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Title: Socioeconomic inequalities in knee pain, knee osteoarthritis and health-related quality of life: a population-based cohort study in southern Sweden

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Abstract

Objective: To determine socioeconomic inequalities in frequent knee pain (FKP), knee osteoarthritis (OA) and associated health-related quality of life (HRQoL) in Sweden.

Methods: In 2007 a postal questionnaire about knee pain was sent to a random sample of 10 000 residents of Malmö, Sweden (7 402 individuals responded). Subjects reporting pain with duration ≥ 4 weeks in one or both knees in the past 12 months were classified as having FKP. A random sample of 1 527 subjects with and without FKP attended a clinical and radiographic knee examination and responded to generic and disease-specific HRQoL questionnaires. We used the individuals' level of education and occupation as socioeconomic status (SES) measures, and we calculated the relative index of inequality (RII) using Poisson regression with robust standard errors adjusted for age and sex. We applied weighting to account for a possible selection bias that might arise from non-responses in the study.

Results: With education, the RIIs (95% CI) for FKP and knee OA were 0.71 (0.61 to 0.84) and 0.56 (0.34 to 0.93), respectively. With occupation, corresponding figures were 0.70 (0.60 to 0.82) and 0.59 (0.37 to 0.94), respectively. There were socioeconomic gradients in HRQoL in favor of people with better SES. RIIs for FKP and HRQoL but not knee OA were essentially similar after additional adjusting for mediators.

Conclusions: In Sweden there are socioeconomic gradients related to both FKP, knee OA as well as HRQoL in favor of people with better SES. SES should be taken into account in health resource allocation pertaining to knee-related disorders.

Introduction

Knee osteoarthritis (OA) is one of the most common chronic diseases in the elderly. In Sweden, it is estimated that about one in four individuals in the general population aged 56-84 suffers from chronic knee pain and about one in seven persons above 45 years of age has doctor-diagnosed knee OA [1]. Knee OA is often associated with physical disability and increased risks of, e.g., falls, comorbidities, and overall deterioration in health-related quality of life [2-4], translating into substantial health care costs and productivity losses for individuals and societies [5, 6]. According to the Global Burden of Disease (GBD) Study 2010, 2.2% of global years lived with disability was attributed to knee and hip OA (knee OA accounted for 83% of this) [7]. A recent systematic review of cost-of-illness studies concluded that cost of OA accounted for 0.25% to 0.50% of a country's gross domestic product (GDP) [8]. In addition, prevalence and burden of OA is expected to increase due to the aging population and increased prevalence of obesity [9].

There is evidence that lower socioeconomic status (SES) is associated with higher prevalence of knee OA [10-13] and knee pain [14-16], and worse health-related quality of life (HRQoL) [17, 18]. A few studies (mostly focused on knee OA) have been conducted in Sweden evaluating the association between OA and occupation [19-21]. However, none of these studies quantified socioeconomic disparities using inequality measures. Further, while radiographic knee OA is often associated with knee pain, knee pain may also occur due to reasons other than knee OA [15]. Therefore, using uniform methodology, assessing the differential impact of SES on knee pain *and* knee OA is relevant. Most previous studies have applied logistic regression and report odds ratio (OR) as an estimate of prevalence

ratio (PR). There are two main limitations with this approach: first, the OR overestimates the PR when prevalence is high (> 10%) [22, 23] and second, it does not account for the size of the socioeconomic groups [24].

Thus, the aims of the current study was to determine the socioeconomic inequalities in knee pain, knee OA and knee-related quality of life, accounting for both the prevalence of these outcomes and the size of the socioeconomic groups, in a large random sample of residents of the Malmö region in southern Sweden.

Method and Material

Setting and Participants

The Malmö OA study (MOA) originated from the Malmö Diet and Cancer Study (MDCS) cohort established between 1991 and 1996. A cohort of 28 098 men (aged 45–73 years) and women (aged 44–74 years) living in the city of Malmö had participated in MDCS and completed baseline examinations [25]. In the stage I of the MOA study, a postal questionnaire about knee pain was sent to a 10 000 random sample from the MDCS who were still alive and resident in the Malmö area in 2007. A total of 7 402 respondents (response rate 74%) answered a question about whether they had knee pain during the previous 12 months and its duration (<1 week, 1-4 weeks, 1-3 months, >3 months). Subjects with pain in one or both knees in the past 12 months and duration of minimum 4 weeks were classified as having frequent knee pain. In the stage II of the MOA, a random sample of 1300 subjects with knee pain and 650 subjects without knee pain were invited to a clinical visit and radiographic examination [1]. A total of 1 527 subjects (response rate

78.3%) participated in the stage II and responded to the EuroQol-5D-3L (EQ-5D-3L) and the Knee injury and Osteoarthritis Outcome Score (KOOS) questionnaires (the median time between answering the questionnaire in the stage I and participating in clinical and radiographic examination was 266 days). The study was approved by the Regional Ethics Committee in Lund and informed consent was obtained from all participants in accordance with the Declaration of Helsinki.

