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(Accepted 19 October 1993)

Osteoarthritis of weight bearing joints of lower limbs in former élite male athletes

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Abstract

***Objective*—To compare the cumulative 21 year incidence of admission to hospital for osteoarthritis of the hip, knee, and ankle in former élite athletes and control subjects.**

***Design*—National population based study.**

***Setting*—Finland.**

***Subjects*—2049 male athletes who had represented Finland in international events during 1920-65 and 1403 controls who had been classified healthy at the age of 20.**

***Main outcome measures*—Hospital admissions for osteoarthritis of the hip, knee, and ankle joints identified from the national hospital discharge registry between 1970 and 1990.**

***Results*—Athletes doing endurance sports, mixed sports, and power sports all had higher incidences of admission to hospital for osteoarthritis than controls. Age adjusted odds ratios compared with controls were 1·73 (95% confidence interval 0·99 to 3·01, P=0·063) in endurance, 1·90 (1·24 to 2·92, P=0·003) in mixed sports athletes, and 2·17 (1·41 to 3·32, P=0·0003) in power sports athletes. The mean age at first admission to hospital was higher in endurance athletes (70·6) than in other groups (58·2 in mixed sports, 61·9 in power sports, and 61·2 in controls). Among the 2046 respondents to a questionnaire in 1985, the odds ratios for admission to hospital were similar in all three groups after adjusting for age, occupation, and body mass index at 20 (2·37, 2·42, 2·68).**

***Conclusions*—Athletes from all types of competitive sports are at slightly increased risk of requiring hospital care because of osteoarthritis of the hip, knee, or ankle. Mixed sports and power sports lead to increased admissions for premature osteoarthritis, but in endurance athletes the admissions are at an older age.**

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BMJ 1994;308:231-4

Introduction

Because osteoarthritis is a common and often debilitating joint disorder knowledge about predisposing factors is important. An association between obesity and osteoarthritis of the knee has been shown,[1 2] but data on the association with osteoarthritis of the hip are inconclusive.[3] Strenuous occupational physical loading is associated with osteoarthritis of the hip,[3 4] and participation in sports may also influence the risks of developing osteoarthritis. Klünder *et al* and Lindberg *et al* found that osteoarthritis of the hips was more common in former soccer players than in controls.[5 6] Vingård *et al* found that men who did lots of sport of any kind had an increased risk of developing osteoarthritis of the hip.[7] There is no general agreement on whether running can predispose to primary osteoarthritis of the hip.[8-12]

We conducted a national population based study to

TABLE I—*Number of subjects at entry to study and numbers still alive on 1 January 1970 and 31 December 1990*

Sports	No of subjects at entry	No of subjects in 1970	Mean age (range) in 1970	No of subjects in 1990
Endurance sports:	342	281	50·5 (27-82)	189
Long distance running	199	163	49·4 (27-82)	110
Cross country skiing	143	118	52·1 (32-79)	79
Mixed sports:	1160	998	43·7 (21-80)	760
Soccer	313	252	45·4 (23-76)	178
Ice hockey	179	163	39·6 (23-76)	141
Basketball	95	85	35·0 (21-57)	78
Track and field*	573	498	45·6 (24-80)	363
Power sports:	946	770	47·0 (23-85)	488
Boxing	302	234	46·3 (23-72)	154
Wrestling	326	256	48·7 (25-85)	150
Weight lifting	124	113	44·6 (24-75)	78
Throwing	194	167	46·8 (26-80)	106
All sports	2448	2049	45·9 (21-85)	1437
Controls	1712	1403	44·1 (24-86)	959

*Jumping (n=201), sprinting (n=132), hurdling (n=91), middle distance running (n=95), and decathlon (n=54).

compare the cumulative 21 year incidence of admissions to hospital for osteoarthritis of the hip, knee, and ankle in former élite male athletes with that in subjects who represent the healthy male population at the age of 20.

Subjects and methods

We identified 2448 male athletes who had represented Finland in selected sports at least once in the Olympic games, World, or European championships, or intercountry competitions during 1920-65 (table I).[13] Control subjects were selected for the first 85% of athletes traced.[13] Controls were selected from Finnish men who at the age of 20 were classified as completely healthy (class AI, fully fit for ordinary military service) at the medical examination for induction into compulsory military service. The controls were selected from the public archives of the register of men liable for military service and matched for age and area of residence with athletes. The original cohort comprised 2401 athletes and 1712 controls. Ice hockey players, basketball players, and weight lifters were included in the study group after the control sample had been chosen and so no controls were chosen for them.

