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Title: Are prior foot/ankle or knee injuries in youth sports associated with current hip pain in young adulthood?

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Title: Are prior foot/ankle or knee injuries in youth sports associated with current hip pain in young adulthood?

Abstract:

Context: Hip pain is a concern in young adults, with previous hip injury recognized as a key contributing factor. However, little is known about how prior non-hip lower extremity injuries impact current hip pain.

Objectives: To determine (1) whether past foot/ankle and knee youth sports injuries are associated with current hip pain in young adults, and (2) the role of foot/ankle, knee, and hip pain in contributing to poor patient-reported lower extremity function in young adults.

Design: Cross-sectional study

Setting: Electronic survey

Patients or Other Participants: 424 young adults with previous youth sports participation

Main Outcome Measures: Individuals self-reported prior youth sports foot/ankle, knee, and hip injury histories, current pain in these regions, and current function using the Lower Extremity Functional Scale. Ordinal logistic regression models assessed the association of prior foot/ankle and/or knee injuries with current hip pain. Secondary analyses evaluated the impact of (1) foot/ankle and hip injury history on current knee pain and (2) knee and hip injury history on current foot/ankle pain. Finally, we explored the relationship between current lower extremity region pain and function.

Results: A history of both foot/ankle AND knee injuries [odds ratio (OR)=4.91; 95% confidence interval (CI)=2.80-8.60] or foot/ankle injury alone [OR=2.72, 95% CI=1.68-4.41] was associated with increased odds of current hip pain; a knee injury history alone was not [OR=1.17, 95% CI=0.64, 2.15]. Hip and foot/ankle injury histories were both associated with increased current knee pain. Greater current foot/ankle pain, but not knee or hip pain, was linked to worse current lower extremity function.

Conclusions: Prior lower extremity injuries, particularly involving the foot/ankle, increased the likelihood of current hip pain. Multi-region lower extremity injury histories appear to have a compounding effect on hip pain intensity.

Keywords: injury history, foot/ankle, young adult, lower extremity, hip pain

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Key points:

- A history of youth foot/ankle and knee injuries or foot/ankle injury alone were associated with an increased likelihood of experiencing more severe current hip pain in young adults.
- Young adults reporting more severe current foot/ankle pain had significantly greater odds of worse lower extremity function.
- Clinicians should consider the impact of youth foot/ankle and knee injury histories when addressing hip pain in young adults.

Hip pain is a prevalent musculoskeletal concern, affecting 10% of the general population and 10% of adolescents aged 13-19.[1] This condition often leads to physician visits and imposes a significant financial burden on the healthcare system.[2] Beyond its impact on healthcare costs, hip pain frequently results in considerable time away from sports activities.[3] In the US, approximately 60 million youth participate in sport, with 44 million engaging in multiple sports.[4] The overall lower extremity injury rate among youth (high school) athletes has been reported as 8.23 injuries per 10,000 athlete exposures (AEs) across gender-comparable sports, with ankle and knee sprains/strains being the most common types of lower extremity injuries resulting in medical disqualification.[5] A recent cohort study found that 40% of youth elite football players reported hip and/or groin pain.[6] Furthermore, young adults with hip pathology and pain have been shown to experience significant quality of life deficits.[7]

Prior studies have established a strong link between injury history and the subsequent development of site-specific joint pain. Anterior cruciate ligament (ACL) and meniscus injuries have been associated with knee pain and functional limitations 10 to 20 years after injury.[8] Moreover, recent evidence in patients younger than 16 years of age has demonstrated that undergoing ACL reconstruction at age ≥ 12 years is associated with a diagnosis of post-traumatic knee osteoarthritis within 5 years.[9] Previous ankle injury has also been found to be a risk factor for ankle pain and OA progression.[10] Similarly, a history of hip injury has been linked to the development of ipsilateral hip pain.[11] CAM morphology, a known risk factor for hip osteoarthritis, is thought to develop during adolescence, likely a result of intense sports or activity during growth spurts.[12–14] While most of these studies address the site specificity in the injury-symptom relationship, they do not explore whether an injury in one anatomical location could adversely impact a neighboring region.

