Influence of Work on the Development of Osteoarthritis of the Hip: A Systematic Review

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ABSTRACT. ***Objective.*** To evaluate the evidence for the influence of physical workload on the occurrence of osteoarthritis (OA) of the hip.

Methods. We carried out a database search of Medline, Embase, and the Cochrane library to identify observational studies, and articles on the relationship between workload and hip OA were identified. Methodological quality of the selected studies was assessed using a standardized set of criteria. The outcome of each study was compared with its study characteristics and methodological quality score. Finally, a best-evidence synthesis was used to summarize the results from the individual studies.

Results. Two retrospective cohort studies and 14 case-control studies were included in this review. There was a slight negative, but not significant association between the study outcome and the methodological quality score. Overall, moderate evidence was found for a positive association, with an odds ratio of approximately 3, between previous heavy physical workload and the occurrence of hip OA. In addition, for the subcategories, i.e., ≥ 10 years farming or lifting heavy weights (≥ 25 kg), moderate evidence was found for a positive relationship with hip OA. Possible selection of the populations studied may be partly responsible for the association we identified.

Conclusion. The evidence for the influence of previous heavy physical workload on the occurrence of hip OA is moderate. (J Rheumatol 2001;28:2520–8)

Key Indexing Terms:
OSTEOARTHRITIS HIP ARTHRITIS
MUSCULOSKELETAL DISEASES WORK WORKLOAD

Osteoarthritis (OA) of the hip is a major cause of morbidity and disability in the elderly, and the problem will increase with the aging of the population in Western societies. In addition to the personal and social discomfort, the economic consequences are enormous. The costs of OA have risen over recent decades, accounting for up to 1 to 2.5% of the gross national product for countries such as the USA, Canada, the UK, France, and Australia[1].

Many epidemiological studies have investigated potential determinants of OA. These studies are important for our understanding of the causes of OA and will lead to improvement of preventive measures.

One of the recognized determinants of interest for hip OA is the amount of physical workload, where forces or loads act upon the hip joint. Besides several narrative reviews[2-4], Maetzel and colleagues performed a systematic review on this topic in 1997, in which a consistently positive but weak association between work related exposure and hip OA was reported[5]. However, several new articles have become available, investigating the influence of workload on the development of hip OA. More data on this subject gives us the opportunity to update the literature and carry out a subgroup analysis for the type of workload and the way the hip OA was measured.

We performed a systematic review identifying and assessing available studies to provide updated knowledge of the proposed association of physical workload and the occurrence of OA of the hip.

MATERIALS AND METHODS

Identification and selection of literature. To identify observational studies, relevant publications were searched using the following databases: Medline (1966 to April 2000), the Cochrane library (1993 to April 2000), and EMBASE (1980 to April 2000). The following keywords were used: [hip and (arthritis or arthrosis or osteoarthritis or osteoarthrosis) or coxarthrosis] and (risk factor or causative or determinants or predictor or etiology) and (case-control or retrospective or prospective or longitudinal or followup or cohort) [A detailed list can be obtained from the corresponding author]. The search was extended by screening the reference lists of all relevant articles identified.

A study was eligible for inclusion if it fulfilled all the following criteria: (1) one of the aims of the study was to investigate an association between hip OA and the amount of workload; (2) the articles were written in English, Dutch, German, French, Danish, Norwegian or Swedish; (3) the article was a full text article; (4) patients in the studies had to have radiological and/or clinical hip OA, or a (total) hip replacement or be on the waiting list for one; and (5) the study design was a cohort or a case-control study.

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A study was excluded if the studied population had a specific underlying pathology, such as trauma (fractures), infection, rheumatoid arthritis, ankylosing spondylitis, Perthes' disease, tuberculosis, hemochromatosis, sickle cell disease, Cushing's disease, or femoral head necrosis.

Methodological quality assessment. Variation of the methodological quality of observational studies may influence the results and conclusions of our investigation. Therefore, the quality of each included study was assessed using the following procedure. Two reviewers (AL and SB-Z) independently scored the quality of the selected papers according to a standardized set of criteria (Table 1). These criteria have been used in previous reviews of observational studies in the field of musculoskeletal disorders[6,7] and were modified to cover the topic of our review. The criteria concern both the internal validity and the informativeness of the study. Only items reflecting the internal validity of the studies were used to assess the methodological quality.

