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Title Page

Informative Title: Is there an increased risk of falls and fractures in people with early diagnosed hip and knee osteoarthritis? Data from the Osteoarthritis Initiative.

Concise Title: Falls and fractures in early osteoarthritis

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Data collection/gathering: TS

Data analysis: TS, MM

Data interpretation: TS, EH, MP, MM

Preparation of written report: TS, EH, MP, MM

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Abstract

Aims: To assess the probability of individuals with early-diagnosed hip or knee osteoarthritis experiencing a fall and/or fracture compared to a cohort without osteoarthritis.

Methods: Data were analysed from the Osteoarthritis Initiative dataset. We identified all people who were diagnosed with hip or knee osteoarthritis within a 12 month period, compared to those without osteoarthritis. We determined whether there was a difference in the occurrence of falls, with or without a consequential fractures, between people newly diagnosed with hip or knee osteoarthritis compared to those who had not using odd ratios (OR) and 95% confidence intervals.

Results: 552 individuals with hip osteoarthritis were compared to 4244 individuals without hip osteoarthritis. 1350 individuals with knee osteoarthritis were compared to 3445 individuals without knee osteoarthritis. People with knee osteoarthritis had a 54% greater chance of experiencing a fall compared to those without (OR: 1.54; 95% CI: 1.35 to 1.77). People with hip osteoarthritis had a 52% greater chance of experiencing a fall compared to those without hip osteoarthritis (OR: 1.52; 95% CI: 1.26 to 1.84). People with knee and hip osteoarthritis demonstrated over an 80% greater chance of experiencing a fracture in the first 12 months of their diagnosis compared to those without hip or knee osteoarthritis (TKA: OR 1.81; THA: OR 1.84).

Conclusions: There is an increased risk of falls and fractures in early-diagnosed knee and hip osteoarthritis compared to those without osteoarthritis. International guidelines on the management of hip and knee osteoarthritis should consider the management of falls-risk.

Keywords: Joint degenerative; older people; falls; lower limb; arthritis; injury

Introduction

Falls are a serious threat to wellbeing of older people. They are a significant cause of morbidity and mortality.¹ It has been estimated that approximately 30% of community-dwelling individuals aged 65 years and older, and 50% aged 85 years and older, will experience a fall annually.² This can have a number of consequences including fall-related injury with associated fractures, reduced confidence and functional independence and ultimately a greater need for long-term care.² Falls-related fracture is considered the most serious of sequaele.³ Kannegaard et al⁴ estimated that the cumulative mortality among hip fracture patients is 37.1% in men and 26.4% in women 12 months post-fracture. A number of factors have been associated with increased risk of falls. These have included demographic, socio-economic, medical and morbidity-related, poly-pharmacy, environmental and physical, including impaired mobility, balance and gait problems.⁵

Osteoarthritis is one of the most common musculoskeletal disorders in the elderly.⁶ The incidence of osteoarthritis is increasing, with the increasing global ageing population, it is projected that the prevalence of osteoarthritis will increase from approximately 10% of people aged 60 years or older to 40% over the next 20 years.^{7,8} Osteoarthritis is associated with joint pain and stiffness, reduced balance, impeded mobility and loss of functional independence.⁹ These factors have all been previously demonstrated to be risk factors for falls in cohorts of older people.^{10,11}

Previous studies have demonstrated a link between osteoarthritis of the knee and falls. Doré et al¹¹ recently reported the association between the number of lower limb joints affected and falls risk, reporting an increased likelihood of falling in symptomatic osteoarthritis cohorts. However, previous literature has not examined the risk of subsequent fracture specifically as a falls-related injury in a large cohort such as the Osteoarthritis Initiative dataset. This is important given that fracture is the most serious consequence of falls associated with mortality in older people. It also remains unclear whether falls risk is different for people newly diagnosed with hip or knee osteoarthritis, rather than people diagnosed *per se*, irrespective of the duration since diagnosis.