Radiographic evaluation and knee OA definitions

Both knees were radiographed in a weight-bearing and semi-flexed position (knees in 10-15 degrees of flexion) using a posterior-anterior beam direction (film focus distance 110 cm, 60 kV and 10 mA) with the aid of fluoroscopy to optimally align the tibia plateau. An independent senior radiologist specialized in musculoskeletal conditions who was blinded to the clinical data assessed joint space narrowing and osteophytes according to the atlas from the Osteoarthritis Research Society International [26]. We defined *radiographic knee OA* if one or more of the following criteria were fulfilled in either the medial or lateral tibiofemoral compartment: joint space narrowing grade 2 or worse, the sum of marginal osteophyte grades in the same compartment 2 or worse, joint space narrowing grade 1 and osteophyte grade 1 in the same compartment approximating Kellgren and Lawrence (KL) grade 2 or worse [27]. Radiographic knee OA status for 42 (2.8%) individuals was not available. We also defined *clinical knee OA* using the American College of Rheumatology (ACR) clinical criteria according to the recursive positioning method determined by the study nurse blinded to radiographic signs [28]. Five items are considered in the ACR criteria [28]: 1) knee pain for most days of prior month, 2) crepitus on active joint motion, 3)

morning stiffness <30 minutes in duration, 4) age 39 years and older, and 5) bony enlargement of the knee on examination. Knee OA was present if items 1, 2, 3, 4 or items 1, 2, 5 or items 1 and 5 were present. Using status of radiographic and clinical knee OA, we additionally created a binary variable indicating the presence of any knee OA (either radiographic or clinical). The subjects with missing value on any definition were considered missing (n=42).

HRQoL

The EQ-5D-3L is a generic multi-attribute instrument to elicit health-related preferences. The EQ-5D-3L covers five attributes: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each attribute has three levels: no problems, some or moderate problems, and severe problems, resulting in 243 (3⁵) possible health states [29]. The responses to these attributes were weighted using the Swedish time trade-off value set [30] to calculate an index score. The responses to the EQ-5D-3L were missing for 12 individuals.

The KOOS is a validated knee specific instrument consisting of 42 questions covering 5 subscales: “pain”, “other symptoms”, “activities of daily living (ADL)”, “function in sport and recreation (Sport/Rec)”, and “knee-related quality of life (QoL)” [31, 32]. Standardized answer options are given (5 Likert boxes) and a value from 0 to 4 is assigned to each response. A normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) is then calculated for each subscale. As our subjects were elderly, we included a sixth answer option (not applicable) into the case report form for the subscale Sport/Rec. If the box "not applicable" was marked, the item was treated as missing data. Since a large

number of subjects selected this option, we decided not to include this subscale in our analysis. The responses for “pain”, “ADL” and “QoL” subscales were missing for 3, 2, and 2 individuals, respectively. The responses to the HRQoL questionnaires were dichotomized using median as cut off point and we created the binary variables “higher than median” or “equal or less than median”.

SES measures

We stratified level of education into three categories: 1) “low” included those who had ≤ 9 years of education (i.e. completed or not completed the 9 years of compulsory school), 2) “medium” included those who had 10 to 12 years of education (i.e. upper secondary school) and 3) “high” included those who had education at the college or university level. Data on education were not available for 292 and 51 individuals in the MOA study at stage I and II, respectively.

We classified occupation into socioeconomic index groups (Table 1A in the appendix), based on questions concerning job titles and actual work tasks using the criteria by Statistics Sweden [33]. We defined five occupation groups: 1) unskilled manual workers, 2) skilled manual workers, 3) low-level non-manual employees, 4) intermediate non-manual employees, 5) high-level non-manual employees and self-employed professionals. Self-employed professionals included self-employed persons in occupations normally requiring at least six years of post-comprehensive school education. Individuals with missing data on occupation (n=313), farmers (n=15), and self-employed other than professionals and farmers (n=317) were excluded from the analysis on knee pain (the stage I of the MOA) due

to their unclear relative position compared to the other socioeconomic groups (while there is educational requirement for all socioeconomic groups, no educational requirement applies to people in these two categories, Table 1A in the appendix) [34]. Corresponding figures for knee OA and HRQoL part of the analysis (the stage II of the MOA) were n=56, n=3, and n=59, respectively. It should be noted that these people were excluded when occupation was used as SES and were included with education as SES.

Due to low number of people with knee OA, we dichotomized level of education as “less than 12 years of education” versus “12 years education and higher”, and occupation as “manual work” versus “non-manual work” in quantifying socioeconomic inequality in knee OA.

Statistical analysis

In unadjusted analysis, we calculated chi-square statistics for the trend of the proportion of people with knee pain and knee OA across SES groups. In adjusted analysis, the relative socioeconomic inequalities in knee pain, knee OA and HRQoL were assessed by calculating the Relative Index of Inequality (RII). The RII is a regression-based measure that takes into account the whole sample rather than only concentrating on two extreme socioeconomic groups [24]. To calculate the RII, the population was ranked by education/occupation (from the lowest to the highest) and then the study sample in each category of education/occupation was assigned a modified riddit-score (a fractional rank) based on the midpoint of range in the cumulative distribution of the study sample in a given category. For example, if the lowest level of education category comprised 5% of the sample, every individual in this category is

assigned a value of 0.025 (0.05/2), and if second category comprise 20% of sample, then every individual in this category is assigned a value of 0.15 (.05+ [0.2/2]) and so forth.