Regional interdependence is a concept in which 'seemingly unrelated impairments in a remote anatomical region may contribute to, or be associated with, the patient's primary complaint.'[15] In the lower extremity, altered biomechanics at one joint can have an impact on both distal and proximal segments. For instance, chronic ankle instability has been found to alter hip muscle strength and knee flexion angles during a single leg jump.[16] Further, hip abductor weakness and fatigue can influence sagittal plane ankle

kinematics.[17] Additionally, several non-biomechanical factors, such as psychological stress and central sensitization, may affect pathways that modulate the sensation of musculoskeletal pain beyond the injured region.[18] However, the relationship between foot/ankle and knee injuries and subsequent development of hip symptoms has yet to be investigated.

This study's primary aim is to investigate the association between prior non-hip lower extremity injuries and subsequent development of hip pain, utilizing a convenience sample of young adults who previously participated in youth sports. We hypothesized that young adults with prior youth sport-related injuries to the foot/ankle, knee, or both are likely to experience more severe subsequent hip pain than those without a history of injuries. The secondary aim of this study is to explore the cross-sectional relationship between current pain in the foot/ankle, knee, and hip and current lower limb function, assessed by the Lower Extremity Functional Scale (LEFS).

METHODS

An electronic survey was distributed to all (N=21,619) undergraduate and graduate students at a large U.S. university from December 2019 to January 2020. While details of this survey have been published elsewhere,[19] pertinent aspects related to the current study are included. This study was approved by the university's Institutional Review Board (IRB), and all participants provided their informed consent to be included. We followed the Strengthening the Reporting of Observational Studies In Epidemiology (STROBE) reporting guidelines where applicable.[20]

To be included in the study, individuals must: 1) be between the ages of 18-24, 2) have participated in sports both before and during high school, and 3) answered "no" to a question asking whether they had sustained an injury within the last 3 months that caused them to miss at least 1 day of their preferred activity.

Variables and outcome measures:

Demographics. Demographic variables collected included age, sex at birth, height (feet and inches), weight (pounds), primary sport, race, and ethnicity.

Injury history and lower extremity region pain. Participants reported if they had any history (yes/no for each region) of foot/ankle, knee, and/or hip injuries during their youth and adolescent sports career that had impacted their ability to play their sport for at least one week. They rated their current pain during a typical week for each region (foot/ankle, knee, hip) using the Visual Analogue Scale (VAS) on a 0-to-10-cm scale, where 0 = no pain and 10 = worst pain imaginable.

Lower extremity function. Participants assessed their current lower extremity function using the Lower Extremity Functional Scale (LEFS), a validated measure of lower limb function for a range of musculoskeletal conditions.[21] This questionnaire requires individuals to rate their level of difficulty in performing 20 specific activities on a scale from 0 (severe difficulty or unable to perform) to 4 (no difficulty). The total score ranges from 0 to 80, with 80 indicating no functional deficits and 0 indicating extreme deficits.

Data Analysis

Demographics. Height and weight were converted to metric units for data analysis, and BMI was calculated.

Injury history (exposure variable). For the primary aim investigating the association between histories of foot/ankle and knee youth sport injury and current hip pain in young adulthood, the exposure variable of injury history was categorized as: 0 = no injury history, 1 = knee injury history ONLY, 2 = foot/ankle injury history ONLY, and 3 = knee AND foot/ankle injury history.

Current lower extremity region pain (outcome variable). Although pain was collected as a continuous measure on the VAS, there were many participants with VAS ratings of 0 or less than 1, suggesting a negatively skewed distribution. To address this, VAS scores were converted to an ordinal variable, using cutoff values from the literature. We categorized pain intensity using the clinically important difference of 2 points on the VAS: no pain (VAS score = 0), mild pain (0< VAS score <2), and moderate or higher pain (VAS score ≥2).[22] We also conducted a sensitivity analysis using alternative cutoff values, where pain was classified as: no pain (VAS score = 0), mild pain (0< VAS score <3.5), moderate pain (3.5≤ VAS score <6.5), and severe pain (VAS score ≥6.5).[23]

Lower extremity function. Because the distribution of LEFS scores was positively skewed towards 80, the scores were transformed into a binary variable based on age-normative values for healthy young adults.[24] Individuals with a LEFS score of ≥75 were considered as being within age norms, while those with a score of <75 were categorized as below age norms.

