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Foot Pain in Relation to Ipsilateral and Contralateral Lower-Extremity Pain in a Population-Based Study

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Abstract

Background: Clinical observations note that foot pain can be linked to contralateral pain at the knee or hip, yet we are unaware of any community-based studies that have investigated the sidedness of pain. Because clinic-based patient samples are often different from the general population, the purpose of this study was to determine whether knee or hip pain is more prevalent with contralateral foot pain than with ipsilateral foot pain in a population-based cohort.

Methods: Framingham Foot Study participants (2002–2008) with information on foot, knee, and hip pain were included in this cross-sectional analysis. Foot pain was queried as pain, aching, or stiffness on most days. Using a manikin diagram, participants indicated whether they had experienced pain, aching, or stiffness at the hip or knee and specified the side of any reported pain. Sex-specific multinomial logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals for the association of foot pain with knee and hip pain, adjusting for age and body mass index.

Results: In the 2,181 participants, the mean ± SD age was 64 ± 9 years; 56% were women, and the mean body mass index was 28.6. For men and women, bilateral foot pain was associated with increased odds of knee pain on any side (ORs = 2–3; $P < .02$). Men with foot pain were more likely to have ipsilateral hip pain (ORs = 2–4; $P<.03$), whereas women with bilateral foot pain were more likely to have hip pain on any side (OR = 2–3; $P < .02$).

Conclusions: Bilateral foot pain was associated with increased odds of knee and hip pain in men and women. For ipsilateral foot and hip pain, men had a stronger effect compared with women.

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Musculoskeletal pain is generally a subjective symptom, but it can lead to substantial disability in men and women.[1–6] Defining and grading pain continues to be a challenge in clinical patients and population-based studies as the scientific community continues to search for causes and effects of pain.

Foot pain is common,[7,8] presents as a frequent symptom in patients, and is often associated with other lower-extremity pathologic abnormalities.[9–11] Before assigning causality of one joint pain to another, it is important to first document a significant association with foot pain and other joints. The foot is the first structure in the kinetic chain to make contact with the ground during weightbearing activities. If the foot is exhibiting pain, antalgic response could affect movement patterns of the proximal structures (knee, hip, and low back). Whether the aberrant movement patterns are primary or secondary, pain may be associated with or referred from (eg, radicular symptoms) any site in the kinetic chain.

Previous work from the Framingham Foot Study suggested that pronated foot function contributes to low-back symptoms in women.[12] Ipsilateral and contralateral foot pain may be differentially associated with pain at other sites. Studies have shown knee function and strength to be associated with pain in the contralateral knee[13–15] and hip disease to be associated with ipsilateral knee pain,[16] but the association between foot pain and contralateral or ipsilateral knee and hip pain remains unknown.

With a focus on the relation between foot pain and knee and hip pain, our overall goal was to provide practitioners with evidence-based guidance for evaluation and options for treatment for their patients. A significant association between foot pain and other lower-extremity joint pain would direct the physician to query patients presenting with such symptoms in other areas of the lower extremity, encouraging a broader treatment strategy. The purpose of this study was to evaluate whether knee and hip pain are more prevalent with contralateral foot pain than with ipsilateral foot pain in a population-based sample of men and women.

Materials and Methods

Population

The Framingham Foot Study, an ancillary study of the Framingham Heart Study, occurred between 2002 and 2008 and included members of the Framingham Offspring Cohort and a community sample. The Framingham Offspring Cohort, formed in 1971, comprised the adult offspring (and their spouses) of the original Framingham Heart Study cohort members (a population-based sample of the town of Framingham, Massachusetts, enrolled in 1948–1951).[17,18] The community sample was derived from census-based, random-digit dialing in the Framingham community, selecting individuals who were 50 years old and ambulatory.[7]

Members of the Framingham Foot Study received a validated foot examination[19] evaluating specific foot disorders, pain, pain location (including side of pain), and pain severity. All of the participants were ambulatory, cognitively intact, and able to give informed consent for the study. Of the 2,188 Framingham Foot Study participants, seven were excluded due to missing information on covariates, leaving data from 2,181 people for the present analysis. The institutional review boards of Hebrew SeniorLife and Boston University Medical Center

(Boston, Massachusetts) approved this study, and all of the participants provided signed informed consent.