Then we used Poisson regression with robust standard errors [22, 35] to calculate RII as follows:

$$\ln(Y) = \beta_0 + \beta_1 \text{ridit} + \beta_2 \text{Age} + \beta_3 \text{Sex} + \text{error}$$

Where Y is our outcome variable (i.e., knee pain, knee OA, and HRQoL \leq median score), and exponential of β_1 gives an estimate of RII which can be interpreted as relative rate ratio between the hypothetically highest and hypothetically lowest education/occupation categories (i.e. an RII $>$ 1 implies a positive relationship between knee-related health outcomes and SES variables and an RII $<$ 1 implies an inverse relationship). In this case, more distance from 1 implies more profound socioeconomic inequality. Moreover, to examine if mediators (smoking, and body mass index [BMI] for knee pain and knee OA; and smoking, BMI and knee OA for HRQoL) can explain socioeconomic inequalities, we re-estimated our models including these variables in the above equation. In the analysis of knee pain, we used self-reported data on smoking and BMI from the Malmö Diet and Cancer Study. In the analysis of knee OA and HRQoL, we used self-reported data on smoking from the MOA questionnaires were used. The respondents described their smoking status as current smoker, ex-smoker, or never smoked. The participants' weight and height were measured at the clinic visit by the study nurse and BMI was calculated as weight (kg) / height (m)².

Moreover, to avoid loss of information due to dichotomization of HRQoL measures, in a sensitivity analysis we included HRQoL measures as continuous and used the ordinary least squares (OLS) regressions with robust standard errors as follows:

$$HRQoL = \beta_0 + \beta_1 r_{idit} + \beta_2 Age + \beta_3 Sex + error$$

In this case, β_1 gives an estimate of the Slope Index of Inequality (SII) which can be interpreted as the absolute difference in the HRQoL between the hypothetically highest and hypothetically lowest education/occupation categories (i.e., $SII > 0$ indicates that individual in higher SES level have higher HRQoL and $SII < 0$ shows opposite).

To test if socioeconomic inequalities differ across age groups (56-65 years, 66-75 years, and ≥ 75 years) and between sexes, we estimated the RIIs for these subgroups. Then we obtained the joint parameter vector and a simultaneous (co-)variance matrix of the sandwich/robust type for coefficients from these sub-models by using seemingly unrelated estimation and compared those using Wald tests.

We applied weighting to account for a possible selection bias that might arise from non-responses in stages I and II of the MOA study [36]. A logistic regression model with sex, age on 1 January 2007, education, smoking, and BMI as covariates was used to estimate the probability of response in the survey, and the reciprocal was used as a weight in the analysis of socioeconomic inequalities in knee pain. Similar logistic regression models including knee pain status as an additional covariates were applied to estimate the probability of participation and attendance at the clinical examination. The sampling weights (the reciprocal of the sampling probability for those with and without knee pain) were multiplied by the weights for response, participation and attendance to construct the final weights used

in analysis of RIIs and SIIs for knee OA and HRQoL. Statistical analysis was conducted in STATA software version 13.

Results

The characteristics of the study sample in both stages of the MOA are presented in Table 1. In both stages, the proportion of men and women in the group with the highest level of education was similar (24.3% women vs. 22.9% men in stage I, and 25.3% women vs. 22.2% men in stage II). On the other hand, there were lower proportions of women in high-level non-manual and self-employed professionals in both stages (11.7% women vs. 22.0% men in stage I, and 12.3% women vs. 21.6% men in stage II).

Knee pain

The highest and lowest proportion of knee pain was observed among the lowest and highest socioeconomic groups, respectively (slope = -0.023, $P_{\text{trend}} < 0.001$ for education; and slope = -0.021, $P_{\text{trend}} < 0.001$ for occupation; Figure 1). The RIIs for both education and occupation showed statistically significant socioeconomic inequalities in knee pain in favor of individuals with better SES (Table 2). These inequalities were persistent after controlling for smoking and BMI. Subgroup analyses did not reveal any statistically significant differences in socioeconomic inequalities across age groups and sex.

Knee OA

Individuals with low level of education and high level of education had the highest and lowest prevalence of knee OA, respectively. People in unskilled manual and intermediate

non-manual categories had the highest and the lowest proportion of knee OA, respectively (slope= - 0.042, $P_{\text{trend}} = 0.012$ for education; and slope = -0.017, $P_{\text{trend}} = 0.072$ for occupation, Figure 2).

There were socioeconomic inequalities in radiographic knee OA and knee OA by any definition in favor of individuals with better SES, i.e. the proportion of knee OA was lower among people with better SES. These socioeconomic inequalities in knee OA disappeared after adjusting for BMI and smoking. RIIs for knee OA were similar across age and sex groups (Table 2).

HRQoL

Evaluating socioeconomic inequality in HRQoL revealed that while there was no statistically significant gradient in EQ-5D-3L index scores, there were in general significant inequalities in knee-related quality of life in favor of individuals with better SES, i.e., the probability of reporting higher knee-related quality of life scores were higher among people with better SES (Table 3). These socioeconomic gradients were essentially similar even after additional controlling for smoking, BMI and knee OA. Subgroup analyses suggested that these socioeconomic inequalities largely were similar across age and sex groups (there was difference in socioeconomic inequality across age groups for KOOS-pain subscale using education as SES measure, $p=0.017$). Estimating the SIIs (Table 2A in the appendix) resulted in similar pattern (there was difference in socioeconomic inequality across age groups for KOOS-pain subscale using education as SES measure, $p=0.038$).

Discussion

We determined the socioeconomic inequality in knee pain, knee OA, and knee-related HRQoL in a large population-based cohort of middle-aged and elderly in southern Sweden. Investigating socioeconomic inequalities in knee-related health outcomes has important policy implications in terms of identifying major risk groups and planning target group-specific interventions to prevent potentially disabling knee disorders. Our study provides detailed estimates of the relative inequality and revealed that the proportion of knee pain and knee OA was lower among individuals with better SES and they reported higher HRQoL. Further, these socioeconomic inequalities were persistent after controlling for mediators for knee pain and HRQoL. There were no essential differences in socioeconomic inequalities across age groups and sexes.