The purpose of this analysis was firstly to determine if there was a difference in the occurrence of falls, with or without a consequential fractures, between people newly diagnosed with unilateral hip or knee osteoarthritis within the preceding 12 months compared to those who had not. Secondly we aimed to explore the risk factors associated with falls and subsequent fracture for people with unilateral hip or knee osteoarthritis. Using these findings, it will be possible to

better identify when people may be at a greater risk of a fall and falls-related fracture and therefore lead to a greater understanding of the relationship between hip and knee osteoarthritis and these risks.

Materials and Methods

Data used in the preparation of this article were obtained from the Osteoarthritis Initiative (OAI) database, which is available for public access at <http://www.oai.ucsf.edu/>. The OAI is a large-scale, multi-centre (four sites across the USA: the Ohio State University; the University of Maryland School of Medicine; the University of Pittsburgh and the Memorial Hospital of Rhode Island in Pawtucket, Rhode Island), longitudinal cohort study aimed to investigate the role of biomarkers in the development and progression of lower limb osteoarthritis. Through this, ethical approval has been granted from the Committee on Human Research, University of California, San Francisco (IRB approval number 10-00532 Approved 10th March 2015).

Baseline data collected from volunteers to the study, commenced between February 2004 to May 2006, with data longitudinally collected at 12, 24, 30, 36, 48, 60, 72 and 84 months follow-up intervals. Data collected has included: individual's demographic characteristics, previous and current medical history including medical morbidities, lifestyle and physical activity behaviours (assessed using the Physical Activity Scale for the Elderly (PASE)).¹² The minimally clinically important difference for the total PASE score is 87 points.¹³ For this analysis, we collated data on: the number of participants who reported a fall within the first 12 months of a diagnosis of osteoarthritis; the frequency of falls in this period; and whether a fracture was sustained during this period.

To answer this research question, from the OAI dataset, we included all community-dwelling people who were diagnosed with unilateral hip or knee osteoarthritis by a medical practitioner (clinical with or without radiological evidence) within 12 months of the corresponding data collection period. We excluded people who had bilateral hip or knee osteoarthritis, although people with unilateral hip *and* knee osteoarthritis were potentially eligible. A matched-cohort was identified of community-dwelling individuals who had not been diagnosed with hip or knee osteoarthritis (i.e. had not presented to a physicians with joint pain diagnosed as osteoarthritis) from the OAI dataset. The cohorts were matched for: age, ethnicity and PASE score to account for the potential confounder of level of participating physical activity.⁵ There was no overlap of patients between these two groups.

Data Analysis

Descriptive statistics were initially used to analyse the trends and patterns in categorical and continuous data. The normality of the dataset was analysed using the Shapiro-Wilks test.

The aim of the analysis was to determine whether there was a difference in occurrence of falls, with or without a consequential fractures, between people newly (within 12 months) diagnosed with unilateral hip or knee osteoarthritis, within the preceding 12 months, compared to those who had not. To determine this we compared the newly diagnosed unilateral hip or knee osteoarthritis cohorts to non-osteoarthritis cohorts using a Student T-Test to assess mean cumulative falls, and a chi-square test to assess the occurrence of a fall and the occurrence of a fracture in a 12 month period between the groups. We also determine the odds of experiencing a fall and fracture in a 12 month period with odd ratios (OR) and 95% confidence intervals (CI) for each cohort.

Secondly, we aimed to determine which factors may be associated with the occurrence of a fall and/or fracture in people who had been diagnosed with unilateral hip or knee osteoarthritis within the preceding 12 months. To determine this, a univariate analysis was initially undertaken with the dependent variables: the occurrence of a fall in the preceding 12 months and the occurrence of a fracture in the preceding 12 months. The independent variables identified through previous research as potential explanatory factors included: age, gender, ethnicity, marital status, employment status; previous total hip arthroplasty (THA); previous total knee arthroplasty (TKA); diagnosis of hip osteoarthritis; diagnosis of knee osteoarthritis; and use of bisphosphonates (assessed as a binary 'yes/no' response) in a 12 month interval. Based on these, all variables identified as significant at $p < 0.1$ on univariate analysis were entered into a multivariate logistical regression model. All logistical regression data was expressed as odd ratios with 95% confidence intervals and p-values. The Wald statistic was used to assess statistical significance in each regression model. All analyses were undertaken using STATA version 12.0 (STATA Corp LP, Texas, USA).