Foot, Hip, and Knee Pain

Generalized foot pain was measured using the following query about foot pain based on the National Health and Nutrition Examination Survey pain questions: “On most days, do you have pain, aching, or stiffness in either of your feet?” Possible responses were no; yes, left foot only; yes, right foot only; or yes, both feet. To assess pain at other sites, participants were given a diagram of the body with ten joint regions highlighted (shoulders, elbows, hips, wrists, knees, ankles, neck, upper back, middle back, and lower back) and were asked: “On most days, do you have pain, aching, or stiffness in any of your joints?” Participants who reported pain, aching, or stiffness in any of the areas were instructed to mark which regions were affected. Participants who indicated pain at the right knee, left knee, right hip, or left hip were defined as having pain in the respective area.

From the information collected on foot, hip, and knee pain, three four-category variables were created to indicate participants with no pain, bilateral pain, left-sided pain only, or right-sided pain only for each pain location (foot, hip, and knee).

Covariates

Age, height, and weight were collected at the foot examination. Weight was measured to the nearest half pound using a standardized balance beam scale, and height (without shoes) was measured using a calibrated stadiometer to the nearest one-quarter inch. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared.[2] Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression Scale. Smoking status (current, former, never) and self-rated health (excellent, good, fair, poor) were also recorded at the foot examination.

Statistical Analyses

Descriptive statistics were generated for study variables using means and standard deviations or percentages where appropriate. Differences between men and women were assessed using the Student *t* test and the χ^2 test. Sex-specific multinomial logistic regression was used to calculate odds ratios and 95% confidence intervals for the association between the four-category foot pain variable (no foot pain, bilateral foot pain, left foot pain only, right foot pain only) and the four-category knee and hip pain variables (no pain, bilateral pain, left-sided pain only, right-sided pain), adjusting for age and BMI, both considered as continuous variables in the models. These multinomial logistic regression models allowed us to examine the association between contralateral pain (foot pain on the opposite side as the hip or knee pain) and ipsilateral pain (foot pain on the same side as the hip or knee pain). Crude models were also examined, but results were similar to those of the adjusted models. In addition, adding depressive symptoms to the models did not change the results. Thus, age- and BMI-adjusted results are presented. All of the analyses were performed with the SAS statistical analysis package (version 9.3; SAS Institute Inc, Cary, North Carolina).

Results

In the 2,181 participants in this study, the mean ± SD age was 64. ± 9 years; 56% were women, and the mean ± SD BMI was 28.6 ± 5.5 (Table 1). Seventy percent of the participants were never smokers, and approximately 57% rated their health as good or excellent. Men were slightly older and had a higher BMI compared with women, as expected in a population-based sample. Although most of the sample did not report foot pain, 16% reported bilateral foot pain, 6% right foot pain only, and 5% left foot pain only. Slightly more women reported foot pain than men. Although most of the participants did not report knee pain, 15% reported bilateral knee pain, 8% right knee pain only, and 6% left knee pain only. Similar to foot pain, women reported more knee pain than men. Hip pain reporting was similar, with 7% of participants reporting bilateral hip pain, 7% right hip pain only, and 4% left hip pain only. Again, women reported more hip pain than men.

Foot Pain in Relation to Knee Pain

After adjusting for age and BMI, men with right foot pain compared with no foot pain were five to seven times more likely to have bilateral or right (ipsilateral) knee pain compared with no knee pain but not left (contralateral) knee pain. Men with bilateral foot pain compared with no foot pain were two to three times more likely to have bilateral, right, and left knee pain compared with no knee pain. Thus, men with bilateral foot pain were more likely to report any knee pain than not. There was no association between left foot pain and knee pain on either side (Table 2).

