Patellar fractures are associated with an increased risk of total knee arthroplasty

A matched cohort study of 6096 patellar fractures with a mean follow-up of 14.3 years

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ABSTRACT

Aims: To investigate the incidence of total knee replacement (TKR) following patella fractures and compare this to an age- and gender-matched group without a prior patella fracture.

Patients and Methods: A national matched cohort study based on the Danish National Patient Register including all citizens of Denmark (approximately 5.7 million) was undertaken. 6096 patients who sustained a patella fracture in Denmark between January 1, 1996, and December 31, 2000, were included and followed until December 31, 2015, with regard to treatment with TKR and/or knee arthroscopy.

Results: Patients with a patella fracture had an increased risk of TKR (hazard ratio (HR): 1.83, 95%CI: 1.57-2.13) compared to citizens without a patella fracture, and the effect was strongest during the first five years (HR: 3.02, 95%CI: 2.26-4.03). Patients with a patella fracture also had a higher risk of knee arthroscopy (HR: 3.94, 95%CI: 3.49-4.46), and the effect was highest during the first five years after the fracture (HR: 7.40, 95%CI: 6.32-8.66).

Conclusions: Patella fractures are associated with a considerably increased risk of total knee arthroplasty and knee arthroscopy. The consequences of a patella fracture are more severe than previously documented, and patients must expect a lifelong increased risk of TKR.

- Patients suffering a patella fracture has an increased risk of TKR and knee arthroscopy throughout life.

INTRODUCTION

The modern elderly population has an increased demand for a pain-free and active lifestyle with a high functional capacity.[1] They want to stay active without limitations due to joint pain. This may contribute to the steady increase in joint replacements around the world.[1] Identifying early factors associated with an increased risk of joint pain, osteoarthritis, and knee joint replacement has become increasingly important.

Patella fractures account for 0.7-1%[2,3] of all fractures, with an incidence of 13.1/100,000/year.[4] Despite the commonality, little information exists about the long-term consequences following a patella fracture.[3,5–12] Recent literature suggests that 50 percent of patients with patella fractures continue to experience symptoms affecting their function during activities of daily living and quality of life (QOL).[5,9,13]

Traumatic knee injuries that involve the tibia may increase the risk of posttraumatic knee osteoarthritis (OA).[10,14,15] The injury mechanisms underpinning the development of OA may be related to the forces applied to the chondral surfaces at the time of injury, fracture comminution, and mode of injury.[15] Post-injury factors such as the quality of articular surface reduction and the choice of treatment method could also contribute to the risk of posttraumatic knee OA following a patella fracture.[5,6]

Total knee replacement (TKR) is commonly required in the treatment of end-stage knee osteoarthritis. A large-scale retrospective study of 19,641 TKR procedures showed that 0.5% of all patients treated with a TKR reported a history of a patella fracture.[14] This suggests that a patella fracture may increase the risk of TKR later in life.

The primary aim of this study was to investigate the incidence of TKR following patella fractures compared to an age- and gender-matched group without a prior patella fracture.

The secondary aims were to investigate the incidence of knee arthroscopy following a patella fracture and compare this to an age- and gender-matched group without a prior patella fracture and, furthermore, to compare the time to TKR and arthroscopy of the knee following a patella fracture compared to that of an age- and gender-matched non-exposed group.

PATIENTS AND METHODS

Study design

The study was designed as a matched cohort study using prospectively obtained registry data from the Danish National Patient Register on all citizens of Denmark.

All patients who sustained a patella fracture in Denmark between January 1, 1996, and December 31, 2000, were included and followed until December 31, 2015, regarding treatment with TKR (including patellofemoral replacement) and/or knee arthroscopy.

Danish law requires that all patient contacts with hospital and outpatient clinics in Denmark are registered in the Danish National Patient Register.[16] Hospital identification, date and time of activity, and patient's municipality (among other characteristics) are registered. A Civil Registration Number (CPR) is given to all residents of Denmark and registered in the Civil Registration System, and information

on emigration and death is recorded in this registry.[17] This enables researchers to have a complete and valid registration of all health-related issues on an individual level in a complete population.[18]

The Local Ethics Committee was asked to approve the study and answered that the study design does not need notification. The Danish Data Protection Agency approved the study (J. nr. 2008-58-0028, Id: 2016-176). The reporting of the study complies with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.[19]

The full study protocol and study analysis plan was published online before the start of the study.[XX] The reporting of the present study lacks information considering ipsilateral and contralateral information as predefined because side-specific information was not a required part of data in the Danish National Patient Register.