All Finnish citizens are assigned a personal identification (social security) code. We used the code to perform accurate computerised record linkage to other registers. Data on profession, marital status, and survival were collected from the central population registry. Table I shows the number of subjects who were still alive in January 1970 and December 1990. The life expectancy of the athletes, especially that of endurance athletes, was previously found to be higher than that of controls.[13]

TABLE II—*International Classification of Diseases codes used to define the diagnostic categories of osteoarthritis of the weight bearing joints of the lower limbs*

Joint	ICD 8 (1970-1985)	ICD 9 (1986-1990)
Hip	713,00	7151E 7152E
Knee	713,01	7151F 7152F
Ankle (talocrural)	713,02	7151G 7152G

We grouped the athletes according to the type of sports training. Endurance sports are those that require a high amount of repetitive loading of the weight bearing joints, mixed sports include those with a greater risk of high impact loads and sprains of the joints, and power sports include sports producing less repetitions but higher forces when loading the joints (table I). The mean ages of athletes varied between groups. Skiers were oldest and ice hockey and basketball players youngest (table I).

The hospital discharge reports of all hospitals including private hospitals (recorded in a nationwide register kept by the National Board of Health) were searched from the beginning of 1970. Table II shows the ICD codes used to form the diagnostic categories of osteoarthritis of the hip, knee, and ankle. The agreement between hospital discharge records and the written patient history for musculoskeletal diagnoses has been reported to be 96·4%.[14] We used primary diagnoses to exclude subjects in whom osteoarthritis was not the main reason for the admission to hospital. All subjects who had lower limb joint infection or rheumatoid arthritis diagnosed in hospital were excluded.

In 1985 we posted a questionnaire to surviving former athletes and controls (n=2528, 60·8% of the original cohort). The items of the questionnaire included data on height and weight at the age of 20, current weight, physical activity, and discontinuation of sporting career. The response rate was 77% (777/1010) for controls and 84% (1282/1518) for athletes. On the basis of the questionnaire the subjects' body mass index at the age of 20 (weight (kg)/(height (m))^2) was classified as <26, 26 to 28, or ≥ 28.

Occupational data were collected partly from the central population registry and partly from the 1985 questionnaire study. Occupational groups were classified into the following main categories: executives, clerical workers, skilled workers, unskilled workers, and farmers (missing data 5·8% (199)).[15] The occupation of each person was classified according to the one in which he had been longest.

STATISTICAL ANALYSES

Analysis of survival data was based on Cox's proportional hazards model.[16] By analogy with the logistic model, the hazard ratios estimated by Cox model are termed here odds ratios.[16] Confidence intervals were calculated on the basis of normal distribution. Age, body mass index, and occupational group were included

TABLE III—*Crude cumulative incidence of admissions to hospital for osteoarthritis of the weight bearing joints of the lower limbs during 1 January 1970 to 31 December 1990 according to type of sport*