Results

As summarised in Figure 1, in total, 552 individual with unilateral hip osteoarthritis were compared to 4244 individuals without hip osteoarthritis. Of these 321 (58%) people also had unilateral knee osteoarthritis. In the knee osteoarthritis analysis, 1350 individuals with unilateral knee osteoarthritis were compared to 3445 individuals without knee osteoarthritis. Of these 262 (19%) people also had unilateral hip osteoarthritis.

The demographic characteristics of the four groups is presented in Table 1. This demonstrated these were broadly similarities in characteristics between the hip analysis group, although there was a higher percentage of individuals employed at baseline analysis in the hip osteoarthritis compared to the non-hip osteoarthritis cohort (48% versus 60%), and a higher proportion of individuals diagnosed with knee osteoarthritis in the hip osteoarthritis group compared to non-hip osteoarthritis cohort (12% versus 58%). The percentage of individuals prescribed bisphosphonate was slightly higher in the non-hip osteoarthritis cohort compared to the hip osteoarthritis cohort (87% versus 80%). Similarly, there appeared a slightly greater percentage of individuals employed at baseline in the knee osteoarthritis cohort (49%) compared to the non-knee osteoarthritis cohort (35%), and a higher percentage diagnosed with hip osteoarthritis in the knee osteoarthritis cohort (19%) compared to the non-knee osteoarthritis cohort (1%).

Hip Osteoarthritis Analysis

People with hip osteoarthritis demonstrated a greater likelihood of experiencing a fall within the first 12 months post-diagnosis compared to those without hip osteoarthritis (OR: 1.52; 95% CI: 1.26 to 1.84; $p < 0.01$). The chance of experiencing a fall was 52% greater for people with hip osteoarthritis compared to those without. Whilst there was a difference in the cumulative number of falls within the assessing 12 month period, with significantly greater numbers in the hip osteoarthritis cohort ($p < 0.01$), this remained relatively low in each group (0.47 versus 0.66; Table 2).

There was a greater likelihood of experiencing a fracture in people who had hip osteoarthritis compared to those without (OR: 1.84; 95% CI: 1.23 to 2.75; $p < 0.01$). Thus those with hip osteoarthritis demonstrated an 84% greater chance of experiencing a fracture compared to those without hip osteoarthritis.

On univariate analysis, the variable bisphosphonate use (OR: 1.30; 95% CI: 1.08 to 1.56), physician-diagnosed knee osteoarthritis (OR: 1.20; 95% CI: 1.00 to 1.45) and ethnic background (OR: 1.14; 95% CI: 0.96 to 1.37) were identified as significant predictors of falls in the first 12 months post-diagnosis of hip osteoarthritis. However, when analysed on multivariate analysis, none of these variables remains statistically significant predictors of falls (Supplementary Table 1).

When the data were assessed for predictors of fractures, both the use of bisphosphonates (OR: 2.51; 95% CI: 1.77 to 3.56) and physician-diagnosed knee osteoarthritis (OR: 1.43; 95% CI: 0.96 to 2.14) were identified as significant predictors. On multivariate analysis, only

bisphosphonate use was identified as statistically significant with those taking bisphosphonates over twice as likely to have experienced a fracture within the assessing 12 month interval (OR: 2.27; 95% CI: 1.45 to 3.56).