After adjusting for age and BMI, women with right foot pain compared to those without foot pain were two to three times more likely to have left (contralateral) or right (ipsilateral) knee pain compared with those without knee pain but not bilateral knee pain. Women with bilateral foot pain compared to those with no foot pain were two to three times more likely to have bilateral, right, and left knee pain compared with no knee pain. Thus, women with bilateral foot pain were more likely to have any knee pain than not. Similar to the men, there was no association between left foot pain and knee pain on any side (Table 3).

Foot Pain in Relation to Hip Pain

After adjusting for age and BMI, men with right foot pain compared with no foot pain were 3.6 times more likely to have right (ipsilateral) hip pain compared with no hip pain. Men with left foot pain compared with no foot pain were five times more likely to have left (ipsilateral) hip pain compared with no hip pain. Men with bilateral foot pain compared with no foot pain were 2.5 times more likely to have left or right hip pain compared with no hip pain but not bilateral hip pain (Table 4).

After adjusting for age and BMI, women with bilateral foot pain compared with no foot pain were two to three times more likely to have bilateral hip pain, right hip pain, and left hip pain compared with no hip pain. Thus, women with bilateral foot pain are more likely to have any hip pain than not. There was no association between right or left foot pain and hip pain on any side (Table 5).

Discussion

We found that foot pain was associated with bilateral and ipsilateral knee pain in men and women. Foot pain was also associated with ipsilateral hip pain in men, whereas in women bilateral foot pain was associated with ipsilateral, contralateral, and bilateral hip pain. To our knowledge, this is the first report of a population-based study that considered sidedness of lower-extremity pain in relation to reporting of foot pain.

Clinicians note that patients with foot problems often present with contralateral pain at other lower-extremity sites and that few patients report bilateral pain. Yet, this study provides population-based evidence that most participants reporting pain are reporting bilateral pain, with up to 16% of older adults reporting bilateral lower-extremity pain.

A theory that may explain these results examines the correlated and compensatory postures and movements of an individual.[20] The basic premise is that pathologic abnormalities of structures in the neuromusculoskeletal system can result from skeletal malalignment (ie, abnormal joint alignment or bone deformity). These skeletal malalignments manifest themselves in correlated and compensatory postures and movements. For example, an individual with primary genu varum and medial compartment knee osteoarthritis may have a correlated posture and movement of hip abduction with a compensatory posture and movement pattern of foot pronation. When the foot pronates it can reduce the varus thrust at the end of the contact phase and partially off-load the medial compartment of the knee, hence reducing pain. If this same individual had a rigid cavus foot posture, this could actually increase the varus thrust and exacerbate the knee pain. The clinical challenge is to identify the primary, correlated, and compensatory sites in the lower extremity that are associated with a patient's pain and to devise a treatment plan that is cognizant of these relationships and, therefore, effective for managing the patient's pain and underlying pathologic disorder. The correlated and compensatory posture and movement theory may explain how multijoint osteoarthritis develops, as well as other pathologic abnormalities and associated pains that can result from overuse or trauma to one or more structures in the kinetic chain.

These findings advocate for a change in the paradigm of how patients with lower-extremity pain should be evaluated clinically. Typically, patients are told to "take off everything but your shoes and socks" when they come into a medical clinic. Clinicians should inquire about pain and examine patients' feet. For clinicians who provide foot-related care, asking patients about hip or knee pain may provide further insights. Clinicians who provide care for hips and knees may benefit their patients by asking them about their foot pain. If a patient presents with multilevel pain, it is possible that these pains are completely independent in etiology but it is also possible that they are related through lower-limb malalignments that have invoked correlated postures and movements. In a world where medical imaging has come to the forefront of patient diagnoses and care, these results remind health-care providers that the basic physical examination and patient history remains important in identifying pain and related patterns in patients.