The observed inverse associations between SES and knee pain, knee OA and HRQoL in our study are in line with previous studies from several countries [10-18, 37, 38]. It is well documented that lifestyle risk factors of knee pain, knee OA and worse HRQoL such as obesity and smoking [39, 40] are more prevalent among people with lower SES level [41, 42]. However, even after adjusting for these risk factors in our study, the socioeconomic inequalities persisted in knee pain and HRQoL implying the role of other mediators. It has been suggested that anxiety, depression and stress are positively associated with pain and these are more common in persons with lower SES [43-45]. Moreover, individuals with lower SES level generally have lower self-efficacy and use more passive and less effective coping strategies which might act as a mediator between SES and knee-related outcomes [46, 47]. Manual work involves higher physical demands, e.g., knee bending and heavy

lifting tasks, have previously been proposed as risk factors for knee pain [15, 16, 44]. In addition, Christensen et al. [47] reported that people with lower SES suffering from musculoskeletal pain in general receive less support at work than people with higher SES. Higher prevalence of knee pain, knee OA and worse HRQoL among people with lower SES in our study support the hypothesis of “double suffering” [48] meaning that people with low SES not only experience more frequent knee pain and knee OA but also report worse HRQoL than their counterparts with better SES. Our findings and findings from previous studies, especially regarding socioeconomic inequality in the access to knee joint replacements,[49-51] suggest that SES should be taken into account in any decision-making regarding prevention and treatment of knee pain and its consequences. Special attention should be paid to individuals in lower level of SES by policy-makers and caregivers.

While there were socioeconomic inequalities in knee OA based on radiographic signs, the inequality in clinical knee OA was less pronounced, even if the point estimates were similar. A higher proportion of people with radiographic knee OA (28%) compared with clinical knee OA (20%) may be an explanation. This could limit the power of the study to detect any statistically significant socioeconomic differences with respect to clinical knee OA. Another explanation could be linked to the ACR criteria used to define the clinical knee OA. These criteria are based on a set of clinical signs (such as crepitus) that may be underreported by the older persons if they are perceived as a natural part of the ageing process. Previous studies documented disparity in the impact of different OA definitions on prevalence and incidence of OA [52] and also knee-related quality of life [53]. These findings imply that

the definition used in diagnosis of knee OA should be taking into account when interpreting and comparing the results of different studies.

Using data from a large random sample of a population-based study, measuring both radiographic and clinical knee OA, accounting for the size of the socioeconomic groups, using both generic and disease-specific measures of HRQoL, and applying appropriate statistical method for estimating prevalence ratios are the main strengths of the current study. However, several limitations of the study should be considered. First, knee pain and explanatory variables including education, smoking and BMI (for knee pain analysis) were self-reported and thus prone to recall bias and measurement error. This may bias our results especially if these measurement problems are systematically associated with SES. For example, d’Uva et al. [54] reported that people with better SES tend to over-report pain and if such association existed in our study, then the reported socioeconomic inequality in our study is possibly underestimated. Second, other potential mediators including physical activity were not included due to lack of data. Third, eleven percent of people with knee pain and 30% of subjects without knee pain did not agree to participate in the stage II of the MOA. Although we accounted for non-participation using weighting, it may be a potential source of selection bias if non-participation was caused by unmeasured factors. Fourth, the cross-sectional design of our study does not allow for any causal inference.

In conclusion, this large population-based study revealed the presence of socioeconomic inequality in knee pain, knee OA and HRQoL in favor of people with better SES among middle-aged and elderly people in Sweden. The socioeconomic inequality in knee OA was mainly due to difference in lifestyle risk factors (i.e., smoking and BMI) across

socioeconomic groups. However, socioeconomic inequalities in knee pain and HRQoL were not fully explained by smoking, BMI and knee OA implying that other factors should explain these inequalities. While clinicians are not able to modify the SES measures used in the study, our results highlight the importance of engaging a patient-centered approach taking patients' SES into account in the management of knee pain and knee OA. For example, patients with lower education might need more support regarding self-management or adherence to treatment. Moreover, individual SES should be taken into account in health resource allocation pertaining to knee-related disorders.

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Author's contributions: AAK participated in the design, analysis, and interpretation of results and drafting the manuscript. MGdV and SL participated in conception of the study, acquisition of data, and revision of the manuscript for important intellectual content. AT and ME participated in acquisition of data, interpretation of results, and revision of the manuscript for important intellectual content. All authors approved the final manuscript.

Competing interest statement: MGdV is employed by AstraZeneca and is an owner of AstraZeneca shares as part of the bonus system. All other authors have declared no conflicts of interest.