Knee Osteoarthritis Analysis

People with knee osteoarthritis demonstrated a greater likelihood of experiencing a fall within the first 12 months post-diagnosis compared to those without knee osteoarthritis (OR: 1.54; 95% CI: 1.35 to 1.77; $p < 0.01$). The chances of experiencing a fall were 54% greater for people with knee osteoarthritis compared to those without. Whilst a significantly greater cumulative number of falls occurred in the knee osteoarthritis cohort ($p < 0.01$; -0.22 to -0.10), this remains small compared to the non-knee osteoarthritis cohort (0.45 to 0.61; Table 2). There was also a greater likelihood of experiencing a fracture in people newly diagnosed with knee osteoarthritis compared to those without (OR: 1.81; 95% CI: 1.34 to 2.43; $p < 0.01$). Thus those with knee osteoarthritis were at 81% greater chance of experiencing a fall compared to those without knee osteoarthritis.

On univariate analysis, the use of bisphosphonates (OR: 1.32; 95% CI: 1.07 to 1.63), previous THA (OR: 2.16; 95% CI: 1.03 to 4.51), contralateral TKA (OR: 0.39; 95% CI: 0.15 to 1.01) and hip osteoarthritis (OR: 1.38; 95% CI: 1.07 to 1.77) were identified as significant predictors of falls in the first 12 months post-diagnosis of knee osteoarthritis. Of note, the presence of a contralateral TKA was associated with a reduction in falls probability by 61%, whereas having undergone a THA demonstrated an increased chance of experiencing a fall (OR: 2.16; Table 3). On multivariate analysis, the variables bisphosphonate use (OR: 1.29; 95% CI: 1.08 to 1.55), previous THA (OR: 2.15; 95% CI: 1.03 to 4.49) and physician-diagnosed hip osteoarthritis (OR: 1.35; 95% CI: 1.05 to 1.72) remained statistically significant predictors of falls in the assessment period.

The variables of bisphosphonate use (OR: 2.37; 95% CI: 1.60 to 3.53) and previous THA (OR: 3.83; 95% CI: 1.30 to 11.21) were identified as significant predictors of fracture within the first 12 months post-osteoarthritis diagnosis on univariate analysis. On multivariate analysis, both bisphosphonate use (OR: 2.12; 95% CI: 1.47 to 3.04) and previous THA (OR: 3.83; 95% CI: 1.30 to 11.28) remained statistically significant predictors. People taking bisphosphonates were over twice as likely and those who had undergone previous THA were nearly four-times more likely to experience fracture during the first 12 months post-diagnosis of knee osteoarthritis.

Discussion

People who are newly diagnosed with osteoarthritis of the hip or knee are at greater risk of experiencing a fall and/or fracture in the initial 12 months post-diagnosis. The chances of experiencing a fall are over 50% greater and the chances of experiencing a fracture are 85% greater than people of a similar age and characteristics who do not have hip or knee osteoarthritis. Significant predictors of falls in people with knee osteoarthritis include hip osteoarthritis, bisphosphonate use and previous THA, with the latter two factors identified as significant predictors of fracture. Whilst no statistically significant predictors were identified for falls risk in people with hip osteoarthritis, bisphosphonate use was identified as a significant predictor of fracture within a 12 month period, although it was unclear whether this was a cause or consequence of fracture in people with physician-diagnosed hip osteoarthritis.

The findings of this study support that of previous literature. Doré et al¹¹ reported a similar increase in risk of people with osteoarthritis and specifically reported that risk of falling increased with the number of painful joints. They reported an increased odds of a fall for those with one osteoarthritic joint being 53%, by two joints by 74%, whilst the chances of a fall increased to 85% with three or more osteoarthritic joint.¹¹ De Zwart et al¹⁴ reported that muscle strength was the most significant independent variable associated with falls in people with knee osteoarthritis, with factors such as proprioception and joint laxity less significant. These findings mirror that of Knoop et al¹⁵ analysis of 283 participants from the Amsterdam Osteoarthritis cohort. Accordingly the results of Doré et al¹¹ and those of this analysis may be related to increased physical risk of experiencing a fall due to reduced hip or/and knee strength and proprioception, leading to greater instability and reduced capability to compensate balance when made unstable and curtailing of physical activity and independence.^{16,17}