The results of this study should be interpreted acknowledging several important limitations. First, this was a cross-sectional study, thus we cannot determine temporality between the onset of foot pain and hip or knee pain. Future longitudinal studies are needed to determine whether the foot pain is causing the pain in higher joints of the body or whether pain in the higher extremities may be causing different loading patterns in the foot, thus causing pain. In addition, we do not have any information on the cause or severity of the hip, knee, or foot pain.

This study also has several strengths. We have large numbers of men and women, with sufficient power to examine sex-specific results. This is a population-based community sample of older adults rather than a report from a clinical sample. We also used robust statistical methods to examine sidedness of pain across the lower extremities, as well as the ability to take the effects of age and BMI into account when examining the patterns of pain reported in these participants.

In conclusion, we found that bilateral foot pain was associated with increased odds of knee and hip pain in men and women. For ipsilateral foot and hip pain, men had a stronger effect compared with women.

References

1. BINGEFORS K, ISACSON D: Epidemiology, co-morbidity, and impact on health-related quality of life of self-reported headache and musculoskeletal pain: a gender perspective. Eur J Pain 8: 435, 2004. [PubMed: 15324775]
2. VAN DER WAAL JM, BOT SD, TERWEE CB, et al.: The incidences of and consultation rate for lower extremity complaints in general practice. Ann Rheum Dis 65: 809, 2006. [PubMed: 16269430]
3. PICAVET HS, SCHOUTEN JS: Musculoskeletal pain in the Netherlands: prevalences, consequences and risk groups, the DMC(3)-study. Pain 102: 167, 2003. [PubMed: 12620608]
4. MIRANDA H, VIIKARI-JUNTURA E, MARTIKAINEN R, et al.: A prospective study on knee pain and its risk factors. Osteoarthritis Cartilage 10: 623, 2002. [PubMed: 12479384]
5. GUREJE O, VON KORFF M, SIMON GE, et al.: Persistent pain and well-being: a World Health Organization study in primary care. JAMA 280: 147, 1998. [PubMed: 9669787]
6. GUREJE O, SIMON GE, VON KORFF M: A cross-national study of the course of persistent pain in primary care. Pain 92: 195, 2001. [PubMed: 11323140]
7. DUFOUR AB, BROE KE, NGUYEN US, et al.: Foot pain: is current or past shoewear a factor? Arthritis Rheum 61: 1352, 2009. [PubMed: 19790125]
8. THOMAS MJ, RODDY E, ZHANG W, et al.: The population prevalence of foot and ankle pain in middle and old age: a systematic review. Pain 152: 2870, 2011. [PubMed: 22019150]
9. MUNTEANU SE, ZAMMIT GV, MENZ HB. Factors associated with foot pain severity and foot-related disability in individuals with first metatarsophalangeal joint OA. Rheumatology (Oxford) 51: 176, 2012. [PubMed: 22096012]
10. KEEN HI, REDMOND A, WAKEFIELD RJ, et al.: An ultrasono-graphic study of metatarsophalangeal joint pain: synovitis, structural pathology and their relationship to symptoms and function. Ann Rheum Dis 70: 2140, 2011. [PubMed: 21857026]
11. OTTER SJ, LUCAS K, SPRINGETT K, et al.: Foot pain in rheumatoid arthritis prevalence, risk factors and management: an epidemiological study. Clin Rheumatol 29: 255, 2010. [PubMed: 19997766]
12. MENZ HB, DUFOUR AB, RISKOWSKI JL, et al.: Foot posture, foot function and low back pain: the Framingham Foot Study. Rheumatology (Oxford) 52: 2275, 2013. [PubMed: 24049103]