Sports	Hip No (%)	Hip 95% Confidence interval	Knee No (%)	Knee 95% Confidence interval	Ankle No (%)	Ankle 95% Confidence interval	Hip, knee, or ankle No (%)	Hip, knee, or ankle 95% Confidence interval
Endurance sports	15 (5·3)	3·0 to 8·7	7 (2·5)	1·0 to 5·1	0		19 (6·8)	4·1 to 10·4
Long distance running	9 (5·2)	2·6 to 10·2	4 (2·5)	0·7 to 6·3	0		11 (6·9)	3·5 to 12·0
Cross country skiing	6 (5·1)	1·9 to 10·7	3 (2·5)	0·5 to 7·2	0		8 (6·8)	3·0 to 12·9
Mixed sports	25 (2·5)	1·6 to 3·7	19 (1·9)	1·2 to 3·0	6 (0·6)	0·3 to 1·3	50 (5·0)	3·7 to 6·6
Soccer	8 (3·2)	1·4 to 6·2	5 (2·0)	0·7 to 4·6	2 (0·8)	0·1 to 2·8	15 (6·0)	3·4 to 9·6
Ice hockey	7 (4·3)	1·7 to 8·7	3 (1·8)	0·4 to 5·3	3 (1·8)	0·4 to 5·3	13 (8·0)	4·3 to 13·3
Basketball	0		1 (1·2)	0·0 to 6·4	0		1 (1·2)	0·0 to 6·4
Track and field*	10 (2·0)	1·0 to 3·6	10 (2·0)	1·0 to 3·6	1 (0·2)	0·0 to 1·1	21 (4·2)	2·6 to 6·4
Power sports	27 (3·5)	2·3 to 5·0	24 (3·0)	2·0 to 4·6	3 (0·4)	0·1 to 1·1	51 (6·6)	5·0 to 8·6
Boxing	7 (3·0)	1·2 to 6·1	4 (1·7)	0·5 to 4·3	1 (0·4)	0·0 to 2·4	12 (5·1)	2·7 to 8·8
Wrestling	12 (4·7)	2·5 to 8·1	12 (4·7)	2·5 to 8·1	0		23 (9·0)	5·8 to 13·2
Weight lifting	4 (3·5)	1·0 to 8·8	3 (2·7)	0·6 to 7·6	1 (0·9)	0·0 to 4·8	8 (7·1)	3·1 to 13·5
Throwing	4 (2·4)	0·7 to 6·0	5 (3·0)	1·0 to 6·9	1 (0·6)	0·0 to 3·3	8 (4·8)	2·0 to 9·2
All sports	67 (3·3)	2·6 to 4·1	50 (2·4)	1·8 to 3·2	9 (0·4)	0·2 to 0·8	120 (5·9)	4·9 to 7·0
Controls	20 (1·4)	0·9 to 2·2	18 (1·3)	0·8 to 2·0	0		36 (2·6)	1·8 to 3·5

*See table I for details.

as confounders in the Cox model by using the program BMDP 2L. To control the effect of exposure years, those who died during the follow up period were put into the "lost" category in the model. The event was based on the first recorded episode of lower limb osteoarthritis. The differences in the number of days in hospital between groups were tested with the Mann-Whitney U test.

Results

In all, 120 (5·9%, 95% confidence interval 4·9% to 7·0%) athletes and 36 (2·6%, 1·8% to 3·5%) controls were admitted to hospital for osteoarthritis of the hip, knee, or ankle during the 21 year follow up period ($P<0·0001$) (table III). Admissions for osteoarthritis of the hip (athletes 3·3% *v* controls 1·4%) and knee (2·4% *v* 1·3%) were more common than for osteoarthritis of the ankle (0·4% *v* 0·0%) (table III). Endurance athletes, mixed sports athletes, and power sports athletes all had a higher incidence of osteoarthritis than controls (table III, figure). The mean age at admission for osteoarthritis was higher in endurance athletes than in other groups. In Cox regression analysis the age adjusted odds ratios for admissions to hospital for osteoarthritis of the hip, knee, or ankle compared with controls were 1·73 (95% confidence interval 0·99 to 3·01, $P=0·063$) in endurance sports athletes, 1·90 (1·24 to 2·92, $P=0·0030$) in mixed sports athletes, and 2·17 (1·41 to 3·32, $P=0·0003$) in power sports athletes (table IV). The odds ratios adjusted for age and occupational group were 1·71 for endurance athletes, 1·83 for mixed sports athletes, and 2·13 for power sports athletes.

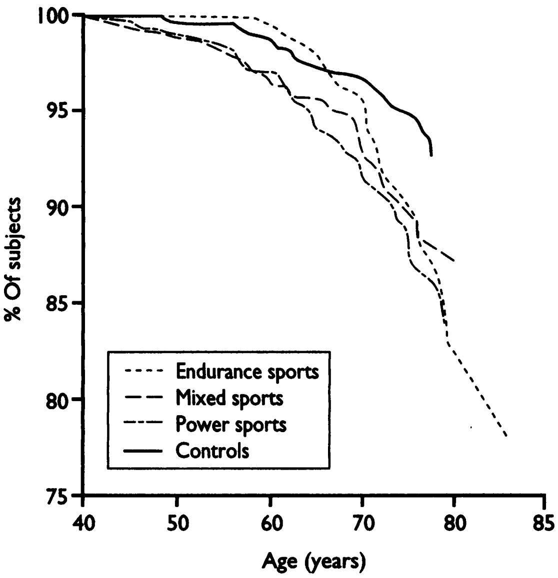
TABLE IV—*Age adjusted odds ratio for admissions to hospital for osteoarthritis of the hip, knee, or ankle during 1 January 1970 to 31 December 1990 among former élite athletes compared with controls and mean (SD) age at first admission*