References

1. Turkiewicz A, Gerhardsson de Verdier M, Engstrom G, Nilsson PM, Mellstrom C, Lohmander LS, et al. Prevalence of knee pain and knee OA in southern Sweden and the proportion that seeks medical care. *Rheumatology (Oxford)* 2015;54 5: 827-35.
2. Kadam UT, Jordan K, Croft PR. Clinical comorbidity in patients with osteoarthritis: a case-control study of general practice consultants in England and Wales. *Ann Rheum Dis* 2004;63 4: 408-14.
3. Muraki S, Akune T, Oka H, En-yo Y, Yoshida M, Saika A, et al. Association of radiographic and symptomatic knee osteoarthritis with health-related quality of life in a population-based cohort study in Japan: the ROAD study. *Osteoarthritis Cartilage* 2010;18 9: 1227-34.
4. Arden NK, Crozier S, Smith H, Anderson F, Edwards C, Raphael H, et al. Knee pain, knee osteoarthritis, and the risk of fracture. *Arthritis Rheum* 2006;55 4: 610-5.
5. Agaliotis M, Mackey MG, Jan S, Fransen M. Burden of reduced work productivity among people with chronic knee pain: a systematic review. *Occup Environ Med* 2014;71 9: 651-9.
6. Hubertsson J, Petersson IF, Thorstensson CA, Englund M. Risk of sick leave and disability pension in working-age women and men with knee osteoarthritis. *Ann Rheum Dis* 2013;72 3: 401-5.
7. Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012;380 9859: 2163-96.
8. Puig-Junoy J, Ruiz Zamora A. Socio-economic costs of osteoarthritis: A systematic review of cost-of-illness studies. *Semin Arthritis Rheum* 2014.
9. Zhang Y, Jordan JM. Epidemiology of osteoarthritis. *Clin Geriatr Med* 2010;26 3: 355-69.
10. Callahan LF, Cleveland RJ, Shreffler J, Schwartz TA, Schoster B, Randolph R, et al. Associations of educational attainment, occupation and community poverty with knee osteoarthritis in the Johnston County (North Carolina) osteoarthritis project. *Arthritis Res Ther* 2011;13 5: R169.
11. Rossignol M. Primary osteoarthritis and occupation in the Quebec national health and social survey. *Occup Environ Med* 2004;61 9: 729-35.
12. Rossignol M, Leclerc A, Hilliquin P, Allaert FA, Rozenberg S, Valat JP, et al. Primary osteoarthritis and occupations: a national cross sectional survey of 10 412 symptomatic patients. *Occup Environ Med* 2003;60 11: 882-6.
13. Hannan MT, Anderson JJ, Pincus T, Felson DT. Educational attainment and osteoarthritis: differential associations with radiographic changes and symptom reporting. *J Clin Epidemiol* 1992;45 2: 139-47.
14. Jhun HJ, Sung NJ, Kim SY. Knee pain and its severity in elderly Koreans: prevalence, risk factors and impact on quality of life. *J Korean Med Sci* 2013;28 12: 1807-13.
15. Miranda H, Viikari-Juntura E, Martikainen R, Riihimaki H. A prospective study on knee pain and its risk factors. *Osteoarthritis Cartilage* 2002;10 8: 623-30.
16. O'Reilly SC, Muir KR, Doherty M. Occupation and knee pain: a community study. *Osteoarthritis Cartilage* 2000;8 2: 78-81.
17. Cleveland RJ, Luong ML, Knight JB, Schoster B, Renner JB, Jordan JM, et al. Independent associations of socioeconomic factors with disability and pain in adults with knee osteoarthritis. *BMC Musculoskelet Disord* 2013;14: 297.

18. Peters TJ, Sanders C, Dieppe P, Donovan J. Factors associated with change in pain and disability over time: a community-based prospective observational study of hip and knee osteoarthritis. *Br J Gen Pract* 2005;55 512: 205-11.
19. Sandmark H, Hogstedt C, Vingard E. Primary osteoarthrosis of the knee in men and women as a result of lifelong physical load from work. *Scand J Work Environ Health* 2000;26 1: 20-5.
20. Holmberg S, Thelin A, Thelin N. Is there an increased risk of knee osteoarthritis among farmers? A population-based case-control study. *Int Arch Occup Environ Health* 2004;77 5: 345-50.
21. Vingard E, Alfredsson L, Goldie I, Hogstedt C. Occupation and osteoarthrosis of the hip and knee: a register-based cohort study. *Int J Epidemiol* 1991;20 4: 1025-31.
22. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res Methodol* 2003;3: 21.
23. Khang YH, Yun SC, Lynch JW. Monitoring trends in socioeconomic health inequalities: it matters how you measure. *BMC Public Health* 2008;8: 66.
24. Mackenbach JP, Kunst AE. Measuring the magnitude of socio-economic inequalities in health: an overview of available measures illustrated with two examples from Europe. *Soc Sci Med* 1997;44 6: 757-71.
25. Manjer J, Carlsson S, Elmstahl S, Gullberg B, Janzon L, Lindstrom M, et al. The Malmo Diet and Cancer Study: representativity, cancer incidence and mortality in participants and non-participants. *Eur J Cancer Prev* 2001;10 6: 489-99.
26. Altman RD, Hochberg M, Murphy WA, Jr., Wolfe F, Lequesne M. Atlas of individual radiographic features in osteoarthritis. *Osteoarthritis Cartilage* 1995;3 Suppl A: 3-70.
27. Englund M, Roos EM, Lohmander LS. Impact of type of meniscal tear on radiographic and symptomatic knee osteoarthritis: a sixteen-year followup of meniscectomy with matched controls. *Arthritis Rheum* 2003;48 8: 2178-87.
28. Altman R, Asch E, Bloch D, Bole G, Borenstein D, Brandt K, et al. Development of criteria for the classification and reporting of osteoarthritis. Classification of osteoarthritis of the knee. Diagnostic and Therapeutic Criteria Committee of the American Rheumatism Association. *Arthritis Rheum* 1986;29 8: 1039-49.
29. Brooks R. EuroQol: the current state of play. *Health Policy* 1996;37 1: 53-72.
30. Burstrom K, Sun S, Gerdtham UG, Henriksson M, Johannesson M, Levin LA, et al. Swedish experience-based value sets for EQ-5D health states. *Qual Life Res* 2014;23 2: 431-42.
31. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynnon BD. Knee Injury and Osteoarthritis Outcome Score (KOOS)--development of a self-administered outcome measure. *J Orthop Sports Phys Ther* 1998;28 2: 88-96.
32. Roos EM, Roos HP, Ekdahl C, Lohmander LS. Knee injury and Osteoarthritis Outcome Score (KOOS)--validation of a Swedish version. *Scand J Med Sci Sports* 1998;8 6: 439-48.
33. Sweden S. Socioekonomisk indelning. *Meddelande i Samordningsfrågor* 1982[Swedish socio-economic classification, SEI. Reports on Statistical Coordination, in Swedish with an English summary]. Stockholm: Statistics Sweden. 1982. (Available at http://www.scb.se/Grupp/Hitta_statistik/Forsta_Statistik/Klassifikationer/_Dokument/SEI_AGG-Eng.pdf)