13. JUNGMANN PM, NEVITT MC, BAUM T, et al.: Relationship of unilateral total hip arthroplasty (THA) to contralateral and ipsilateral knee joint degeneration: a longitudinal 3T MRI study from the Osteoarthritis Initiative (OAI). Osteoarthritis Cartilage 23: 1144, 2015. [PubMed: 25819583]
14. COTOFANA S, WIRTH W, PENA ROSSI C, et al.: Contralateral knee effect on self-reported knee-specific function and global functional assessment: data from the Osteoarthritis Initiative. Arthritis Care Res (Hoboken) 67: 374, 2015. [PubMed: 25302424]
15. STEIDLE-KLOC E, WIRTH W, GLASS NA, et al.: Is pain in one knee associated with isometric muscle strength in the contralateral limb? data from the osteoarthritis initiative. Am J Phys Med Rehabil 94: 792, 2015. [PubMed: 25768069]
16. WANG W, GELLER JA, NYCE JD, et al.: Does ipsilateral knee pain improve after hip arthroplasty? Clin Orthop Relat Res 470: 578, 2012. [PubMed: 21997782]
17. DAWBER T, MEADORS G, MOORE F: Epidemiological approaches to heart disease: the Framingham Study. Am J Public Health Nations Health 41: 279, 1951. [PubMed: 14819398]
18. FEINLEIB M, KANNEL W, GARRISON R, et al.: The Framingham Offspring Study: design and preliminary data. Prev Med 4: 518, 1975. [PubMed: 1208363]
19. HAGEDORN TJ, DUFOUR AB, RISKOWSKI JL, et al.: Foot disorders, foot posture, and foot function: the Framingham foot study. PLoS One 8: e74364, 2013. [PubMed: 24040231]
20. RIEGGER-KRUGH C, KEYSOR JJ: Skeletal malalignments of the lower quarter: correlated and compensatory motions and postures. J Orthop Sports Phys Ther 23: 164, 1996. [PubMed: 8808518]

Table 1.

Description of Framingham Foot Study participants, 2002–2008.

	All (n=2181)	Men (n=959)	Women (n=1222)
Age (36–92 years)	64.1 (9.0)	64.6 (8.9)	63.7 (9.1) *
BMI (16.59–58.38 kg/m^2)	28.6 (5.5)	29.0 (4.6)	28.2 (6.1) *
Obese (BMI 30+)	737 (34%)	349 (36%)	388 (32%) *
Height	65.7 (3.8)	68.8 (2.8)	63.3 (2.5) *
Weight	176.0 (39.3)	195.6 (33.7)	160.7 (36.4) *
Female	1222 (56%)	-	-
Smoke regular (no)	1524 (70%)	680 (71%)	844 (70%)
Yes, Now	215 (10%)	92 (10%)	123 (10%)
Yes, Not now	427 (20%)	183 (19%)	244 (20%)
Self-rated Health, Excellent	478 (22%)	205 (22%)	273 (23%)
Good	748 (35%)	315 (33%)	432 (36%)
Fair	927 (43%)	426 (45%)	501 (41%)
Poor	15 (1%)	8 (1%)	7 (1%)
No Foot pain	1596 (73%)	758 (79%)	838 (69%) *
Right foot only	127 (6%)	39 (4%)	88 (7%)
Left foot only	102 (5%)	36 (4%)	66 (5%)
Both feet	356 (16%)	126 (13%)	230 (19%)
No knee pain	1528 (70%)	704 (73%)	824 (67%) *
Right knee only	185 (8%)	62 (6%)	123 (10%)
Left knee only	131 (6%)	63 (7%)	68 (6%)
Both knees	337 (15%)	130 (14%)	207 (17%)
No hip pain	1798 (82%)	840 (88%)	958 (78%) *
Right hip only	147 (7%)	40 (4%)	107 (9%)
Left hip only	87 (4%)	33 (3%)	54 (4%)
Both hips	149 (7%)	46 (5%)	103 (8%)
No shoulder pain	1737 (79.64%)	781 (81.44%)	956 (78.23%)
Right shoulder only	168 (7.70%)	72 (7.51%)	96 (7.86%)
Left shoulder only	111 (5.09%)	42 (4.38%)	69 (5.65%)
Both shoulders	165 (7.57%)	64 (6.67%)	101 (8.27%)
Low back pain	749 (34.34%)	288 (30.03%)	461 (37.73%) *
Mid back pain	176 (8.07%)	39 (4.07%)	137 (11.21%) *
Upper back pain	173 (7.93%)	43 (4.48%)	130 (10.64%) *

* $p<0.05$ men versus women

Table 2.