In case of disagreement, both reviewers tried to achieve consensus; if disagreements were not resolved, a third reviewer (BK) was consulted to achieve a final judgment.

Several items are not applicable to a certain type of study design (e.g., cohort study or case-control study), and therefore do not contribute to the total score of that particular study. This means that the maximum score of each study (= 100%) was based only on the items applicable to that particular type of study design. Positive scores were summed to an overall internal validity score.

Best-evidence synthesis. Because observational studies are heterogeneous with regard to the study population, methodological quality, and determinants and outcome measures for hip OA, we refrained from statistically pooling the data[8], and performed a "best-evidence" synthesis[9,10]. The studies were divided into subgroups according to the type of study design. A cohort study was judged the most valid design, followed by case-control study. After that, the studies were ranked according to their methodological quality score[11]:

1. Strong evidence is provided by generally consistent findings in multiple high quality cohort studies.
2. Moderate evidence is provided by general consistent findings
• in one high quality cohort study and 2 or more high quality case-control studies
• in 3 or more high quality case-control studies.
3. Limited evidence is provided by (general consistent) findings
• in a single cohort study
• in 2 or more case-control studies.
4. Conflicting evidence was provided by conflicting findings (i.e., < 75% of the studies reported consistent findings).
5. No evidence was provided when no studies could be found.

A study was considered to be of high quality if the methodological quality score was > 60%.

Data extraction. Two researchers (AL, SB-Z) collected the characteristics of the included studies independently of each other. They collected items on the definition of the studied population, how the presence or absence of hip OA was assessed, the assessment of the amount of workload, if the study corrected for potential confounding factors, and which results were reported.

When a study reported several outcomes because of a division of the study population into subgroups, the outcomes were combined (where applicable and possible) using Mantel-Haenszel statistics, methods described by Clayton and Hills[12], or the method described by Tan and colleagues[13]. Because of dissimilarity according to the outcome, where possible, we computed the odds ratios (OR). We abstracted outcomes on heavy workload in general, and made subgroups for farming and heavy lifting, where possible.

Publication bias. For the validity of a systematic review, identification of all relevant articles is crucial[14]. The amount of potential publication bias in our study was analyzed by means of a funnel plot, in which the study outcome (OR) was plotted against the sample size of the study. In the absence of publication bias, the plot will resemble a symmetrical inverted funnel[15]; we visually examined the funnel plot for symmetry.

Table 1. Criteria for assessment of methodological quality for cohort and case-control designed studies.

Item	Criteria	V/I*	CH/CC†
Study population			
1	Selection before disease was present or at uniform point	V	CH/CC
2	Cases and controls were drawn from the same population	V	CC
3	Participation rate ≥ 80% for cases/cohort	V	CH/CC
4	Participation rate ≥ 80% for controls	V	CC
5	Sufficient description of baseline characteristics	I	CH/CC
Assessment of risk factor			
6	Exposure assessment was blinded	V	CH/CC
7	Exposure was measured identically in studied population	V	CC
8	Exposure was assessed prior to the outcome	V	CH/CC
Assessment of hip OA			
9	Hip OA was assessed identically in studied population	V	CH/CC
10	Presence of hip OA was assessed reproducibly	V	CH/CC
11	Presence of hip OA was according to valid definitions	V	CH/CC
12	Classification was standardized	I	CH/CC
Study design			
13	Prospective design was used	V	CH/CC
14	Followup time ≥ 3 years	V	CH
15	Withdrawals ≤ 20%	V	CH
16	Information for completers vs withdrawals	I	CH
Analysis and data presentation			
17	Frequency of most important outcomes was given	I	CH/CC
18	Appropriate analysis techniques were used	V	CH/CC
19	Adjusted for at least age and sex	V	CH/CC

* V: criterion on validity/precision; I: criterion on informativeness.
† CH: applicable to cohort designed studies; CC: applicable to case-control studies.