Study population and data retrieval

The exposed group of patients with a patella fracture was identified through a retrospective review of all Danish patients diagnosed with a patella fracture between January 1, 1996, and December 31, 2000. All patients who were registered regardless of contact type with the ICD-10 diagnosis code for "patella fracture" (S82.0) were identified in the Danish National Patient Register. Basic characteristics, gender, and age at the time of diagnosis were obtained. Patients were included at the time of first contact with a patella fracture reported to the Danish National Patient Register. Patients with prior patella fractures and patients with prior TKR were excluded from

the study. All patients were followed with regard to surgery with TKR and/or arthroscopic surgery of the knees identified in the Danish National Patient Register.

The non-exposed group consisted of individuals identified from the Civil Registration System matched to the exposed case based on age and gender. For each exposed case, we included 10 non-exposed citizens who had not experienced a patella fracture or a TKR before the inclusion date. Information regarding arthroscopy of the knees and TKR were obtained from the Danish National Patient Register.

Both exposed and non-exposed individuals were censored in case of emigration from the country or at the end of follow-up. Death was considered a competing event and so was receiving a TKR when considering knee arthroscopy as the outcome.

Primary and secondary outcome

The primary outcome was treatment with a TKR. The secondary outcome was treatment with knee arthroscopy.

Statistical methods

The risk of experiencing a TKR over time was assessed using cumulative incidence proportions which were calculated using the Aalen-Johansen estimator.[20]

The analysis evaluating the effect of patella fracture on the incidence of TKR was performed using a Cox proportional hazards regression model comparing the exposed and non-exposed groups. The effect estimate was reported as a hazard ratio with a corresponding 95% confidence interval to estimate the incidence rate ratio. Results from the crude analysis without adjustments are reported. Furthermore, we repeated

the analysis stratified by age groups (0-50, 51+) and gender. To investigate the assumption of proportional hazards, the follow-up time is divided into five-year periods.

Additional analyses were performed to investigate the effect of patella fracture on the secondary outcome (knee arthroscopy) following the same methods as for the main analysis except that TKR, in addition to death, was considered as a competing event for arthroscopy.

All analyses were performed using Stata statistical software (StataCorp LP), and the significance level for analyses (α) was set to 0.05.

RESULTS

Between January 1, 1996, and December 31, 2000, we identified 6,096 patients who sustained a patella fracture in Denmark. The median age of patients was 50.6 (IQR: 28.5-68.9) years, and 49.1% were women. The average observational period was 14.3 years.

Primary outcome

The analysis showed that 3.3% of patients with a prior patella fracture were treated with a TKR (N=200) and that 2% of patients without a prior patella fracture were treated with a TKR (N=1,239) during the observational period. Patients with a prior patella fracture had a 1.83 (95%CI: 1.57-2.13) times higher hazard ratio (HR) compared to patients without a prior patella fracture. The effect was highest during the first five years after the fracture (HR: 3.02 (95%CI: 2.26-4.03)) (Table 1).

The cumulative incidence of TKR during the entire observational period expressed for the two groups is shown in Figure 1. The figure shows a significantly increased risk of TKR in patients with a prior patella fracture compared to patients without a prior patella fracture throughout the observational period.

Analyses of age and gender difference on TKR

Both genders show a significantly increased incidence of TKR in patients with a prior patella fracture compared with patients without a prior patella fracture. Compared to women, men presented with an increased incidence of TKR throughout the observational period. The age group above 50 years presented with a substantially increased risk compared to the age group below 50 years. However, the age group below 50 years presented with a proportionately greater risk of TKR compared to the reference population when compared to the age group above 50 years. (Supplemental figure 1-4).