Sport	Odds ratio	95% Confidence interval	Mean (SD) age at first admission
Endurance sports	1·73	0·99 to 3·01	70·6 (7·4)
Long distance running	1·84	0·93 to 3·61	70·3 (6·9)
Cross country skiing	1·58	0·74 to 3·41	70·9 (8·5)
Mixed sports	1·90	1·24 to 2·92	58·2 (12·1)
Soccer	2·10	1·15 to 3·84	56·2 (9·8)
Ice hockey	4·23	2·24 to 7·99	53·3 (12·0)
Basketball	1·04	0·14 to 8·41	26·0
Track and field*	1·39	0·81 to 2·38	63·8 (10·2)
Power sports	2·17	1·41 to 3·32	61·9 (10·0)
Boxing	1·70	0·89 to 3·28	61·5 (10·2)
Wrestling	2·75	1·63 to 4·64	64·0 (10·0)
Weight lifting	2·74	1·27 to 5·86	57·3 (10·7)
Throwing	1·53	0·71 to 3·29	60·9 (8·8)
All sports	1·97	1·36 to 2·87	61·7 (10·6)
Controls	1·0	—	61·2 (9·6)

*See table I for details.

TABLE V—*Adjusted odds ratio for admission to hospital for osteoarthritis of the hip, knee, or ankle in 2046 subjects who completed 1985 questionnaire*

Sport	Adjusted for age	Adjusted for age and: Occupational group	Body mass index at age of 20	Occupational group and body mass index
Endurance:				
Odds ratio	2·25	2·38	2·49	2·42
95% Confidence interval	1·18 to 4·27	1·23 to 4·60	1·20 to 4·35	1·26 to 4·68
P value	0·016	0·012	0·014	0·011
Mixed sports:				
Odds ratio	2·20	2·35	2·19	2·37
95% Confidence interval	1·27 to 3·67	1·32 to 4·17	1·29 to 3·72	1·32 to 4·24
P value	0·0045	0·0040	0·003	0·0029
Power sports:				
Odds ratio	2·54	2·75	2·48	2·68
95% Confidence interval	1·48 to 4·53	1·56 to 4·85	1·45 to 4·27	1·51 to 4·75
P value	0·0007	0·0003	0·0008	0·0005
All sports:				
Odds ratio	2·31	2·50	2·31	2·50
95% Confidence interval	1·44 to 3·72	1·51 to 4·17	1·44 to 3·72	1·50 to 4·15
P value	0·0002	0·0001	0·0002	0·0001
Controls (odds ratio)	1·0	1·0	1·0	1·0



Kaplan-Meier estimates of the proportion of subjects alive and not admitted to hospital for osteoarthritis of the hip, knee, or ankle by age

Among subjects who replied to the 1985 questionnaire, when the body mass index was also adjusted for all three groups had similar odds ratios (table V). In the Cox model adjusted for age and body mass index, the occupational group did not explain the risk for osteoarthritis, but subjects with a body mass index above 28 at the age of 20 ($n=28$) had a 2·12-fold increased risk (0·52 to 8·73, $P=0·35$) compared with subjects with body mass index less than 26. Subjects with a body mass index above 30 in 1985 had a 2·41-fold increased risk (1·33 to 4·36, $P=0·0043$) compared with subjects with a body mass index less than 26.

The median total number of days in hospital was 11 (range 2-40) in controls, 17 (3-45; $P=0·052$ compared with controls) in endurance sports athletes, 15 (3-55; $P=0·132$) in mixed sports athletes, and 16 (2-105; $P=0·020$) in power sports athletes.

Discussion

Control subjects were free of any disease or injury at the time of their compulsory military service and were at least as healthy as the athletes. Not all the athletes were free of disease or injury, but they can be regarded as free from osteoarthritis at the time when they were representing Finland in sports needing extremely good lower limb function. Nevertheless the selection of controls in our study has some limitations and our results cannot be generalised widely. The age distribution differed in the athletic groups and controls (table I), and there were no control subjects for the ice hockey players, basketball players, or weight lifters. As the ice hockey and basketball players had lower mean age in 1970 and a much higher proportion of them were alive in 1990, the comparisons with the control group for these athletes may be biased. Osteoarthritic changes are common in people over 65 years of age. Hospital discharge information underestimates the true incidence of osteoarthritis in the population, a limitation which also must be recognised in our study. Our study records only the most severe cases needing hospital treatment.