RESULTS

Identification and selection of the literature. Altogether 2921 references were initially identified; of these, 16 articles met our selection criteria[16-31]. After screening the reference lists of the selected studies, another 3 studies were included[32-34].

For each of 3 studies, there was more than one publication — references numbered 22 and 28, 19 and 30, and 26 and 27 — reporting different aspects of the study. All publications were used to extract data regarding the methods used and the results. Thus, finally 16 studies were included in this review.

Publication bias. To investigate the amount of publication bias for our study, a funnel plot was made up (Figure 1). The plot shows the relationship between the distribution of the point estimates of the association between obesity and hip OA and the sample size (n). One study[30] could not be plotted due to a lack of data to calculate an OR. The plot shows a more or less equal distribution.

Description of the studies. Table 2 gives a description of the characteristics of the included studies. All studies collected their data in a retrospective manner. Two studies had a cohort design[17,20] and 14 studies were case-control design[16–19,21,23-25,27-29, 31-33].

Eight studies included only males[17,18,23,24,28,32-34], whereas 2 included only females[29,30].

Fourteen studies were carried out in Northern Europe, most of them in Scandinavia[20,21,24,25,27-29,32,34], but also in England[16-19,23]. The 2 others where carried out in the US[33] and in Japan[31].

The assessment of physical workload in 13 studies was carried out by means of an interview or a questionnaire[16–18,20,23-25,28,29,31-34], whereas 2 studies used the inclusion criteria (e.g., workers at a shipyard or physical education teachers)[19,21]. One study used registered information[27].

In 9 of the 16 studies, assessment of the amount of physical workload was done using the subjects' job titles, e.g., agricultural workers, bricklayers, dockers, etc[18,19,21,23–25,27,32,34]. The 7 other studies collected information on specific occupational activities, such as kneeling, squatting, heavy lifting, etc. Besides workload in general, 7 studies reported on farming separately[17,18,24,25,27,32,34]. Most of them used a cutoff point of ≥ 10 years of farming and compared that with no, < one year, or < 10 years of farming.

Six studies reported on heavy lifting activities separately[16,17,28,29,31,32], where heavy weight was mostly described as ≥ 25 kg.

The assessment of hip OA was most of the time based on clinical information — e.g., on waiting list for a (total) hip replacement (THR), after a THR, physician diagnosed hip OA, but 3 studies characterized hip OA by radiographic materials only (e.g., radiograph, IV urograph)[17,18,21].

Results of the studies. All studies revealed a positive association between heavy vs light physical workload (defined in various ways) and hip OA. The OR diverged between 1.1[21] and 13.8[34]. Twelve studies reported a statistically significant outcome[16-18,20,24,25,27,28,31-34], where the OR diverged between 1.9[16] and 13.8[34].

Looking at subgroups, in the 7 studies reporting on farming vs light physical workload or no farming the outcomes diverged between OR of 2 and 13.8, of which 6 were statistically significant[18,24,25,27,32,34]. The 6 studies on lifting heavy weights reported OR between 1.5 and 3.5,

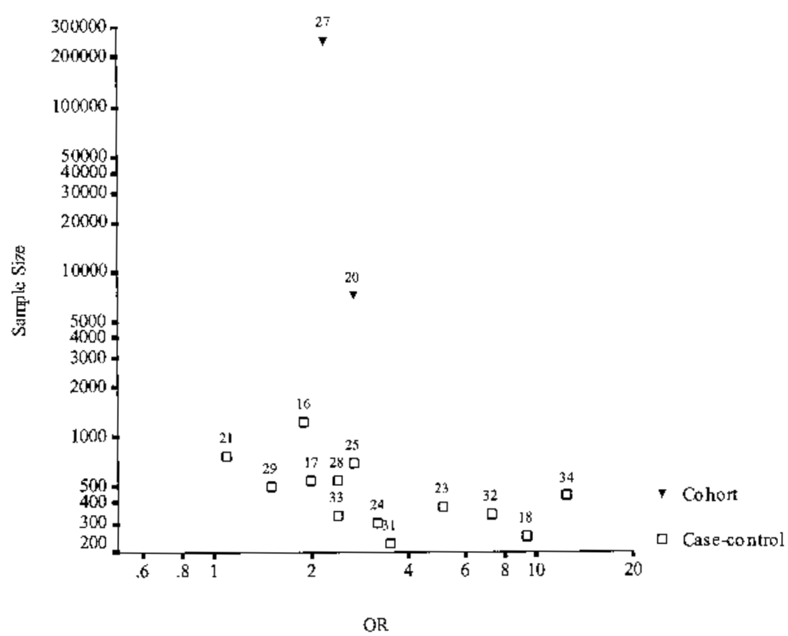

Figure 1. Funnel plot. Numbers in the graph represent references.