Secondary outcomes—knee arthroscopy

The analysis showed that 6.8% of patients with a prior patella fracture were treated with a knee arthroscopy (N=416) and 2.1% of patients without a prior patella fracture were treated with a knee arthroscopy (N=1,249). Patients with a prior patella fracture had a 3.94 (95%CI: 3.49-4.46)) times higher hazard compared to patients without a prior patella fracture. The effect was highest during the first five years after the fracture (HR: 7.40 (95%CI: 6.32-8.66)) (Table 2).

The cumulative incidence of knee arthroscopy during the entire observational period is shown in Figure 2. The figure shows a significantly increased risk of knee arthroscopy in patients with a prior patella fracture compared to patients who had not experienced a prior patella fracture throughout the observational period.

The analyses of age and gender differences in the incidence of knee arthroscopy show an almost equal risk between genders. The analysis stratified on age showed that the age group below 50 years of age had a considerably increased risk compared to the age group above 50. The vast majority of increased risk of arthroscopy is observed within the first three years following fracture. (Supplemental Figure 5-8).

DISCUSSION

Patients with a prior patella fracture had an 83% higher incidence of TKR in the years following their injury compared to a similar group of individuals without a patella fracture. The incidence was highest during the first five years following a patella fracture. Collectively, these results indicate that patients with a patella fracture may be at risk of developing posttraumatic osteoarthritis, long-term pain, and may experience early treatment with TKR.

The long-term consequences of patella fractures may be more serious than previously anticipated, especially in younger patients. Julin et al.[21] reported that young age impairs the prognosis of TKR and is associated with increased revision rates. The outcome of revision surgery following TKR has been reported with impaired function, increased pain, and decreased QOL.[22,23] Moreover, Houdeck et al.[14] reported that a patella fracture before TKR was associated with a worse outcome but equivalent implant survival. Consequently, surgeons may be reluctant to offer

younger patients with severe posttraumatic osteoarthritis following a patella fracture treatment with TKR. Further research needs to address this and focus on other treatment modalities which might postpone or reduce the need for TKR following a patella fracture.

National preference regarding the use of patella resurfacing in primary TKR might influence the threshold when considering the possibility to treat patients experiencing pain following a patella fracture with a primary TKR. Compared to other Scandinavian countries, Denmark has a high resurfacing rate of 76%, which might influence the number of patients treated with a TKR following a patella fracture.[24]

Patients with a previous patella fracture had a four times higher incidence of a knee arthroscopy compared to the control group. This is a new finding, and the literature lacks information about this association. These findings may be a strong indicator that many patients experience pain and decreased knee function, especially in the first years following a patella fracture. However, this study did not include clinical information regarding the underlying causes leading to surgery and the subsequent outcomes following the procedures.

A significant strength is the design of this study. Using high-quality data registries in Denmark, we included the entire population of patients with patella fractures and compared this to a non-exposed age- and gender-matched control group. Coding in the Danish National Patient Register is required by national law since 1978, and allocation of payment to health care providers is partly based on this coding. In general, the Danish National Patient Register is widely accepted as one of the world's

most valid health registries with several decades of follow-up.[18] However, a small private activity, especially regarding arthroscopy, might have eluded the registry until mandatory registration by private hospitals was introduced in 2003. Although this might have had some effect on the crude incidence of surgery, this effect would have been present in both groups. A further limitation is the observation period of 14.3 years on average which may be too short to capture the full long-term consequences, and hence, our results may be conservative estimates. Moreover, ipsilateral and contralateral information of TKR and arthroscopy is missing as side-specific information was not a required part of data in the Danish National Patient Register. This is a limitation and as result, the ipsilateral risk of TKR and arthroscopy is likely higher than the risk estimates reported in the present study. Due to the nature of the study, information regarding fracture classification, treatment methods and outcome is not available. As a consequence, no subgroup analysis with regards to type of fracture and treatment modalities on the risk of TKR and arthroscopy is possible.

In conclusion, patella fractures are associated with a considerably increased risk of total knee replacement and a highly increased risk of knee arthroscopy compared with an age- and gender-matched control group with no prior patella fracture.