Given the associated risks presented in this analysis, and the high probability that people with newly diagnosed osteoarthritis will experience a fall, it would appear sensible that falls advice; guidance and training to reduce such risks should be incorporated into early management of people with osteoarthritis. Whilst strength and exercise training are advocated in international guidance for osteoarthritis,¹⁸⁻²¹ little attention has been made specifically focusing on falls management strategies in this population. This may be particularly important for those with greatest pain levels and those with multiple joint pain.¹¹ The results would suggest that this should be questioned and future guidance should include recommendations on examining individual's falls risk and intervening where appropriate to mitigate these risks in a tailored, individualistic way.^{22,23}

Bisphosphonate use was a consistent predictor of falls and fracture risk in both people with hip or knee osteoarthritis. This finding should be interpreted with caution. Given the longitudinal data collection phases adopted by the OAI programme, it was not possible to distinguish the timing of bisphosphonate use in relation to falls or fracture events. Since it is international guidance that people at risk of falls with subsequent insufficiency fractures should be routinely prescribed some form of bisphosphonate,^{24,25} it could be interpreted that these cohorts were prescribed bisphosphonates following their initial fall within the 12 month follow-up period. Thus, this finding is a measurement artefact rather than indicating a causal relationship between bisphosphonate use and fracture or falls. In this respect, this finding would suggest that guidance, at-least in part, being met where bisphosphonate prescription is being undertaken for this 'at-risk' subgroup of the osteoarthritis population. Furthermore, since the assessment of bisphosphonate used was a binary outcome (i.e. yes/no), it is unclear how issues related to medication adherence or dosage influenced the outcome of these analyses. This provides further strength to the notion that this particular conclusion should be viewed with caution.

This study has indicated that people living in the community, demonstrated a significantly higher risk of falls compared to those with similar characteristics without newly diagnosed hip or knee osteoarthritis. Nonetheless, the data indicates that falls risk, particularly with older people, remains a high problem irrespective of joint pathology. This is in agreement with previous literature, particularly in those aged 70 years and above.²⁶ Accordingly, the encouragement for older people to be more physically active is supported as a blanket recommendation,^{22,27} not only for the potential risk of falls in osteoarthritic and non-osteoarthritic cohorts, but also for the more general physical and mental health benefits which physical activity confers.²⁸

This analysis presented with five notable limitations, which relate to the use of a large, non-inception, dataset analysed retrospectively to answer these specific research questions. Firstly, it was not possible to determine if there was a difference between osteoarthritis and non-osteoarthritic cohorts for the type of falls experienced and possible contributing factor to falls. Secondly, there was limited data available on the location and type of fracture experienced by the cohort, due to a high number of missing data-points. Such an analysis would have provided an indication as to whether the types of fractures experienced by the cohort differed, and may be a useful addition for future research on this post-surgical population. We were unable to analyse the impact of a diagnosis of osteoarthritis on people's confidence in their mobility. It was not possible to observe whether the process of gaining a diagnosis had a significant impact on perceived mobility and health. Fourth, we did not intend to assess the relationship of falls in this cohort to medical history or co-morbidities. Therefore the contribution of these factors to

this analysis has not been established, but may be investigated in future studies. Finally, the OAI database is a cohort of volunteers from North America. Whilst this provides valuable data, this cohort may be considered a self-selecting sample of potentially healthier and more educated or affluent, altruistic individuals compared to the full spectrum of the population in clinical practice. This may therefore affect the generalisability of these findings to the wider population from different economic, social and cultural backgrounds worldwide.

Conclusion

People with newly diagnosed osteoarthritis of the hip or knee have a higher chance of experiencing a fall with or without subsequent fracture, compared to those with similar characteristics without osteoarthritis. Whilst international guidance on the management of this population has emphasised the benefits of exercise and physical activity, consideration should now be made to specify recommendations on the identification of those at highest risk of falls and interventions to reduce such a risk, and its associated mortality and morbidity.