compared to no or a low exposure to lifting heavy weights. Five of these were statistically significant[16,17,28,29,31,32].

Twelve studies analyzed if the relationship changed with increased exposure to the heaviness of the physical workload[16-18,20,24,25,28,29,31-34]. Ten of these showed a clear dose-response relationship between hip OA and the amount of workload[16-18,20,24,25, 28,29,31,33,34].

No relationship could be found between the outcome of the individual studies and the way they assessed hip OA (on clinical evaluations or with radiograph only) or the sex studied (male or female).

Methodological quality assessment. The 2 reviewers scored 663 items and agreed on 630 items (95%, kappa 0.90). The 33 disagreements were resolved in a single consensus meeting. Table 3 shows the studies in order of their methodological quality score, subdivided for the different types of study design (i.e., cohort and case-control studies). The scores range from 77 to 23%, and the average rating was 54%.

A weak negative correlation between the quality score and the study outcome was found (Spearman correlation coefficient –0.148), implying that the higher the quality score, the smaller the association between physical workload and hip OA (Figure 2). However, these findings were not statistically significant. As well, we must keep in mind that one study could not be plotted due to a lack of data to calculate a point estimate[30].

Best-evidence synthesis. The 2 cohort studies did not meet the criteria for high quality[20,27]. However, 9 of the 14 case-control studies[16-18,24,25,28,29,31,32] could be labelled as "high quality." The outcomes of these studies diverge between an OR of 1.5 and 9.3 for high vs light physical workload. This implies that there is moderate evidence for a positive association between previous physical workload and hip OA with an OR of approximately 3.

For the farming subgroup, the single cohort study did not reach the level of high quality[27]. Five of the 7 case-control studies had a high quality score[17,18,24,25,32], and the outcomes of these studies diverge between OR of 2 and 9.3. So for this subcategory as well there is moderate evidence for a positive relationship between a history of (> 10 years) farming and the occurrence of hip OA, when compared with light workload or no farming.

The 6 case-control studies reporting on the association between lifting heavy vs low weights and hip OA all had a high quality score[16,17,28,29,31,32]. The outcomes diverged between OR 1.5 and 3.5. This also implies there is moderate evidence for a relationship between a history of frequently lifting heavy weights (≥ 25 kg) and occurrence of hip OA.

DISCUSSION

In this systematic review, we summarized the available evidence from the literature on the influence of physical workload on the development of OA of the hip. Based on the evidence, we may conclude that there is moderate evidence for a positive association between hip OA and previous workload in general, as well as for the subcategories of farming and lifting heavy weights.

Although 12 of the 16 studies showed a significant positive association between previous heavy workload and hip OA, the findings did not reach the level of strong evidence. The main reason is that there were no high quality cohort studies. The 2 cohort studies we reviewed as well as the case-control studies all had a retrospective design. With this