Statistical analyses

We report means and standard deviations (SDs) for continuous variables and counts and percentages for ordinal and categorical variables. Data were inspected for any extreme outliers.

First aim: Associations between prior foot/ankle and/or knee youth sports injuries and current hip pain in young adulthood

To minimize the potential influence of a prior hip injury on experiencing current hip pain, participants with a history of hip injury were excluded from the primary analysis.

We examined whether past foot/ankle and knee injuries sustained during youth sports are associated with current hip pain, using cumulative odds ordinal logistic regression with proportional odds models, adjusting for age, sex, and BMI. The exposure variable was injury history (no injury, knee injury ONLY, foot/ankle injury ONLY, and knee AND foot/ankle injury), and the outcome variable was hip pain intensity, categorized into 3 levels (no pain, mild pain, moderate or higher pain). The sensitivity analysis utilized an alternative categorization of pain intensity into 4 levels (no pain, mild pain, moderate pain, severe pain). We also conducted sex-stratified analyses.

We also conducted secondary analyses to investigate the associations between 1) injury history of the hip and/or foot/ankle and current knee pain intensity in individuals without a knee injury history, and 2) injury history of the hip and/or knee and current foot/ankle pain intensity in those without foot/ankle injury history, using similar ordinal regression models.

Second aim: Associations between current lower extremity region pain and current self-reported lower extremity function

We evaluated the role of current pain in the foot/ankle, knee, and hip in contributing to poor patient-reported lower extremity function, using cumulative odds ordinal logistic regression with proportional

odds models, adjusting for age, sex, and BMI. The exposure variable was current LEFS score, dichotomized as within vs. below age normative values, and the outcome variable was current pain intensity in each region (foot/ankle, knee, and hip), categorized into 3 levels (no pain, mild pain, moderate or higher pain).

All regression results are reported as adjusted odds ratios (OR) with 95% confidence intervals (CIs). An OR >1.0 indicates an increased likelihood, and <1.0 indicates a decreased likelihood. Statistical significance was determined at a p-value <0.05. SPSS software was used for all statistical analyses.

RESULTS

Sample demographics. The final sample consisted of 424 participants. Among them, 375 had no history of hip injury and were included in the primary analysis. See Figure 1 for study sample derivation. Shown in Table 1, the entire sample had a mean age of 20.16 years (SD: 1.51) and a mean BMI of 23.96 kg/m^2 (SD: 4.07); 70.0% were female. The most frequently reported youth sports were soccer/football (25.9%), followed by basketball (8.7%), lacrosse (7.8%), and American football (7.1%).

Sample characteristics. Of the 424 participants, 214 (50.5%) had a history of foot/ankle injury, 154 (36.3%) had a history of knee injury, and 49 (11.6%) had a history of hip injury. The mean pain scores for the foot/ankle, knee, and hip were 1.29 (SD: 2.09), 1.45 (SD: 2.12), and 1.99 (SD: 2.40), respectively. The mean LEFS score was 72.2 (SD: 9.38). Table 1 summarizes the study sample characteristics for the entire group (N=424) and for the primary analysis sample of participants without a history of hip injury (N=375).

Associations between prior knee and/or foot/ankle history and current hip pain. Those with a history of both foot/ankle AND knee injury had nearly 5 times greater odds (OR: 4.91; 95% CI: 2.80, 8.60; p<0.001) of worse hip pain compared to those with no injury history (Figure 2). Foot/ankle injury alone also significantly increased the likelihood of worse hip pain (OR: 2.72; 95% CI: 1.68, 4.41; p<0.001) but knee injury alone did not (OR: 1.17; 95% CI: 0.64, 2.15; p=0.616). Results were similar when pain was categorized into four categories (Figure 2). Females had increased odds (OR: 2.24, 95% CI: 1.46, 3.44;

p<0.001) of experiencing more severe hip pain than males. Neither age (p=0.115) nor BMI (p=0.374) were significant covariates in these analyses.

Sex-stratified analyses for injury history and hip pain. Given that sex was a significant covariate, we ran sex-stratified regression models. As shown in Figure 3, the observed patterns of associations were consistent across both sexes (males: top panel; females: bottom panel). For both sexes, the 3-category (black symbols) and 4-category (grey symbols) pain models produced largely similar results.