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Legends:

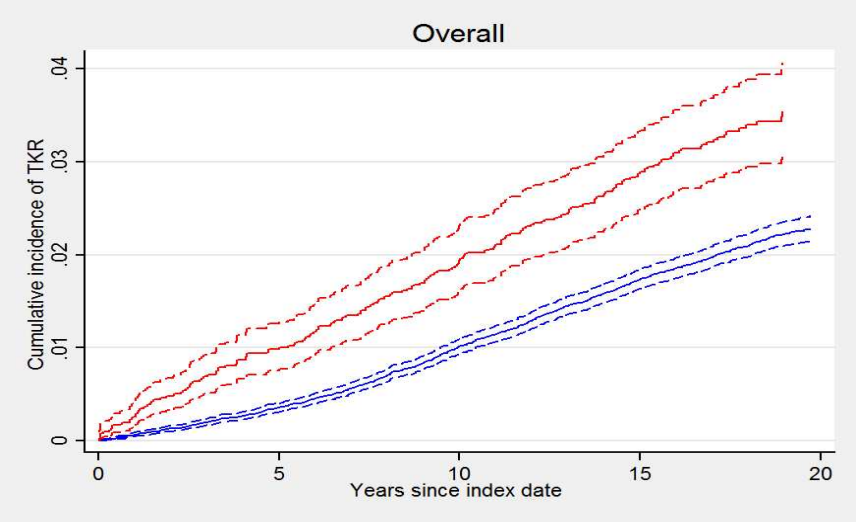
Table 1—Cox proportional hazards regression model of TKR comparing the exposed group with the non-exposed group.

Table 2—Cox proportional hazards regression model of knee arthroscopy comparing the exposed group with the non-exposed group.

Figure 1—Cumulative incidence of TKR
Legends: -- exposed group, -- non-exposed group

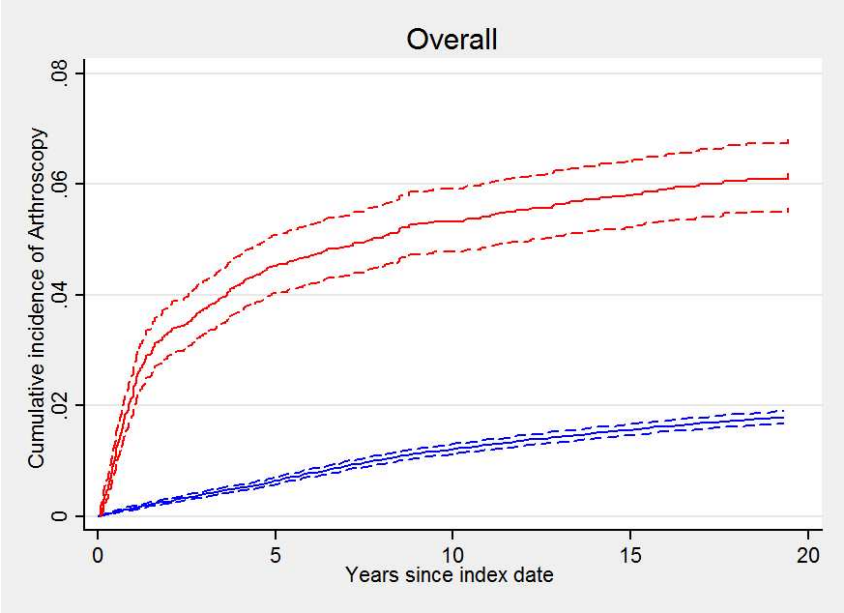
Figure 2– Cumulative incidence of arthroscopy
Legends: -- exposed group, -- non-exposed group

Figure 1—Cumulative incidence of TKR



Legends: -- exposed group, -- non-exposed group

Figure 2– Cumulative incidence of arthroscopy



Legends: -- exposed group, -- non-exposed group

Table 1:

Cox proportional hazards regression of TKR comparing the exposed group with the non-exposed grc

Follow-up time	N at beginning of interval	# events in interval	HR (95% CI)
0-5 years	66958	277	3.02 [2.26 - 4.03]
5-10 years	58917	454	1.56 [1.17 - 2.07]
10-15 years	52107	490	1.50 [1.13 - 2.00]
15-20 years	46083	216	1.67 [1.08 - 2.57]
0-20 years	66958	1437	1.83 [1.57 - 2.13]