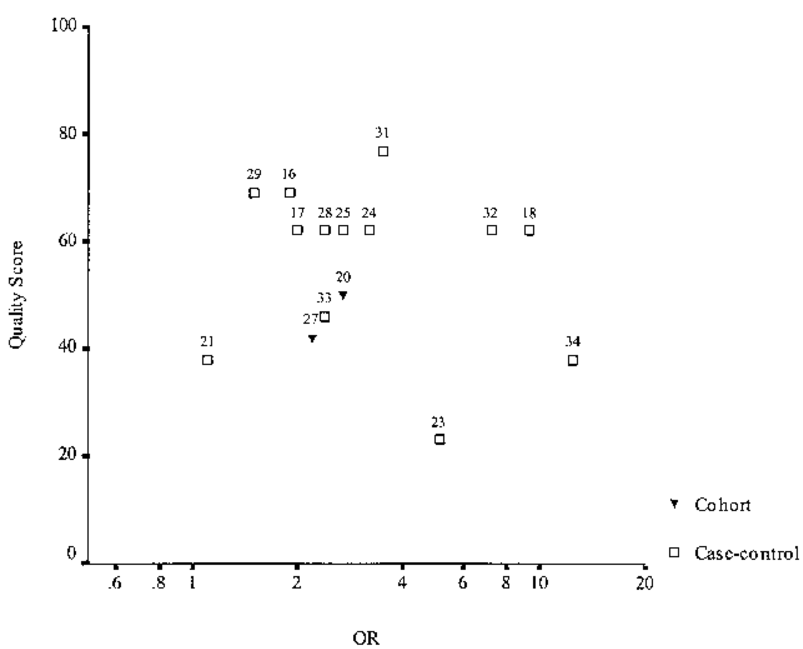

Figure 2. Quality score as a function of the OR. Numbers in the graph represent references.

Table 2. Details of the studies.

Author	Population	Definition Controls	Assessment of Hip OA	Adjusted for	Results (CI)	Validity Score, %
Cohort studies						
Heliovaara[20]	Finnish open population Retrospective followup Age ≥ 30 yrs (n = 7217)		Physician diagnosed (assessed by questionnaire) or findings at examination	Age, sex, trauma	Light workload, OR 1 Heavy workload, OR 2.7 (1.7–4.4)	50
Vingard[26,27]	Swedish open population Retrospective followup 11–13 yr Age 45–75 yrs (n = 250,217)		Clinical (ICD diagnosis for hip OA)	Age, sex, county	Heavy vs light workload Male: RR 2.2 (1.6–2.8) Female: RR 1.6 (0.9–3.1) Farming (≥ 10 yrs) Male, OR 3.8 (2.9–3.9) Female, OR 1.5 (0.9–2.9)	42
Case-control studies						
Yoshimura[31]	Patients on waiting list for THR in Japan Age ≥ 45 yrs (n = 114)	Random selection of the source population (n = 114)	Waiting list for THR	Age, sex, residence, previous knee pain	Lifting < 10 kg, OR 1 Lifing ≥ 25 kg at first job, OR 3.5 (1.3–9.7)	77
Coggon[16]	Residents of 2 districts in England on waiting list for THR Age 45–91 yrs (n = 611)	Random selection of the source population with no hip problems Age 45–91 (n = 611)	On waiting list for THR	Age, sex, BMI, trauma, Heberden's nodes	No lifting, OR 1 Lifting ≥ 25 kg ≥ 10 yrs, OR 1.9 (1.2–3.0)	69
Vingard[29]	Women in a region of Sweden who received THR Age 50–70 yrs (n = 230)	Random selection of all women in the same area with no hip problems (n = 273)	After THR	Age, sex, residence, BMI, sports, smoking, no. of children, HRT	Low exposure to lifting, OR 1 Heavy lifting, OR 1.5 (0.9–2.5)	69
Croft[17]	Men with signs of hip OA on IV-urograph, or a THR, in a district in England Age 60–75 yrs (n = 245)	Men with IV-urograph with no signs of hip OA (n = 294)	Radiograph (JSW ≤ 1.5 mm) or THR	Age, sex, hospital	Lifting ≥ 25 kg ≥ 20 yrs vs < 1 yr, OR 2.5 (1.0–7.3) Farming ≥ 10 yrs vs < 1 yr, OR 2.0 (0.9–4.4)	62
Croft[18]	Random selection of male farmers at 5 general practices in England Age 60–76 yrs (n = 167)	Random selection of men who spent entire careers in office work (n = 83)	Complaints and radiograph (JSW ≤ 1.5 mm) or THR	Age, sex, height, weight, Heberden's nodes	Office work, OR 1 Farming ≥ 10 yrs, OR 9.3 (1.9–44.5)	62
Jacobsson[32]	Men with signs of hip OA on IV-urograph or on a waiting list for THR in South Sweden (n = 106)	Men with IV-urograph with no signs of hip OA (n = 236)	Radiograph/IV-urograph (JSW < 3 mm) or on waiting list for THR	Sex	Heavy vs no heavy workload, OR 7.2 (3.0–17.1) Farming vs no farming, OR 2.0 (1.3–3.2) Heavy vs no heavy lifting, OR 2.4 (1.3–4.3)	62
Olsen, Vingard[22,28]	Men in the area of Stockholm who received a THR Age 50–70 yrs (n = 239)	Random selection of men in the same area (n = 302)	* After THR	Age, sex, BMI, smoking, sport	Low exposure, OR 1 Heavy workload, OR 2.4 (1.5–4.0) Heavy lifting, OR 2.4 (1.5–3.7) (> 40 kg < 30 yrs of age)	62
Thelin[24]	Male patients of 2 hospitals in Sweden who received THR Age 55–70 yrs (n = 98)	Random selection of men from the same area Age 55–70 (n = 201)	* After THR	Sex, residence	Farming > 10 yrs vs other jobs than farming, OR 3.2 (1.8–5.5)	62
Thelin[25]	Population of province of Sweden with signs of hip OA on radiological examination Age > 70 yrs (n = 216)	Random selection of civilians of the same area (n = 479)	* Radiograph (JSW < 3 mm)	Age, sex, residence	Farming vs no farming, OR 2.7 (1.9–3.8)	62
Roach[33]	Men in Chicago with THR or signs of hip OA on radiograph (n = 99)	Same population with no signs of hip OA on IV-urograph (n = 233)	* Clinical (pain) Radiograph/IV-urograph (JSW) or THR	Various confounders	Heavy vs light workload ≥ 15 yrs, OR 2.4 (1.3–4.3)	46