34. Rosvall M, Ostergren PO, Hedblad B, Isacson SO, Janzon L, Berglund G. Occupational status, educational level, and the prevalence of carotid atherosclerosis in a general population sample of middle-aged Swedish men and women: results from the Malmo Diet and Cancer Study. *Am J Epidemiol* 2000;152 4: 334-46.
35. Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004;159 7: 702-6.
36. Little RJ, Vartivarian S. On weighting the rates in non-response weights. *Stat Med* 2003;22 9: 1589-99.
37. Brekke M, Hjortdahl P, Kvien TK. Severity of musculoskeletal pain: relations to socioeconomic inequality. *Soc Sci Med* 2002;54 2: 221-8.
38. Callahan LF, Martin KR, Shreffler J, Kumar D, Schoster B, Kaufman JS, et al. Independent and combined influence of homeownership, occupation, education, income, and community poverty on physical health in persons with arthritis. *Arthritis Care Res (Hoboken)* 2011;63 5: 643-53.
39. Amin S, Niu J, Guermazi A, Grigoryan M, Hunter DJ, Clancy M, et al. Cigarette smoking and the risk for cartilage loss and knee pain in men with knee osteoarthritis. *Ann Rheum Dis* 2007;66 1: 18-22.
40. Fransen M, Su S, Harmer A, Blyth FM, Naganathan V, Sambrook P, et al. A longitudinal study of knee pain in older men: Concord Health and Ageing in Men Project. *Age Ageing* 2014;43 2: 206-12.
41. Eek F, Ostergren PO, Diderichsen F, Rasmussen NK, Andersen I, Moussa K, et al. Differences in socioeconomic and gender inequalities in tobacco smoking in Denmark and Sweden; a cross sectional comparison of the equity effect of different public health policies. *BMC Public Health* 2010;10: 9.
42. Magnusson M, Sorensen TI, Olafsdottir S, Lehtinen-Jacks S, Holmen TL, Heitmann BL, et al. Social Inequalities in Obesity Persist in the Nordic Region Despite Its Relative Affluence and Equity. *Curr Obes Rep* 2014;3: 1-15.
43. Thomtén J, Soares JJF, Sundin O. Pain among women: Associations with socio-economic factors over time and the mediating role of depressive symptoms. *Scand J Pain* 2012;3: 62-7.
44. Yelin E, Callahan LF. The economic cost and social and psychological impact of musculoskeletal conditions. National Arthritis Data Work Groups. *Arthritis Rheum* 1995;38 10: 1351-62.
45. Macfarlane GJ, Norrie G, Atherton K, Power C, Jones GT. The influence of socioeconomic status on the reporting of regional and widespread musculoskeletal pain: results from the 1958 British Birth Cohort Study. *Ann Rheum Dis* 2009;68 10: 1591-5.
46. Cano A, Mayo A, Ventimiglia M. Coping, pain severity, interference, and disability: the potential mediating and moderating roles of race and education. *J Pain* 2006;7 7: 459-68.
47. Christensen U, Schmidt L, Hougaard CO, Kriegbaum M, Holstein BE. Socioeconomic position and variations in coping strategies in musculoskeletal pain: a cross-sectional study of 1,287 40- and 50-year-old men and women. *J Rehabil Med* 2006;38 5: 316-21.
48. Blank N, Diderichsen F. Social inequalities in the experience of illness in Sweden: a "double suffering". *Scand J Soc Med* 1996;24 2: 81-9.
49. Yong PF, Milner PC, Payne JN, Lewis PA, Jennison C. Inequalities in access to knee joint replacements for people in need. *Ann Rheum Dis* 2004;63 11: 1483-9.

50. Brennan SL, Lane SE, Lorimer M, Buchbinder R, Wluka AE, Page RS, et al. Associations between socioeconomic status and primary total knee joint replacements performed for osteoarthritis across Australia 2003-10: data from the Australian Orthopaedic Association National Joint Replacement Registry. *BMC Musculoskelet Disord* 2014;15: 356.
51. Wetterholm M, Turkiewicz A, Stigmar K, Hubertsson J, Englund M. The rate of joint replacement in osteoarthritis depends on the patient's socioeconomic status. *Acta Orthop* 2016; 16:1-7
52. Pereira D, Peleteiro B, Araujo J, Branco J, Santos RA, Ramos E. The effect of osteoarthritis definition on prevalence and incidence estimates: a systematic review. *Osteoarthritis Cartilage* 2011; 19: 1270-1285.
53. Ahmad Kiadalir A, Lamm C, Gerhardsson de Verdier M, Engstrom G, Turkiewicz A, Lohmander LS, et al. Association of knee pain and different definitions of knee osteoarthritis with health-related quality of life: a population-based cohort study. *Osteoarthritis Cartilage* 2016; 24:S236-S237.
54. d'Uva TB1, O'Donnell O, van Doorslaer E. Differential health reporting by education level and its impact on the measurement of health inequalities among older Europeans. *Int J Epidemiol* 2008;37(6):1375-83.