All three types of sports were associated with an increased risk of osteoarthritis, but lower body mass index in endurance athletes may have prevented them from getting osteoarthritis at an early age. The higher than average life expectancy and physically active lifestyle in endurance athletes may explain some of the admissions to hospital at very old age. In earlier studies of long distance running and osteoarthritis, the numbers of subjects have been small and varying

Clinical implications

- Participation in sports and exercise is common and helps prevent cardiovascular diseases
- Participation in sports may predispose to premature osteoarthritis
- This study shows that international athletes from endurance, mixed and power sports have increased need for hospital treatments for osteoarthritis of the hip, knee, and ankle
- In endurance athletes hospital admission occurs first in old age, but mixed sports athletes and power sports athletes also have increased incidence of premature osteoarthritis
- Proper treatment of injuries to the joints in these athletic groups is important to prevent premature osteoarthritis

methods have been used to collect the control group.[8-12] Marti *et al*[9] concluded that long term, high intensity, high milage running should not be dismissed as a potential risk factor for premature osteoarthritis of the hip, and our results support such a risk from competitive sports.

Soccer players have a high incidence of meniscal and ligamentous injuries to the knees.[17] Both meniscal and ligamentous injuries have been shown to be followed by osteoarthritic changes of the knees.[18 19] We also recorded the cumulative incidence of admission to hospital for meniscal injuries (ICD 8, code 724.10) and knee sprains (ICD 8, code 844.00) during 1970-85. Both meniscal injuries and knee sprains were more common in athletes than controls (3·8% *v* 2·0% and 1·1% *v* 0·3%, respectively). The numbers of meniscal injuries and knee sprains were highest in mixed sports (4·6% and 1·4%). Some cases of osteoarthritis of the hip may be prevented by preservative treatment of meniscal injuries and reconstructive treatment of instabilities of knee ligaments.[20 21] Heavy weight training and high body mass in power sports athletes may cause excessive loading of the weight bearing joints of the lower limbs.

Because obesity and occupational loading may predispose to osteoarthritis,[1-3] we controlled for body mass index and occupational group in the Cox model. High body mass index at the age of 20 and in 1985 were associated with increased incidence of osteoarthritis. The higher incidence of severe osteoarthritis in former athletes could not be explained by occupation. A higher proportion of the athletes were in executive or clerical occupations compared with controls.

Recording life time physical activity exactly is difficult, but former international athletes comprise a valid cohort of people with high physical activity. Data from the 1985 questionnaire study showed that over 60% of athletes engaged in regular leisure time physical activity or competitive sports during their whole adult life (after their competitive period), compared with 17% of the controls.[13] These habits may predispose to osteoarthritis but the desire to continue athletic activities may also affect the athletes' propensity to seek treatment of osteoarthritic problems. Indications for surgery for osteoarthritis can vary depending on activity requirements. In this respect it may have been a greater activity level rather than more severe osteoarthritis that led to more admissions to hospital among former athletes. However, the median length of admission was longer in athletes than controls, indicating that the osteoarthritis was at least as severe in athletes as in controls.

In conclusion, athletes from all types of competitive sports are slightly more likely to need hospital care for osteoarthritis of the weight bearing joints of the lower limbs. In endurance athletes the need appears first at older age but mixed sports and power sports also lead to increased incidence of hospital admission for premature osteoarthritis of the lower limbs.

This work was supported by grants from the Yrjö Johansson Foundation and the Finnish Ministry of Education. We thank Professor Tapio Videman (Jyväskylä, Finland) and Michele Battié (Seattle, USA) for their expert comments during preparing this manuscript.

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(Accepted 28 October 1993)

Correction

Estimating numbers of homeless and homeless mentally ill people in north east Westminster by using capture-recapture analysis

Two editorial errors occurred in this paper by Nigel Fisher and colleagues (1 January, pp 27-30). In table II all population subgroups should have been divided according to age <30 and ≥30 years [not age <30 and >30 years]. In the first sentence of the appendix the equation to calculate the total population should have read $N_T = (N_1 \times N_2)/N$ [not $N_T \times (N_1 - N_2)/N$].