* Assessment of hip OA was only carried out for cases.

Table 2. continued

Author	Population	Definition Controls	Assessment of Hip OA	Adjusted for	Results (CI)	Validity Score, %
Case-control studies						
Eastmond, White[19,30]	Female physical education teachers of 5 colleges in England Age 48–54 yrs (n = 577)	Women from general population (n = ?)	* Clinical (pain, stiffness) Radiograph (only for teachers	Age, sex	Age 48–54, $chi^2 = 2.52$ Age 55–60, $chi^2 = 0.43$	38
Vingard[34]	Swedish men from Stockholm region with disability pension due to hip OA (n = 140)	Random selection of men from same area with no disability pension for hip OA (n = 298)	Disability pension because of hip OA	Age, sex, residence	No heavy workload, OR 1 Heavy workload > 20 yrs, OR 12.4 (6.7–23.0) Farming > 10 yrs, OR 13.8 (4.0–48.1)	38
Lindberg[21]	Heavy labor workers of shipyard at Malmö (n = 332)	White collar workers at same shipyard and male teachers (n = 352) Random sample of citizens of Malmö (n = 438)	* Radiograph (JSW < 4 mm at age < 70, JSW < 3 mm at age > 70, JSW difference > 1 mm)	Age, sex	Compared to controls 1, OR 1.1 (0.5–2.5) Compared to controls 2, OR 2.1 (0.8–5.5)	38
Partridge[23]	Male dockers Age 25–64 yrs (n = 206)	Male civil servants at government depot Age 25–64 yrs (n = 171)	Clinical (pain, physical examination	Sex	Civil servants, OR 1 OR 5.1 (0.6–42.8)	23

THR: total hip replacement, HRT: hormone replacement therapy, JSW: joint space width. * Assessment of hip OA was only carried out for cases.

Table 3. Results of the quality score of the studies. Each item was scored "1" when it met the specified criteria listed in the Appendix. When it did not meet the criteria, or it was not described at all, a "0" was assigned. Positive validity scores were summed to an overall internal validity score.