Table 1. Characteristics of the subjects included in the first and second stages of the Malmö osteoarthritis (MOA) study.

	Stage I (postal questionnaire) (n=7 402)	Stage II (clinical visit) (n=1 527)
Women, %	62.2	64.0
Age, years (SD)	70.0 (7.5)	69.4 (7.2)
BMI (SD)	25.7 (4.0)	27.7 (5.0)
Smoking, %		
Never smoked	39.1	39.1
Current smoker	23.9	22.6
Ex-smoker	33.3	35.2
Missing	3.7	3.1
Years of education, %		
≤ 9 years	35.9	35.3
> 9 years & ≤ 12 years	36.4	37.2
>12 years	23.8	24.2
Missing	3.9	3.3
Occupation, %		
Unskilled manual	21.9	21.9
Skilled manual	10.3	10.0
Low-level non-manual	24.6	24.7
Intermediate non-manual	18.9	20.0
High-level non-manual and self-employed professionals	15.6	15.7
Self-employed and farmers excluding professionals	4.5	4.0
Missing	4.2	3.7
Frequent knee pain, %	24.8	67.3

Table 2. Relative index of inequality (RII) in prevalence of frequent knee pain and knee osteoarthritis among subjects in the Malmö Osteoarthritis (MOA) study stages I & II.

	Total	Aged 56-65	Aged 66-75	Aged 76 and older	Men	Women
Frequent knee pain						
Education	0.71 (0.61 to 0.84)**	0.69 (0.53 to 0.89)** ^a	0.79 (0.61 to 1.02)	0.72 (0.53 to 0.97)** ^a	0.67 (0.50 to 0.89)**	0.74 (0.61 to 0.90)** ^a
Occupation	0.70 (0.60 to 0.82)**	0.64 (0.50 to 0.82)**	0.70 (0.54 to 0.90)**	0.85 (0.63 to 1.14)	0.75 (0.57 to 0.99)** ^a	0.69 (0.58 to 0.83)**
<i>Radiographic knee OA</i>						
Education	0.53 (0.29 to 0.98)** ^a	0.52 (0.18 to 1.47)	0.75 (0.30 to 1.90)	0.47 (0.14 to 1.59)	0.46 (0.17 to 1.22)	0.62 (0.28 to 1.36)
Occupation	0.55 (0.31 to 0.98)** ^a	1.13 (0.36 to 3.56)	0.75 (0.32 to 1.79)	0.27 (0.10 to 0.73)** ^a	1.09 (0.39 to 3.06)	0.40 (0.20 to 0.80)** ^a
<i>Clinical knee OA</i>						
Education	0.67 (0.36 to 1.25)	0.76 (0.29 to 2.00)	0.73 (0.25 to 2.13)	0.61 (0.17 to 2.15)	0.73 (0.25 to 2.10)	0.68 (0.32 to 1.44)
Occupation	0.56 (0.29 to 1.06)	0.34 (0.13 to 0.92)** ^a	0.62 (0.21 to 1.83)	1.01 (0.29 to 3.59)	1.37 (0.51 to 3.67)	0.39 (0.17 to 0.87)*
<i>Knee OA, any definition</i>						
Education	0.56 (0.34 to 0.93)** ^a	0.60 (0.27 to 1.34)	0.70 (0.32 to 1.54)	0.50 (0.18 to 1.42)	0.48 (0.21 to 1.11)	0.63 (0.33 to 1.19)
Occupation	0.55 (0.34 to 0.89)** ^a	0.61 (0.26 to 1.42)	0.69 (0.33 to 1.44)	0.40 (0.17 to 0.96)** ^a	0.94 (0.40 to 2.24)	0.43 (0.24 to 0.77)**

** P < 0.01; * P < 0.05.

The RIIs can be interpreted as relative rate ratio between the hypothetically highest and hypothetically lowest education/occupation categories; Estimates adjusted for age and sex and accounted for non-response weights;

^a After additional controlling for BMI and smoking, the relative index of inequality was no longer statistically significantly different than 1.0 (p>0.05).

Table 3. Relative index of inequality (RII) in health-related quality of life among the subject in the Malmö Osteoarthritis (MOA) study stage II.