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Table 2

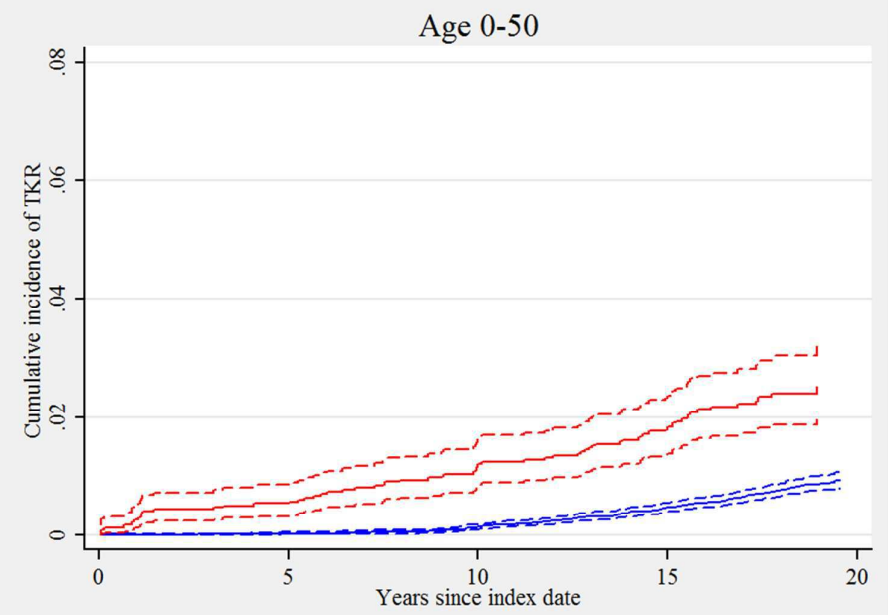
Cox proportional hazards regression of knee arthroscopy comparing the exposed group with the non-

Follow-up time	N at beginning of interval	# events in interval	HR (95% CI)
0-5 years	66680	661	7.40 [6.32 - 8.66]
5-10 years	58027	388	1.51 [1.11 - 2.05]
10-15 years	50913	233	1.57 [1.04 - 2.36]
15-20 years	44762	98	2.06 [1.15 - 3.69]
0-20 years	66680	1380	3.94 [3.49 - 4.46]

-exposed group.