Figure and Table Legends

Figure 1: Flow-chart illustrating the subject selection based on a priori eligibility criteria.

Table 1: Demographic characteristics

Table 2: Difference between osteoarthritis and non-osteoarthritis participants for falls and fracture outcomes over 12 month follow-up

Table 3: Univariate analysis (OR and 95% CI: p-value): factors associated with falls and fractures in people who have newly diagnosed hip or knee osteoarthritis, assessed during the first 12 months post-diagnosis

Supplementary File 1: Multivariate analysis with probability values and odd ratio; 95% confidence intervals (when statistically significant) for predicting falls or fractures in people who have newly diagnosed hip or knee osteoarthritis during the first 12 months post-diagnosis, when indicated as significant on univariate analysis.

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Figure 1: Flow-chart illustrating the subject selection based on a priori eligibility criteria.

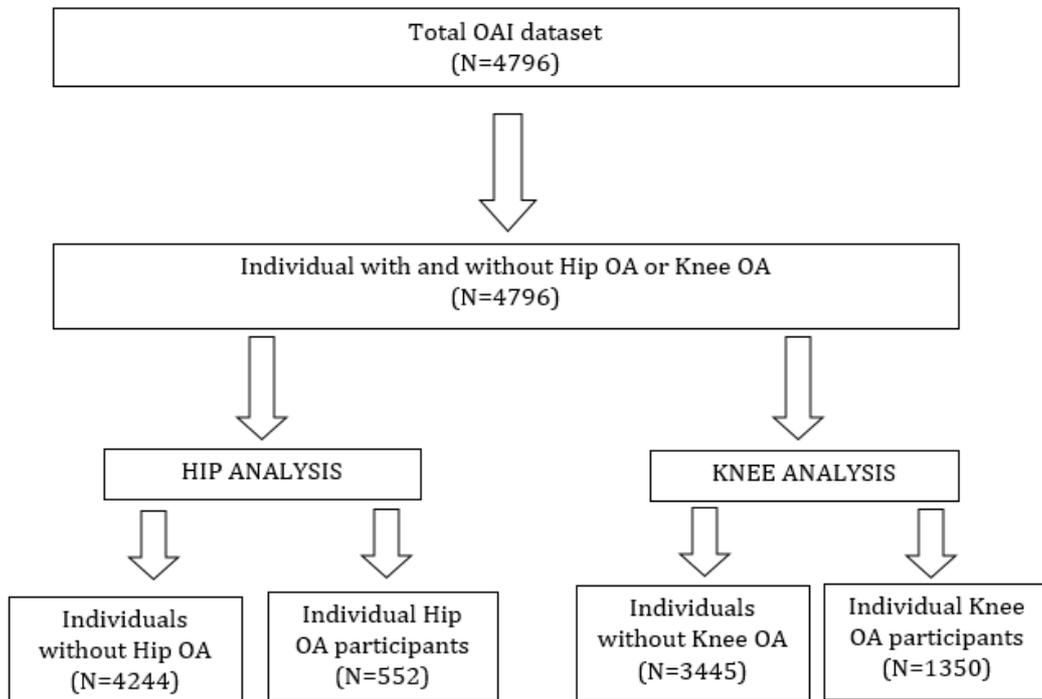


Table 1: Demographic characteristics

	Non-Knee OA cohort	Knee OA diagnosis	Non-Hip OA cohort	Hip OA diagnosis
N	3445	1350	4244	552
Gender (m/f; %)	1508/1937 (43.8/56.2)	534/816 (39.6/60.4)	1801/2443 (42.4/57.6)	191/361 (34.6/65.4)
Mean age in years (SD)	68.9 (8.9)	66.5 (8.8)	69.3 (9.0)	69.4 (9.1)
Race (n; %)				
1: Other non-white	1: 50 (1.5)	1: 28 (2.1)	1: 72 (1.7)	1: 10 (1.8)
2: White or Caucasian	2: 2758 (80.2)	2: 1023 (75.8)	2: 3372 (79.6)	2: 417 (75.5)
3: Black or African American	3: 599 (17.4)	3: 286 (21.2)	3: 756 (17.8)	3: 118 (21.4)
4: Asian	4: 34 (0.9)	4: 13 (0.9)	4: 38 (0.9)	4: 7 (1.3)
Marital Status (n; %)				
1: Married	1: 1761 (71.1)	1: 683 (64.2)	1: 2140 (65.2)	1: 272 (63.0)
2: Widowed	2: 287 (11.6)	2: 131 (12.3)	2: 358 (10.9)	2: 61 (14.1)
3: Divorced	3: 373 (15.1)	3: 147 (13.8)	3: 457 (13.9)	3: 50 (11.6)
4: Separated	4: 35 (1.4)	4: 12 (1.1)	4: 43 (1.3)	4: 4 (0.9)
5: Never married	5: 22 (0.8)	5: 91 (8.6)	5: 284 (8.7)	5: 45 (10.4)
Employed (y; %)	1678 (35.0)	657 (48.7)	2040 (48.1)	250 (60.4)
Number of THA (y; %)	12 (0.3)	20 (1.5)	20 (0.5)	18 (3.3)
Number of TKA (y; %)	11 (0.3)	29 (2.1)	312 (7.4)	16 (2.9)
Number of hip OA diagnosed (y; %)	46 (1.3)	262 (19.4)	0 (0.0)	552 (100.0)
Number of knee OA diagnosed (y; %)	0 (0.0)	1350 (100.0)	498 (11.7)	321 (58.2)
Bisphosphonates prescribed (y; %)	436 (12.7)	196 (14.5)	498 (11.7)	120 (21.7)
Mean PASE score (SD)	148 (82.7)	147.6 (81.0)	146.5 (82.7)	137.1 (80.0)
Type of bisphosphonate prescribed (n; %)				
0: None	0: 2741 (86.3)	0: 1172 (87.1)	0: 3448 (87.4)	0: 443 (80.3)
1: Alendronate	1: 306 (9.6)	1: 129 (9.6)	1: 350 (8.9)	1: 79 (14.3)
2: Risedronate	2: 81 (2.6)	2: 26 (1.9)	2: 93 (2.4)	2: 17 (3.1)
3: Alendronate and Risedronate	3: 41 (1.3)	3: 12 (0.9)	3: 46 (1.2)	3: 8 (1.4)
4: Other	4: 7 (0.2)	4: 7 (0.5)	4: 8 (0.1)	4: 5 (0.9)

f – female; m – male; N – number; OA – osteoarthritis; PASE – Physical Activity Scale for the Elderly; SD – standard deviation; THA – total hip arthroplasty; TKA – total knee arthroplasty; Y - Yes

Table 2: Difference between osteoarthritis and non-osteoarthritis participants for falls and fracture outcomes over 12 month follow-up

	Control Group	OA Group	Odd Ratio (95% CI)	Difference (p-value; 95% CI)
Hip OA	4244	552		
Fall in past 12 months (Y; %)	1101 (25.9)	192 (34.8)	1.52 (1.26 to 1.84)	<0.001 (0.28 to 0.40)
Fracture in past 12 months (Y; %)	133 (3.1)	31 (5.6)	1.84 (1.23 to 2.75)	0.007 (0.03 to 0.08)
Mean Cumulative falls in past 12 months (SD)	0.47 (0.84)	0.66 (1.01)		<0.001 (-0.28 to -0.10)
Knee OA	3445	1350		
Fall in past 12 months (Y; %)	866 (25.1)	461 (34.1)	1.54 (1.35 to 1.77)	<0.001 (0.27 to 0.38)
Fracture in past 12 months (Y; %)	110 (3.2)	76 (5.6)	1.81 (1.34 to 2.43)	0.001 (0.03 to 0.07)
Mean Cumulative falls in past 12 months (SD)	0.45 (0.82)	0.61 (0.95)	N/A	<0.001 (-0.22 to -0.10)

CI – confidence interval; N/A – not assessed; OA – osteoarthritis; SD – standard deviation; Y - Yes

Table 3: Univariate analysis (OR and 95% CI: p-value): factors associated with falls and fractures in people who have newly diagnosed hip or knee osteoarthritis, assessed during the first 12 months post-diagnosis.

	Age	Gender	Bisphosphonate Use	Marital Status	Employment	THR	TKR	Hip OA	Knee OA	Race
Hip OA										
Fall in past 12 months	1.00 (0.99, 1.01) 0.40	1.04 (0.88, 1.22) 0.66	1.30 (1.08, 1.56) 0.01	1.02 (0.96, 1.09) 0.51	1.00 (0.84, 1.20) 0.97	0.57 (0.27, 1.28) 0.18	0.69 (0.31, 1.54) 0.36	-	1.20 (1.00, 1.45) 0.05	1.14 (0.96, 1.37) 0.15
Fracture in past 12 months	1.02 (1.00, 1.04) 0.12	0.81 (0.56, 1.17) 0.26	2.51 (1.77, 3.56) <0.01	1.06 (0.92, 1.22) 0.44	0.81 (0.54, 1.21) 0.31	0.69 (0.17, 2.76) 0.60	0.00 (0.0, 0.0) 1.00	-	1.43 (0.96, 2.14) 0.08	1.24 (0.83, 1.86) 0.30
Knee OA										
Fall in past 12 months	1.00 (0.99, 1.00) 0.97	1.00 (0.86, 1.18) 0.91	1.32 (1.07, 1.63) 0.01	0.98 (0.92, 1.05) 0.62	0.95 (0.80, 1.14) 0.58	2.16 (1.03, 4.51) 0.04	0.39 (0.15, 1.01) 0.05	1.38 (1.07, 1.77) 0.01	-	1.06 (0.89, 1.27) 0.51
Fracture in past 12 months	1.00 (0.97, 1.02) 0.64	1.04 (0.73, 1.50) 0.82	2.37 (1.60, 3.53) <0.01	0.98 (0.85, 1.14) 0.82	1.01 (0.67, 1.52) 0.96	3.83 (1.30, 11.21) 0.02	0.67 (0.09, 5.01) 0.70	1.23 (0.70, 2.17) 0.47	-	0.73 (0.47, 1.14) 0.16

CI – confidence intervals; OA – osteoarthritis; OR – odd ratio; THA – total hip arthroplasty; TKA – total knee arthroplasty

Supplementary File 1: Multivariate analysis with probability values and odd ratio; 95% confidence intervals (when statistically significant) for predicting falls or fractures in people who have newly diagnosed hip or knee osteoarthritis during the first 12 months post-diagnosis, when indicated as significant on univariate analysis.

Hip Osteoarthritis cohort

	Bisphosphonate Use	PASE	Knee OA	Race
Fall in past 12 months	0.99	0.74	0.99	0.67
Fracture in past 12 months	2.27 (1.45, 3.56) <0.01	Not eligible	0.33	Not eligible

Knee Osteoarthritis cohort

	Bisphosphonate Use	THA	TKA	Hip OA
Fall in past 12 months	1.29 (1.08, 1.55) <0.01	2.15 (1.03, 4.49) 0.04	0.06	1.35 (1.05, 1.74) 0.02
Fracture in past 12 months	2.12 (1.47, 3.04) < 0.01	3.83 (1.30, 11.28) 0.02	Not eligible	Not eligible

OA – osteoarthritis; PASE – Physical Activity Scale for the Elderly; THA – total hip arthroplasty; TKA – total knee arthroplasty