	Item																					
	1	2	3	4	5*	6	7	8	9	10	11	12*	13	14	15	16*	17*	18	19	Individual Score	Total Obtainable	Total Score, %
Cohort																						
Heliovaara[20]	0	NA	1	NA	1	0	NA	0	1	1	1	0	0	0	0	0	1	1	1	6	12	50
Vingard[26,27]	0	NA	1	NA	0	0	NA	0	1	0	0	0	0	1	0	0	1	1	1	5	12	42
Case-control																						
Yoshimura[31]	1	1	1	1	1	0	1	0	1	1	1	1	0	NA	NA	NA	1	1	1	10	13	77
Coggon[16]	1	1	1	0	1	0	1	0	1	1	1	1	0	NA	NA	NA	1	1	1	9	13	69
Vingard[29]	0	1	1	1	1	0	1	0	1	1	1	1	0	NA	NA	NA	1	1	1	9	13	69
Croft[17]	0	1	0	0	1	1	1	0	1	1	1	1	0	NA	NA	NA	1	1	1	8	13	62
Croft[18]	1	1	0	0	1	0	1	0	1	1	1	1	0	NA	NA	NA	1	1	1	8	13	62
Jacobsson[32]	1	1	1	1	1	0	1	0	1	1	1	1	0	NA	NA	NA	1	0	0	8	13	62
Olsen, Vingard[22,28]	1	1	1	0	1	0	1	0	0	1	1	1	0	NA	NA	NA	1	1	1	8	13	62
Thelin[24]	1	1	1	1	0	0	1	0	0	1	1	1	0	NA	NA	NA	1	1	0	8	13	62
Thelin[25]	0	1	1	1	0	0	1	0	0	1	1	1	0	NA	NA	NA	1	1	1	8	13	62
Roach[33]	0	1	0	0	1	0	1	0	0	1	1	1	0	NA	NA	NA	1	1	1	6	13	46
Eastmond, White[19,30]	1	0	0	0	0	0	0	0	0	1	1	1	0	NA	NA	NA	1	1	1	5	13	38
Vingard[34]	0	1	0	0	0	1	0	0	1	0	0	0	0	NA	NA	NA	1	1	1	5	13	38
Lindberg[21]	1	1	1	1	0	0	0	0	0	0	0	0	0	NA	NA	NA	1	0	1	5	13	38
Partridge[23]	0	0	1	1	0	0	0	0	1	0	0	0	0	NA	NA	NA	1	0	0	3	13	23

* Informativity item, not included in the analysis. NA: not applicable.

type of design, we have to be cautious with recall bias occurring in the way physical workload was defined — by job title only or with a questionnaire investigating specific activities. Although a specific questionnaire will provide more precise information, the amount of recall bias will be more extensive.

In addition to restrictions of the included studies, this review may have other limitations, as follows.

Identification and selection of literature. Although we put much effort into identifying all relevant articles, our literature search might have some limitations. First, some relevant articles may have been missed because they used other keywords or had unclear abstracts. Second, not all published articles are indexed in databases. Third, we excluded articles written in languages other than English, Dutch, German, French, Danish, Norwegian, or Swedish.

The presumed absence of publication bias found in our results (Figure 1) might be expected in this field of research. Studies that would have found no (or a negative) relationship have, in our opinion, the same opportunities for publication because there are no obvious conflicts of interest.

Quality assessment and best-evidence synthesis. Quality assessment was challenging because there were no tested and validated criteria lists published for observational studies in the field of OA. In addition, limited data were found on performing a best-evidence synthesis with observational studies (in contrast with randomized controlled trials). Thus we presented them in a reproducible manner, and the criteria we used were relatively strict.

Comparison with the results of previous reviews. It is interesting that our results differ from the conclusions drawn in the systematic review of Maetzel, *et al*[5]. Generally, besides considerably more evidence for the relation between physical workload and the occurrence of hip OA, this review shows that this relation is stronger than suggested in the earlier review. This difference is partly due to the fact that 5 studies published before 1994 could be included[20,23,27,30,34], and partly because there has been an expansion in this field of research in recent years, which resulted in 4 more articles[16,25,29,31].

