may have been excluded for THR because of risks during surgery. This introduces an underestimation of the reported relative risks. A less likely possibility is that overweight women are more often referred to doctors and then surgery. In this case, there will be an overestimate of the risk. A study including not only women who have had hip surgery but also less severe cases of hip arthrosis should be interesting. However, the problems of finding all cases in such a study will be substantial and will introduce another bias.

The participation rate was high among cases and controls. As expected, the rate was higher in the group of women with total hip replacement. However, 89% of the controls were interviewed and 82% participated in the whole investigation. The information obtained by interview about BMI, smoking and hormone therapy in the 8% who did not return their questionnaires on occupational workload did not differ substantially from those who did. In the analysis, only women with a complete investigation including both interview and questionnaires, were used. A small number declined to participate, could not be reached by telephone or were too ill to answer (5% among the cases and 11% among the controls). Lifestyle factors among such refusals could of course differ from those participants in both directions and thus influence the relative risk estimates in different ways. As the number of non-re-

sponders was relatively small, the impact on the results is considered limited.

In epidemiological research, continuous longitudinal data on exposure is much in demand but very difficult to obtain, especially in a disorder like arthrosis with probably a long onset period. In such cases, exposure assessments and changes in exposure years previously can be of interest both for causation and for understanding modifying effects of the disorder under study and its severity and consequences (Greenland and Robins 1985a). Therefore in most epidemiological studies we have to rely on retrospective exposure assessments collected by questionnaires or interviews. To remember exposures and events long ago is hard. The validity and reliability of the data collected depend on the accuracy of the study design and the quality of the questionnaires and questions used. A certain misclassification probably always exists.

Most of the women in this study have gained weight during life, especially in connection with the menopause. Both women with THR and the referents may underestimate their weight earlier in life. The ideal of beauty during many decades has been a slim figure and women may idealize their appearance in earlier days. This will introduce a non-differential misclassification. If a person has smoked or taken contraceptives or estrogen substitution or not is probably easier to remember correctly. Cigarettes smoked or number of years on hormone therapy are more like to cause bias and are not used in the calculations.

A differential misclassification of exposure can occur if the cases and the referents recall their exposure differently. Whether a differential misclassification has occurred is a complicated question and in most cases impossible to answer. The association of BMI and hip arthrosis shows a dose-response relationship which would have been less likely with a strong differential misclassification.

If the association between high BMI and hip arthrosis in women observed in this study is causal, the etiological fraction can be calculated (Olsen et al. 1994). The etiological or attributable fraction for a certain exposure is the proportion of cases that could have been avoided if the subjects had not been exposed. The etiological fraction can be seen as a measure of the maximal preventive potential. The calculated etiological fraction (Table 3) is more than 60% for women with BMI > 25 at the age of 40. Thus the preventive potential by weight reduction seems considerable.

Table 3. Calculated "etiological fraction (EF)" for hip arthrosis among women in the case group with a high BMI at the age of 40 as well as for the whole case group

BMI at the age of 40	Number of cases	RR	EF for cases with high BMI	EF for all cases
Low	30	1.0		
Medium	124	2.3	57%	30%
High	76	2.9	66%	31%

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