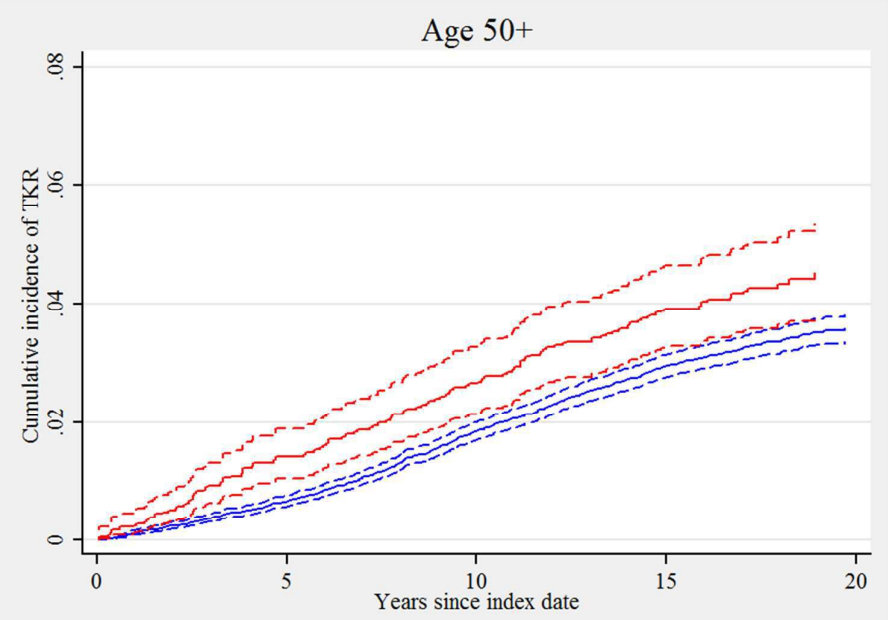
SUPPLEMENTAL FIGURES 1-8

Supplemental Figure 1: *Cumulative incidence of TKR age 0-50*



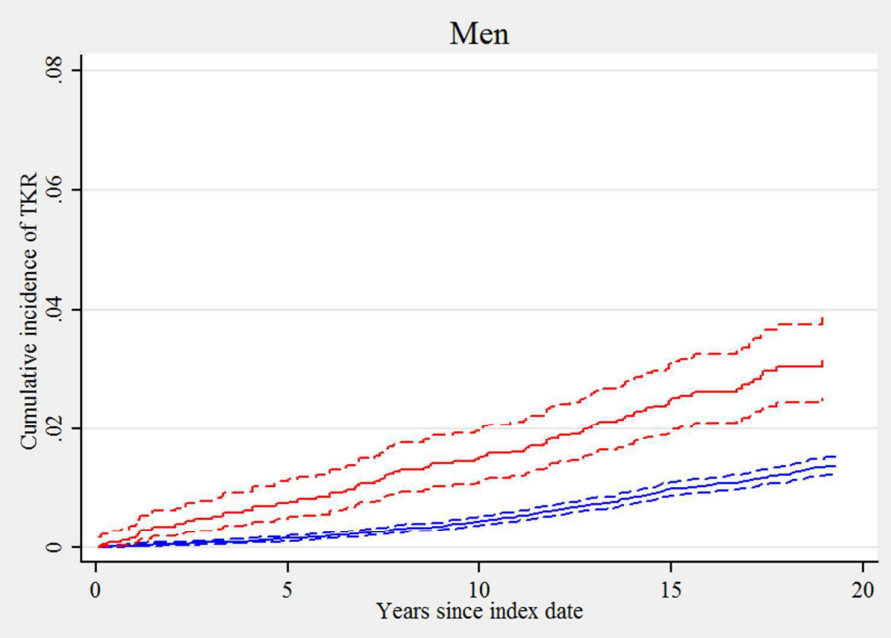
Legends: -- *exposed group,* -- *non-exposed group*

Supplemental Figure 2: *Cumulative incidence of TKR age 50+*



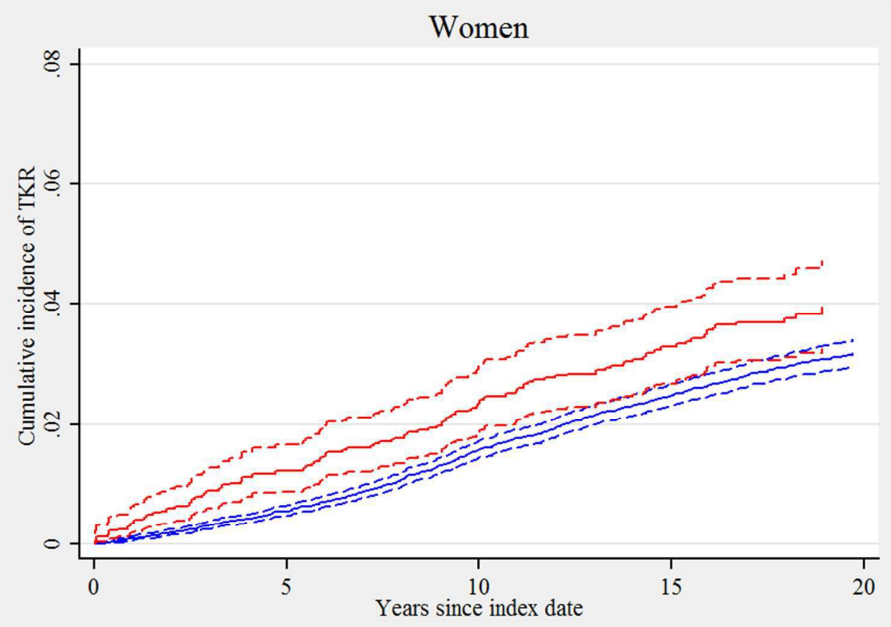
Legends: -- *exposed group,* -- *non-exposed group*