Secondary analyses. Among the 270 participants without a history of knee injury, having a history of ankle/foot AND hip injury (OR: 4.48; 95% CI: 1.52, 13.20; p=0.007) and having a history of foot/ankle injury alone (OR: 2.95; 95% CI: 1.79, 4.85; p<0.001) significantly increased the odds of more severe knee pain (see Table 2). Among the 210 participants without a history of foot/ankle injury, there was no association between previous knee and/or hip injury and current foot/ankle pain (Table 2).

Cross-sectional relationship between location of pain and poor lower extremity function. As shown in Table 3, moderate or higher foot/ankle pain was significantly associated with poor lower extremity function (OR: 3.68; 95% CI: 1.31, 10.38; p=0.014), whereas pain in the knee or hip was not. Females were more likely to experience impaired lower extremity function (OR: 2.76; 95% CI: 1.61, 4.70; p<0.001).

DISCUSSION

The study results highlight the significant role of prior non-hip lower extremity injuries sustained during youth sports, particularly those involving the foot/ankle, in contributing to current hip pain in young adulthood. We found that young adults with a history of both foot/ankle and knee injuries had nearly 5 times greater odds of experiencing more severe current hip pain, compared to those with no prior injuries. Foot/ankle injury history alone also significantly increased the odds of hip pain, while a history of knee injury alone did not. Furthermore, those with a history of foot/ankle and hip injuries were more likely to experience increased knee pain, but knee and hip injury history had no impact on current foot/ankle pain. Our findings also revealed that more severe foot/ankle pain was linked to reduced lower extremity function. These results support the concept of regional interdependence, where injuries in one anatomical

area can have adverse effects on other regions. Interestingly, knee injury history alone was not associated with increased hip pain, underscoring the specific contribution of foot/ankle injuries to hip symptomatology. To our knowledge, this is the first study establishing a connection between youth sports injuries to the foot/ankle and knee and future hip pain.

Previous studies have primarily focused on assessing the relationship between injury history and development of pain at the same joint region. For example, individuals with a history of ACL reconstruction (often in adolescence or early adulthood) have an increased risk of knee pain and osteoarthritis compared to those without such injury.[8,9] Similarly, a history of hip injury elevates the risk of developing hip osteoarthritis.[11] The connection between sport injuries earlier in life and an elevated risk of pain in adulthood is particularly concerning given the current rise of youth sport injuries driven by increased sport participation and early specialization.[25]

Other studies examining the broader impact of lower extremity injuries often lack specificity, making it difficult to assess the **specific** effects of individual and combined joint injuries on hip pain. A 2021 study by van Klij et al. found that individuals with a history of injuries other than the groin region had significantly worse scores on the pain, symptoms, and function subscales of the Hip and Groin Outcome Score compared to those without such history.[26] However, this study did not differentiate between individuals with vs. without prior groin/hip injuries, confounding interpretation of its findings.[26] Likewise, a recent survey of marathon runners combined history of hip and knee injuries that prevented running into a single category, making it difficult to isolate factors specifically contributing to hip or knee pain.[27] Finally, a recent retrospective cohort study suggested a heightened risk of musculoskeletal injury during military training for individuals with prior injuries, yet all lower extremity injuries were aggregated in the analysis without exploring the effects of previous joint injuries on current injury in the adjacent joints.[28] Our study addresses these gaps in the literature by reporting injury histories for the three regions (foot/ankle, knee, and hip) separately, enabling a more detailed analysis of their unique and combined effects on individual pain.

Our findings suggest that the foot/ankle region may play a more influential role in contributing to hip pain in young adulthood than the knee. This connection is supported by research demonstrating a biomechanical link between these joints. For example, healthy young adults with restricted ankle dorsiflexion range of motion exhibited increased hip adduction motion during a step down task.[29] Taylor et al. (2022) found that each degree of reduced ankle dorsiflexion during a vertical drop landing corresponded to a proportional decrease in hip flexion excursion.[30] Yen et al. (2017) further observed altered hip/ankle coordination during gait in individuals with chronic ankle instability (CAI), although they did not evaluate its direct impact on hip pain.[31] