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The Role of Hip Injury and "Giving Way" in Pain Exacerbation in Hip Osteoarthritis: An Internet-Based Case-Crossover Study

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ABSTRACT

Objective: To evaluate the association between hip injury/"giving way" and hip pain exacerbations in persons with symptomatic hip OA.

Methods: We conducted an internet-based case-crossover study to assess hip injury and "giving way" for hip pain exacerbation. Eligible participants with symptomatic hip OA were followed for 90 days and asked to complete online questionnaires at baseline and 10-day intervals (control

periods). They also logged on to the study website to complete questionnaires for an episode of a hip pain exacerbation (case periods) defined as an increase of two points in pain intensity compared with baseline on a numeric rating scale (NRS: 0-10). The relationship of hip injury and "giving way" to the risk of pain exacerbation was examined using conditional logistic regression.

Results: Of 252 patients recruited into the study, we included 133 (53%) subjects who provided data from both case and control periods. Hip injury during the last seven days increased the risk of hip pain exacerbation (odds ratio [OR] 2.74, 95% CI 1.62, 4.62). Hip "giving way" during the last two days was associated with an increased risk of hip pain exacerbation (OR 2.10, 95% CI 1.30, 3.39), and showed a significant relationship between the number of hip "giving way" events and risk of hip pain exacerbations ($p<0.001$).

Conclusion: Hip injury and episodes of hip "giving way" were significantly related to pain exacerbation in persons with symptomatic hip OA. Methods to prevent exposure to injury may help to reduce the burden of pain in persons with hip OA.

Significance and Innovations

- Our findings are novel and extend from the use of novel internet-based methods, and we used each case as his/her own control which is highly applicable to assess the effects of transient exposures (hip injury or "giving way") on pain exacerbations.
- This study used data provided by 133 hip OA patients showed a significant association between hip injury/"giving way" and pain exacerbation in persons with symptomatic hip OA.
- We found that hip injury and episodes of hip "giving way" were risk factors for pain exacerbation in persons with symptomatic hip OA, which could provide some insight into potential mechanisms of pain exacerbation.

Introduction

Osteoarthritis (OA) is the most common form of arthritis with the hip being the second most affected large joint (1). The lifetime risk of developing hip OA can be up to 25% with the incidence rate being 13 per 1000 person-years (2, 3). Hip OA is a major public health problem, particularly as it often leads to costly total hip replacement surgery (4). With increasing life expectancy and hence an ageing population, the burden of hip OA is expected to worsen (1, 5).

Joint pain is the hallmark symptom of OA and is also the major driver of clinical decision-making. Hip pain, together with stiffness and other functional limitations, substantially impairs health and quality of life of patients suffering from hip OA (6). Among patients with hip or knee OA, there are two distinct pain types described: one is a dull, aching pain which becomes constant over time (persistent "background" pain); the other one is an intermittent intense pain which presents with episodes of unpredictable and more severe pain (7). The latter pain has a greater impact on quality of life, but risk factors triggering these exacerbations are largely unknown (8). Previous studies showed that knee injury or buckling, negative affectivity and passive pain coping strategies could trigger pain exacerbations in patients with knee OA, but there are few studies on the risk factors of hip OA pain exacerbations (9, 10).

Mechanical insult to the hip from acute injury or previous hip injury is a risk factor for the development of hip OA (11, 12). "Giving way" or buckling of the joint means perception of the sudden loss of postural support across the joint. The joint "giving way" is usually caused by

joint pain or joint instability but is rarely described in uninjured (non-orthopaedics related) joints (13). The role of hip injury or "giving way" in pain exacerbations in persons with hip OA remains unclear. This study evaluated data from the Internet-based Hip Osteoarthritis Pain Exacerbation (iHOAP) study to determine whether there was any association between hip injury (within seven days) or hip "giving way" (within two days) and pain exacerbations in persons with symptomatic hip OA.

Patients and Methods

Study design We conducted an Internet-based case-crossover study to assess a range of potential risk factors, including hip injury and hip "giving way", for hip pain exacerbation. This method has been previously described in knee OA pain exacerbation studies (9, 10, 14, 15). In brief, the case-crossover design uses each participant as his/her own control to assess the effects of transient exposures (triggers) on episodic events (e.g. pain exacerbation). The study was approved by the ethics committees of the University of Sydney (HREC 2014/801) and University of Melbourne (HREC 1443509), and all participants provided informed consent.

Participants An online screening survey tool was designed for the recruitment of eligible study participants in Australia from May 2015 to June 2017. This tool identified participants that qualified for the study based on their answers to the eligibility criteria questions and eliminated those that were not. The screening survey website link was provided at the websites and local newspapers chosen for advertising the study. We also emailed the link to individuals from previous hip OA studies who gave their consent to be contacted for future research projects. When a potential study candidate registered his/her interest in participation through the screening survey tool, their contact details were emailed to a study coordinator. The study coordinator then contacted participants for further assessment and enrolment. Prospective participants were also asked to provide their most recent hip x-ray.

The inclusion criteria were≥ 40 years old; hip pain on most days (5 -7 days/week or 20-30 days/month) that fluctuates in intensity; at least one hip meeting American College of Rheumatology Criteria for hip OA (clinical (without ESR) plus radiological criteria) (16); Kellgren and Lawrence Classification of hip OA grade ≥ 2 (17); an active e-mail account and

access to the internet and computer; and good understanding of spoken and written English. The exclusion criteria were: a history of total hip replacement in the index hip or plan to have a total hip replacement of the symptomatic hip(s) in the next six months; history of inflammatory arthritis, osteonecrosis or Paget's disease affecting the hip.

Procedures The Internet was used in this study to collect data. Once qualified, the person was enrolled and provided access to the study website. Eligible participants were followed up for 90 days and asked to complete questionnaires (including demographic details, baseline pain level, hip injury and "giving way") at baseline and every succeeding 10-day interval (control periods). The pain level was assessed using the numeric rating scale (NRS; ranged from 0 – "no pain" to 10 – "the worst pain possible") for pain (18, 19). We asked participants to indicate how bad their hip pain was at its mildest, usual and worst times at the baseline online visit. Pain exacerbation was then operationally defined as an increase $\geq$2 points in the participant's pain level compared with his/her mildest hip pain level reported at the baseline visit (a disabling increase in the hip symptoms lasting for more than 8 hours without settling), which was also used in previous studies (9, 10, 14, 15, 20, 21). We chose the threshold for pain exacerbation which was also based on the OARSI Clinical Trial Response Criteria definition for a meaningful change in symptoms (15, 22). When a participant considered he/she was experiencing a pain exacerbation and logged onto the study website, the online questionnaire automatically determined whether the participant had a pain exacerbation or not based on the operational definition and guided them to complete the questionnaires (case periods). Participants were not allowed to know what amount constituted a pain exacerbation to avoid subjectivity or bias. Risk factor assessment questionnaires for control periods and case periods were the same for all online visits.

Participants were asked whether they had an injury (such as fall, slipped, sports injury, tripped) involving the index hip (most painful/affected hip) that limited usual activities during the last seven days and whether they experienced any episodes of the hip "giving way" (defined as sudden loss of postural support across the hip at a time of weight bearing) in the last two days at control periods. As hip "giving way" was assumed more frequently than hip injury, two days' period prior to pain exacerbations was selected for hip "giving way". They were also asked the same questions about whether any injury had occurred to the index hip that limited usual activities during the seven days before the pain exacerbation and whether there were any

episodes of the hip "giving way" during the two days before the pain exacerbation at case periods. All data were collected on a secure password protected study website which was located on a secure server.

Statistical methods Baseline characteristics were summarised as mean (SD) for continuous variables and frequency (%) for categorical variables. Patients who did not provide data on both case periods and control periods were excluded from the analyses. For hip injury, controls that were within seven days before or after a reported flare were excluded. Flares reported within seven days of a previous flare were also excluded. The same rule was applied to hip “giving way” (within two days). Characteristics were summarised for all patients enrolled into the study and for the subgroup included in the analysis. Case periods that occurred within two days prior to a preceding case period were excluded from the analysis. The association of hip injury or “giving way” to the risk of hip pain exacerbation was assessed by conditional logistic regression analysis. The dose-response relationship between number of “giving away” events and risk of pain exacerbation was assessed by conditional logistic regression analysis choosing zero “giving way” event as reference. Odds ratios (OR) and 95% confidence intervals (CI) for the risk factors (hip injury and “giving way”) were reported. All analyses were conducted using STATA version 15.

Results

Of the 252 participants recruited, three failed to answer the questionnaires. One hundred and nineteen patients only provided data on control periods only. One hundred and thirty-three (53%) patients provided data from both periods and were subsequently included in the analysis; one further patient was excluded from the hip “giving way” analysis due to missing data. Baseline demographic characteristics of all participants (n=252) and those with risk factor data included in the current analysis are summarised in Table 1. Participants included in the analyses were representative of all participants recruited and were predominantly female (85%), had an average body mass index around 29 kg/m^2, and an average age of 62.4 years (SD ± 8.2). More than 60% of the participants received a tertiary education (higher than high school education) and more than 70% performed light physical work (sedentary work or standing occupation). On average, the usual hip pain level was around 4.5 (SD ± 2.2; NRS scale) while the mildest pain level was 2 to 3 and the worst pain level was 8 (SD ± 1.8).

On average (252 participants), patients completed the questionnaire 9.5 times (median: 10; range: 0-21). The average number of control periods was 8.1 and the average number of case periods was 1.4.

During the 90-day follow-up, 133 (53%) participants had 350 hip pain exacerbations (case periods); on average, patients experienced 2.6 exacerbations (median: two; range: 1-11).The others (116 participants) provided only control periods or case periods that were excluded as they are not informative for this particular design and analysis. Fifty-one (39%, 51/132) participants had at least one hip injury. Of these, questionnaires were completed for 304 case periods plus 807 control periods were used for the final analysis of the association of hip injury within the last seven days and hip pain exacerbation. Results showed that hip injury increased the odds of pain exacerbations (OR 2.74, 95% CI 1.62, 4.62) compared with no injury to the hip (Table 2).

For hip "giving way", information was completed for 347 case periods and 905 control periods which were used for the final analysis. Among them, 86 (65%, 86/133) participants had at least one hip "giving way". Four participants (1.3%, 4/319) reported falling due to the hip "giving way". Hip "giving way" during the last two days was associated with increased odds of hip pain exacerbation (OR 2.10, 95% CI 1.30, 3.39), and showed a significant dose-response relationship between the number of hip "giving way" events and risk of hip pain exacerbations (Table 3).

Discussion

This study showed a significant association between hip injury/"giving way" and pain exacerbation in hip OA patients, though hip injury was less frequent than hip "giving way" in this study.

Many studies showed that patients with hip or knee OA experience recurrent pain exacerbations, but the underlying mechanisms are still not well-understood (7, 23, 24). Traditionally, pain associated with OA was attributed to inflammation or tissue (joint) injury (referred as "nociceptive pain"), which may cause inflammatory mediators released into the joint and peripheral sensitization (25). Pain fluctuation was shown to be related to changes in bone marrow lesions (BMLs) and synovitis in knee OA patients (23). As a result, injury to the joint was thought to be a potential factor leading to the inflammatory response in the joint and

hyperalgesia/allodynia (9, 25, 26). Moreover, many injuries like slipping or falling may also be the trigger of activity-related pain (25).

Patients with hip or knee OA often have the sensation of joint instability or "giving way"/buckling which is also a cause of falls and fractures (27, 28). In our study, 65% (86/133) of the hip OA population reported at least one episode of hip "giving way" during the 90-day follow-up. Only four falls occurred due to the hip "giving way" which could be explained by the relatively younger age of our sample compared with those at higher risk of falls (29). Buckling or "giving way" was found to be significantly associated with activity limitation and poor physical function (28). The causes of joint (knee/hip) "giving way" in OA patients are still unknown, though biomechanical impairments such as muscle weakness were hypothesized as important causal factors in self-reported knee or hip "giving way" (30). The sudden "giving way" can also occur because of OA pain (13). Studies of knee OA patients found that joint instability could influence knee pain level and that "giving way" events were significantly associated with pain exacerbations (9, 31). Nevertheless, whether hip "giving way" events could trigger pain exacerbations has been scarcely studied previously in OA patients. The results of this study also demonstrated that those who had more episodes of hip "giving way" during the last two days further increased the strength association with pain exacerbations. Similar results were also found in knee OA patients (9).

The aetiology of OA pain is complex and is often considered within the construct of a biopsychosocial model influenced by many factors (32). Mechanical factors, anxiety, depression or the patients' pain coping strategies can all influence the person's pain experience (33). Lifestyle behavioural management strategies such as exercise and weight loss combined with proper medical treatment or psychological therapy are recommended for improving OA pain (34-37). There is also evidence showing that greater strength of the major hip and thigh muscles is associated with better self-reported physical function in patients with hip OA (38). Relevant muscle strengthening and balance training are potential ways to improve hip instability. However, avoiding hip joint injuries such as slipping or twisting could effectively reduce the fluctuation of pain in daily life which will also decrease pain-related fear and increase the patients' adherence to exercise (39).

Our study also has some limitations. Most participants were Caucasians and all required access to the internet and a good understanding of English. Thus, the findings may not generalize to all patients with hip OA. The study relied on retrospective self-report of the risk factors and as such, there is potential for recall bias. Participants were required to complete numerous questionnaires at regular intervals over 90 days. This may have caused participant fatigue leading to underreporting of pain exacerbations and incomplete questionnaires. However, such a potential bias, if it exists, is likely to dilute any association. While we have demonstrated an association, it is not known whether hip injury or "giving way" is a causative factor for hip OA pain exacerbations.

Our findings are novel and extend from the use of novel web-based methods that allow such questions to be asked. In this study, we used each case as his/her own control which is highly applicable to assess the effects of transient exposures (hip injury or "giving way") on pain exacerbations. To address the limitations of traditional study methods, we used the Internet which can facilitate real-time data capture as a powerful resource for efficient data collection (40).

In conclusion, this study found that hip injury and episodes of hip "giving way" were risk factors for pain exacerbation in persons with symptomatic hip OA. The results provide some insight into potential mechanisms of pain exacerbation. Reducing or avoiding activities that lead to hip injury or "giving way" may decrease the risk of hip pain exacerbations in persons with hip OA.

Author contributions

DH, KB, YZ, JM and BM were involved in the conception and design of the study, participants' recruitment and data collection. KF, JM, BM, YZ, RA and DH were involved in data cleaning and data analysis. All authors contributed to drafting the manuscript or revising it. All authors read and approved the manuscript for publication.

References

1. Zhang Y, Jordan JM. Epidemiology of Osteoarthritis. Clinics in Geriatric Medicine. 2010;26(3):355-69.
2. Moss AS, Murphy LB, Helmick CG, Schwartz TA, Barbour KE, Renner JB, et al. Annual incidence rates of hip symptoms and three hip OA outcomes from a U.S. population-based cohort study: the Johnston County Osteoarthritis Project. Osteoarthritis and cartilage. 2016;24(9):1518-27.
3. Murphy LB, Helmick CG, Schwartz TA, Renner JB, Tudor G, Koch GG, et al. One in four people may develop symptomatic hip osteoarthritis in his or her lifetime. Osteoarthritis and cartilage. 2010;18(11):1372-9.
4. Ackerman IN, Bohensky MA, de Steiger R, Brand CA, Eskelinen A, Fenstad AM, et al. Lifetime Risk of Primary Total Hip Replacement Surgery for Osteoarthritis From 2003 to 2013: A Multinational Analysis Using National Registry Data. Arthritis care & research. 2017;69(11):1659-67.
5. Hunter DJ, Schofield D, Callander E. The individual and socioeconomic impact of osteoarthritis. Nature reviews Rheumatology. 2014;10(7):437-41.
6. Birrell F, Croft P, Cooper C, Hosie G, Macfarlane G, Silman A. Health impact of pain in the hip region with and without radiographic evidence of osteoarthritis: a study of new attenders to primary care. The PCR Hip Study Group. Annals of the rheumatic diseases. 2000;59(11):857-63.
7. Hawker G, Stewart L, French M, Cibere J, Jordan JM, March L, et al. Understanding the pain experience in hip and knee osteoarthritis–an OARSI/OMERACT initiative. Osteoarthritis and Cartilage. 2008;16(4):415-22.
8. Hunter DJ, McDougall JJ, Keefe FJ. The symptoms of osteoarthritis and the genesis of pain. Rheum Dis Clin North Am. 2008;34(3):623-43.
9. Zobel I, Erfani T, Bennell KL, Makovey J, Metcalf B, Chen JS, et al. Relationship of Buckling and Knee Injury to Pain Exacerbation in Knee Osteoarthritis: A Web-Based Case-Crossover Study. Interactive journal of medical research. 2016;5(2):e17.
10. Erfani T, Keefe F, Bennell K, Chen J, Makovey J, Metcalf B, et al. Psychological Factors and Pain Exacerbation in Knee Osteoarthritis: A Web Based Case-Crossover Study. Rheumatology: Current Research. 2015.

11. Cooper C, Inskip H, Croft P, Campbell L, Smith G, McLearn M, et al. Individual risk factors for hip osteoarthritis: obesity, hip injury and physical activity. American journal of epidemiology. 1998;147(6):516-22.
12. Lau EC, Cooper C, Lam D, Chan VNH, Tsang KK, Sham A. Factors Associated with Osteoarthritis of the Hip and Knee in Hong Kong Chinese: Obesity, Joint Injury, and Occupational Activities. American Journal of Epidemiology. 2000;152(9):855-62.
13. Felson DT, Niu J, McClennan C, Sack B, Aliabadi P, Hunter DJ, et al. Knee buckling: prevalence, risk factors, and associated limitations in function. Ann Intern Med. 2007;147(8):534-40.
14. Makovey J, Metcalf B, Zhang Y, Chen JS, Bennell K, March L, et al. Web-Based Study of Risk Factors for Pain Exacerbation in Osteoarthritis of the Knee (SPARK-Web): Design and Rationale. JMIR research protocols. 2015;4(3):e80.
15. Ferreira ML, Zhang Y, Metcalf B, Makovey J, Bennell KL, March L, et al. The influence of weather on the risk of pain exacerbation in patients with knee osteoarthritis - a case-crossover study. Osteoarthritis and cartilage. 2016;24(12):2042-7.
16. Altman R, Alarcon G, Appelrouth D, Bloch D, Borenstein D, Brandt K, et al. The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the hip. Arthritis Rheum. 1991;34(5):505-14.
17. Kellgren JH, Lawrence JS. Radiological assessment of osteo-arthrosis. Ann Rheum Dis. 1957;16(4):494-502.
18. Downie WW, Leatham PA, Rhind VM, Wright V, Branco JA, Anderson JA. Studies with pain rating scales. Ann Rheum Dis. 1978;37(4):378-81.
19. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis care & research. 2011;63 Suppl 11:S240-52.
20. Ricci JA, Stewart WF, Chee E, Leotta C, Foley K, Hochberg MC. Pain exacerbation as a major source of lost productive time in US workers with arthritis. Arthritis Rheum. 2005;53(5):673-81.

21. Ricci JA, Stewart WF, Chee E, Leotta C, Foley K, Hochberg MC. Back pain exacerbations and lost productive time costs in United States workers. Spine. 2006;31(26):3052-60.
22. Pham T, van der Heijde D, Altman RD, Anderson JJ, Bellamy N, Hochberg M, et al. OMERACT-OARSI Initiative: Osteoarthritis Research Society International set of responder criteria for osteoarthritis clinical trials revisited. Osteoarthritis and cartilage. 2004;12(5):389-99.
23. Zhang Y, Nevitt M, Niu J, Lewis C, Torner J, Guermazi A, et al. Fluctuation of knee pain and changes in bone marrow lesions, effusions, and synovitis on magnetic resonance imaging. Arthritis Rheum. 2011;63(3):691-9.
24. Allen KD, Coffman CJ, Golightly YM, Stechuchak KM, Keefe FJ. Daily pain variations among patients with hand, hip, and knee osteoarthritis. Osteoarthritis Cartilage. 2009;17(10):1275-82.
25. Hunter DJ, Guermazi A, Roemer F, Zhang Y, Neogi T. Structural correlates of pain in joints with osteoarthritis. Osteoarthritis and Cartilage. 2013;21(9):1170-8.
26. Amaya F, Izumi Y, Matsuda M, Sasaki M. Tissue Injury and Related Mediators of Pain Exacerbation. Current Neuropharmacology. 2013;11(6):592-7.
27. Felson DT. Developments in the clinical understanding of osteoarthritis. Arthritis research & therapy. 2009;11(1):203.
28. Nguyen US, Felson DT, Niu J, White DK, Segal NA, Lewis CE, et al. The impact of knee instability with and without buckling on balance confidence, fear of falling and physical function: the Multicenter Osteoarthritis Study. Osteoarthritis Cartilage. 2014;22(4):527-34.
29. Rubenstein LZ. Falls in older people: epidemiology, risk factors and strategies for prevention. Age and ageing. 2006;35 Suppl 2:ii37-ii41.
30. Knoop J, van der Leeden M, van der Esch M, Thorstensson CA, Gerritsen M, Voorneman RE, et al. Association of lower muscle strength with self-reported knee instability in osteoarthritis of the knee: results from the Amsterdam Osteoarthritis cohort. Arthritis care & research. 2012;64(1):38-45.
31. Fitzgerald GK, Piva SR, Irrgang JJ. Reports of joint instability in knee osteoarthritis: its prevalence and relationship to physical function. Arthritis Rheum. 2004;51(6):941-6.
32. Neogi T. The epidemiology and impact of pain in osteoarthritis. Osteoarthritis and Cartilage. 2013;21(9):1145-53.

33. Dieppe PA, Lohmander LS. Pathogenesis and management of pain in osteoarthritis. The Lancet. 2005;365(9463):965-73.
34. Sandal LF, Roos EM, Bøgesvang SJ, Thorlund JB. Pain trajectory and exercise-induced pain flares during 8 weeks of neuromuscular exercise in individuals with knee and hip pain. Osteoarthritis and Cartilage. 2016;24(4):589-92.
35. Bennell KL, Hinman RS. A review of the clinical evidence for exercise in osteoarthritis of the hip and knee. Journal of Science and Medicine in Sport. 2011;14(1):4-9.
36. Hunter DJ, Bowden JL. Therapy: Are you managing osteoarthritis appropriately? Nature reviews Rheumatology. 2017.
37. Hunter DJ. Osteoarthritis Management: Time to Change the Deck. The Journal of orthopaedic and sports physical therapy. 2017;47(6):370-2.
38. Hall M, Wrigley TV, Kasza J, Dobson F, Pua YH, Metcalf BR, et al. Cross-sectional association between muscle strength and self-reported physical function in 195 hip osteoarthritis patients. Seminars in Arthritis and Rheumatism. 2017;46(4):387-94.
39. Heuts PH, Vlaeyen JW, Roelofs J, de Bie RA, Aretz K, van Weel C, et al. Pain-related fear and daily functioning in patients with osteoarthritis. Pain. 2004;110(1-2):228-35.
40. Rhodes SD, Bowie DA, Hergenrather KC. Collecting behavioural data using the world wide web: considerations for researchers. Journal of Epidemiology and Community Health. 2003;57(1):68-73.

Tables

Table 1. Demographic characteristics of participants

Characteristics (Mean ± SD or %)	All participants/n=252*	Participants/n=133**	Participants /n=119***
Age (years)	62.2 ± 8.3	62.5 ± 8.3	62.0 ± 8.3
Female	199 (79%)	113 (85%)	86 (72.3%)
BMI (kg/m^2)	28.69 ± 6.05	29.12 ± 6.33	28.27 ± 5.72
Index hip (right)	143 (56.7%)	72 (54.1%)	72 (60.5%)
Race			
Caucasian	242 (96%)	126 (94.7%)	116 (97.5%)

Others	10 (4%)	7 (5.3%)	3 (2.5%)
Education Level			
Less than high School	37 (14.7%)	22 (16.5%)	15 (12.6%)
Completed high school	58 (23%)	28 (21.1%)	31 (26.1%)
Higher than high school	157 (62.3%)	83 (62.4%)	73 (61.4%)
Past occupational physical workload level			
Sedentary (mostly sitting) work	111 (44%)	56 (42.1%)	55 (46.2%)
Standing occupation, physically light work	90 (35.7%)	49 (36.8%)	41 (34.5%)
Manual work	47 (18.7%)	25 (18.8%)	22 (18.5%)
Heavy manual work	4 (1.6%)	3 (2.3%)	1 (0.8%)
Baseline pain level (0-10)			
Mildest	2.3 ± 1.9	2.5 ± 2.0	2.0 ± 1.7
Usual	4.3 ± 2.1	4.5 ± 2.2	4.1 ± 2.1
Worst	7.6 ± 1.9	8.0 ± 1.8	7.3 ± 2.0

* Three patients failed to answer.

** With both case and control periods**.** One patient was further excluded for the hip injury analysis.

*** With only control periods or failed to answer.

Table 2. Association in last seven days' of hip injury and hip pain exacerbation (132 subjects)

Hip injury	Case periods (n=304)	Control periods (n=807)	OR (95% CI)	P-value
No	253 (83%)	760 (94%)	-	-
Yes	51 (17%)	47 (6%)	2.74 (1.62, 4.62)	<0.001

Table 3. Association of hip "giving way" in last two days and hip pain exacerbation (133 subjects)

	Case periods (n=347)	Control periods (n=905)	OR (95% CI)	P-value
Hip "giving way"				
No	215 (62%)	718 (79%)	-	-
Yes	132 (38%)	187(21%)	2.10 (1.30, 3.39)	0.002
Number of hip "giving way" events				
0	215 (62%)	718 (79%)	-	-
1	43 (12%)	87 (10%)	1.86 (1.14, 3.04)	
2-5	64 (18%)	92 (10%)	3.39 (2.00, 5.75)	<0.001*
≥6	25 (7%)	8 (1%)	7.86 (2.74, 22.55)	

*Type III P-value.

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