Explanation for the relationship. Considering the possibility for recall bias in all papers we studied, this could only partly explain the relationship we found between high workload and hip OA. In our opinion, the most reasonable explanation is given by Radin and colleagues[35]. They described that microfractures appear in the subchondral bone due to repeated high forces across a joint. Because of a lesser absorbing capacity of the more compact and rigid bone structure, the overlying cartilage has to absorb more force. These forces will in fact cause degeneration of the cartilage tissue. Thus, by this mechanism exposure to repetitive mechanical stress can lead to the development of hip OA. This explanation is supported by our finding that 10 of the 16 studies showed a clear dose-response relationship, one of the criteria for a biological gradient[36].

A frequently postulated explanation for the relationship between high physical workload and hip OA is that people with highly physically demanding jobs may obtain treatment earlier and/or more often than people in less demanding occupations — not necessarily because they have a higher incidence of OA, but possibly because they are more handicapped by it when it occurs. These people will be overrepresented; the exposure of interest may then be associated with the decision to seek treatment. This kind of selection is suggested in a review of the influence of weight on the occurrence of hip OA (unpublished data), where a difference was found between the clinically assessed hip OA vs the radiological OA. In this review, however, the outcome of the individual studies is not related to the way they assessed hip OA — clinically[16,20,23-25,27-34] or radiologically[17,18,21]. The precise reason for the increased risk remains uncertain. Prospective studies on the causal factors of the association between physical workload and hip OA are needed.

The available evidence in the literature indicates that there is moderate evidence for a positive association between the amount of physical workload and the occurrence of hip OA. As well, for the subgroups farming and lifting heavy weights, the evidence is moderate. Future studies, especially prospective cohort studies, should further clarify the precise reasons for this relationship.

APPENDIX

Specified criteria for the methodological quality assessment.

Study population

1. Positive if the study population was selected before any clinical or radiological sign of hip OA was present

   Positive if (sub-) groups were selected at a uniform point of the disease or exposure

2. Positive if the cases and the controls were drawn from the same source population (primary study base)
3. Positive if the participation rate of the cases/population selected and invited to participate at baseline was at least 80%
4. Positive if the controls selected and invited to participate at baseline was at least 80%
5. Positive if at least 7 of the following 12 items were reported at baseline

- Age (mean and SD)
- Sex (number and/or percentage)
- Weight (mean and SD)
- Body mass index (BMI) (mean and SD)
- Race
- Job description
- Sport/leisure time exposure
- History of trauma
- Smoking
- Hormone replacement therapy
- Signs of OA in other joints (OA verified in other joints, Heberden's nodes)
- Characteristics of OA on radiograph or other imaging techniques

Assessment of risk factors

6. Positive if the exposure assessment was blinded with respect to disease status
7. Positive if the exposure was measured in an identical way for the whole studied population
8. Positive if the exposure was assessed prior to the disease outcome

Assessment of hip OA

9. Positive if the way of assessing hip OA was identical for the entire studied population
10. Positive if the measurement instruments used for observing or identifying the presence of hip OA were reproducible

    Positive if (waiting for) a (total) hip replacement (THR) was used as an outcome measure for hip OA

11. Positive if the measurement instruments used for observing or identi-

fying the presence of hip OA were standardized using validated definitions[37,38]

Positive if (waiting for) a THR was used as an outcome

12. Positive if the classification of the radiological osteoarthrosis was standardized using the Kellgren-Lawrence[39] or the Croft[40] classification

Positive if the classification of the clinical OA was standardized using the American College of Rheumatology criteria[41]

Positive if (waiting for) a THR was used

Study design

13. Positive if a prospective design was used

14. Positive if the total followup time was ≥ 3 years

15. Positive if the total number of withdrawals was ≤ 20% (if a retrospective cohort design was used, a negative score was assigned)

16. Positive if demographic/clinical information was presented for completers and withdrawals (if a retrospective cohort design was used, a negative score was assigned)

Analysis and data presentation

17. Positive if frequency or percentage (or mean and SD/CI) of the outcome(s) of the risk factor(s) was used

18. Positive if confounding variables were used in the statistical analysis. (Validated techniques such as multivariate regression or Mantel-Haenszel must have been used)

Positive if (sub-) group analyses were done in case of a heterogeneous population at baseline

Positive if no (sub-) group analysis was made in case of a homogeneous cohort at baseline

19. Positive if there was at least correction for the confounders age and sex by means of matching, restriction, or adjustment in the analysis

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