	Total	Aged 56-65	Aged 66-75	Aged 76 and older	Men	Women
<i>Swedish EQ-5D-3L score ≤ median</i>						
Education	0.79 (0.56 to 1.12)	0.46 (0.25 to 0.83)*	1.02 (0.57 to 1.82)	0.83 (0.48 to 1.46)	0.78 (0.43 to 1.43)	0.79 (0.51 to 1.21)
Occupation	0.75 (0.53 to 1.06)	0.47 (0.25 to 0.86)*	0.97 (0.54 to 1.76)	0.80 (0.46 to 1.39)	0.74 (0.41 to 1.33)	0.76 (0.50 to 1.17)
<i>KOOS-pain score ≤ median</i>						
Education	0.61 (0.42 to 0.90)* ^a	0.53 (0.29 to 0.98)* ^a	1.21 (0.67 to 2.18)	0.32 (0.16 to 0.68)**	0.84 (0.43 to 1.65)	0.54 (0.34 to 0.85)** ^a
Occupation	0.57 (0.39 to 0.83)**	0.47 (0.26 to 0.86)*	0.97 (0.51 to 1.83)	0.37 (0.19 to 0.75)** ^a	0.82 (0.42 to 1.59)	0.50 (0.31 to 0.80)** ^a
<i>KOOS-other symptoms score ≤ median</i>						
Education	0.52 (0.36 to 0.76)**	0.59 (0.33 to 1.05)	0.81 (0.45 to 1.46)	0.28 (0.13 to 0.61)**	0.48 (0.24 to 0.94)*	0.57 (0.37 to 0.89)* ^a
Occupation	0.54 (0.37 to 0.78)**	0.76 (0.45 to 1.30)	0.71 (0.38 to 1.32)	0.26 (0.12 to 0.55)**	0.57 (0.29 to 1.11)	0.55 (0.36 to 0.86)** ^a
<i>KOOS-ADL score ≤ median</i>						
Education	0.52 (0.36 to 0.77)**	0.46 (0.25 to 0.87)* ^a	0.93 (0.51 to 1.69)	0.31 (0.16 to 0.64)**	0.73 (0.38 to 1.43)	0.44 (0.28 to 0.69)**
Occupation	0.49 (0.34 to 0.72)**	0.44 (0.23 to 0.83)* ^a	0.64 (0.34 to 1.18)	0.43 (0.22 to 0.82)* ^a	0.76 (0.40 to 1.44)	0.41 (0.26 to 0.65)**
<i>KOOS-QoL score ≤ median</i>						
Education	0.70 (0.48 to 1.01)	0.55 (0.31 to 0.97)* ^a	1.07 (0.59 to 1.93)	0.57 (0.28 to 1.17)	1.06 (0.56 to 1.99)	0.57 (0.36 to 0.89)* ^a
Occupation	0.55 (0.38 to 0.79)**	0.42 (0.24 to 0.73)**	0.67 (0.36 to 1.23)	0.59 (0.30 to 1.17)	0.84 (0.45 to 1.55)	0.46 (0.29 to 0.71)**

** P < 0.01; * P < 0.05.

The RIIs can be interpreted as relative rate ratio between the hypothetically highest and hypothetically lowest education/occupation categories; Estimates adjusted for age and sex and accounted for non-response weights;

^a After additional controlling for BMI, smoking and knee osteoarthritis, the relative index of inequality was no longer statistically significantly different than 1.0 (p>0.05).

Figures legends

Figure 1. Proportion (%) of people with frequent knee pain across education and occupation groups.

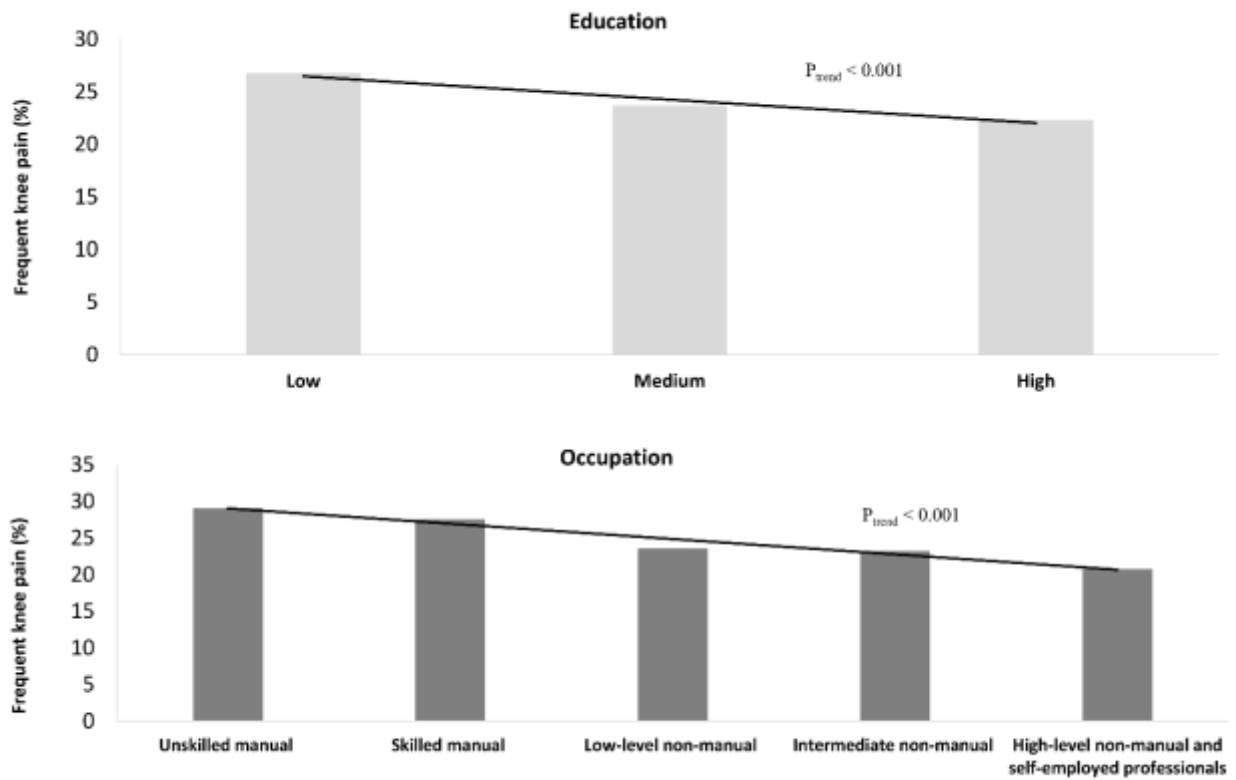


Figure 2. Proportion (%) of people with knee osteoarthritis across education and occupation groups.