Supplemental Figure 3: *Cumulative incidence of TKR in men*



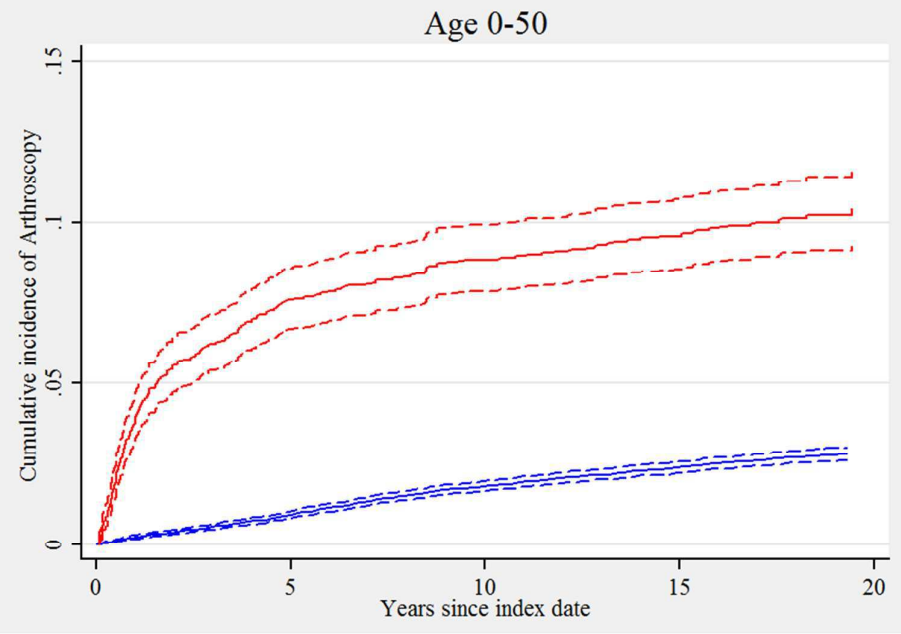
Legends: -- *exposed group,* -- *non-exposed group*

Supplemental Figure 4: *Cumulative incidence of TKR in women*



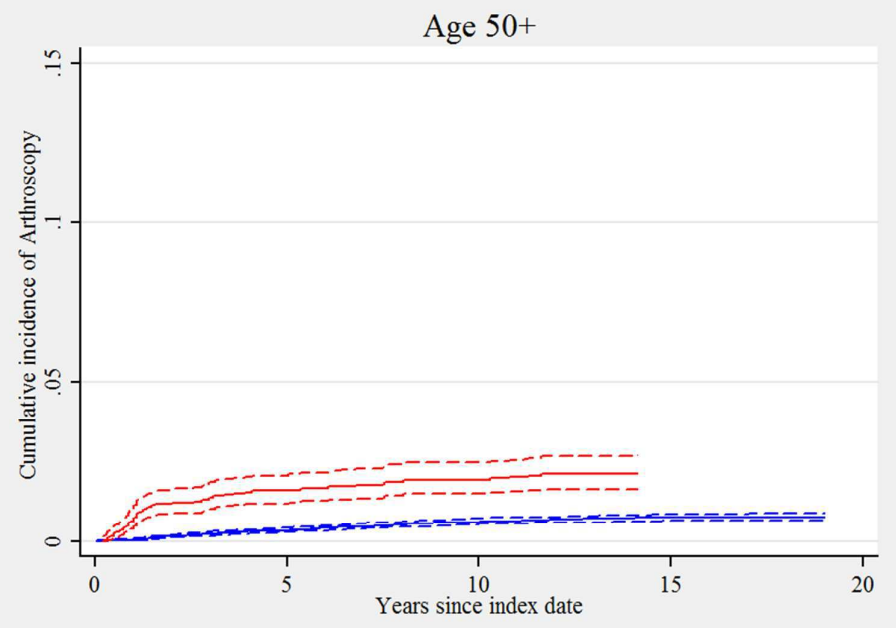
Legends: -- *exposed group,* -- *non-exposed group*