Age and BMI adjusted odds ratios (OR) and 95% confidence intervals for the association between foot pain and knee pain in men. (n=959)

Foot pain	Knee pain	OR	Lower Limit	Upper Limit
Right foot pain	No knee pain	Ref	-	-
	Bilateral knee pain	4.660	2.085	10.414
	Left knee pain	1.507	0.334	6.804
	Right knee pain	6.692	2.708	16.535
Left foot pain	No knee pain	Ref	-	-
	Bilateral knee pain	2.275	0.936	5.526
	Left knee pain	2.363	0.774	7.219
	Right knee pain	0.635	0.083	4.831
Bilateral foot pain	No knee pain	Ref	-	-
	Bilateral knee pain	2.999	1.825	4.926
	Left knee pain	2.198	1.107	4.365
	Right knee pain	2.356	1.172	4.736

Table 3.

Age and BMI adjusted odds ratios (OR) and 95% confidence intervals for the association between foot pain and knee pain in women. (n=1222)

Foot pain	knee pain	OR	Lower Limit	Upper Limit
Right foot pain	No knee pain	Ref	-	-
	Bilateral knee pain	0.998	0.496	2.007
	Left knee pain	2.286	1.005	5.202
	Right knee pain	2.691	1.483	4.882
Left foot pain	No knee pain	Ref	-	-
	Bilateral knee pain	1.258	0.632	2.502
	Left knee pain	1.617	0.603	4.337
	Right knee pain	0.675	0.235	1.939
Bilateral foot pain	No knee pain	Ref	-	-
	Bilateral knee pain	2.927	2.016	4.251
	Left knee pain	2.145	1.162	3.960
	Right knee pain	1.784	1.094	2.911

Table 4.

Age and BMI adjusted odds ratios (OR) and 95% confidence intervals for the association between foot pain and hip pain in men. (n=959)

Foot pain	Hip pain	OR	Lower Limit	Upper Limit
Right foot pain	No hip pain	Ref	-	-
	Bilateral hip pain	0.630	0.083	4.772
	Left hip pain	2.088	0.463	9.416
	Right hip pain	3.643	1.188	11.171
Left foot pain	No hip pain	Ref	-	-
	Bilateral hip pain	1.494	0.340	6.567
	Left hip pain	4.973	1.579	15.667
	Right hip pain	2.065	0.464	9.198
Bilateral foot pain	No hip pain	Ref	-	-
	Bilateral hip pain	1.675	0.770	3.644
	Left hip pain	2.581	1.082	6.157
	Right hip pain	2.534	1.142	5.623

Table 5.

Age and BMI adjusted odds ratios (OR) and 95% confidence intervals for the association between foot pain and hip pain in women. (n=1222)

Foot pain	Hip pain	OR	Lower Limit	Upper Limit
Right foot pain	No hip pain	Ref	-	-
	Bilateral hip pain	1.736	0.813	3.707
	Left hip pain	1.759	0.657	4.711
	Right hip pain	1.237	0.569	2.691
Left foot pain	No hip pain	Ref	-	-
	Bilateral hip pain	1.583	0.644	3.892
	Left hip pain	2.354	0.871	6.363
	Right hip pain	1.271	0.524	3.082
Bilateral foot pain	No hip pain	Ref	-	-
	Bilateral hip pain	3.228	2.029	5.135
	Left hip pain	2.228	1.157	4.290
	Right hip pain	1.742	1.059	2.864