Supplemental Figure 5: *Cumulative incidence of knee arthroscopy age 0-50*



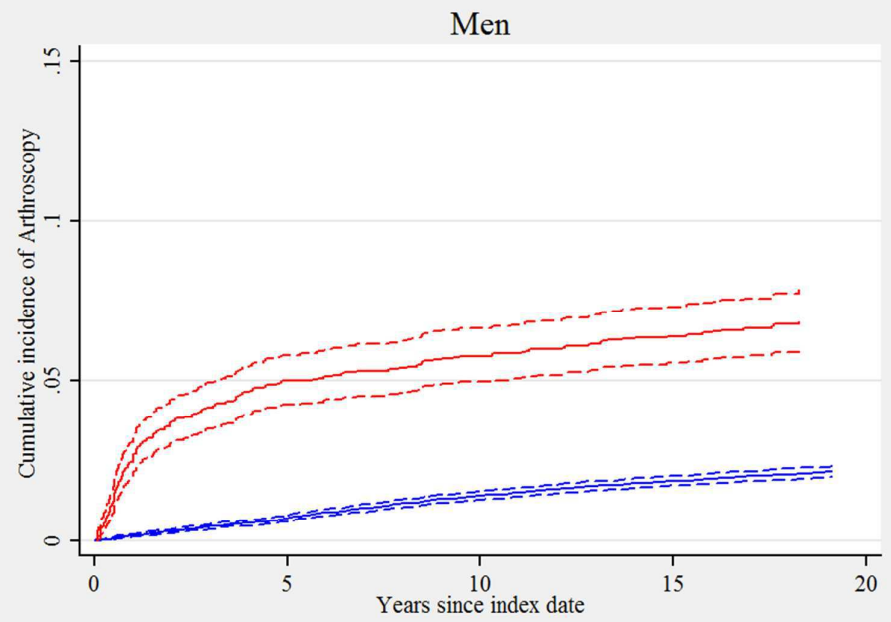
Legends: -- exposed group, -- non-exposed group

Supplemental Figure 6: *Cumulative incidence of knee arthroscopy age 50+*



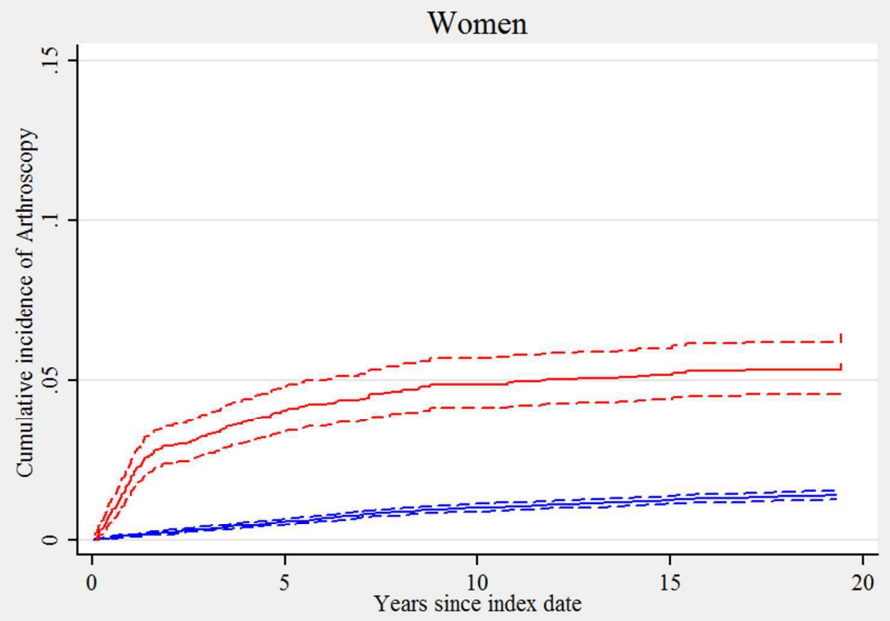
Legends: -- exposed group, -- non-exposed group

Supplemental Figure 7: *Cumulative incidence of knee arthroscopy in men*



Legends: -- *exposed group,* -- *non-exposed group*

Supplemental Figure 8: *Cumulative incidence of knee arthroscopy in women*



Legends: -- *exposed group,* -- *non-exposed group*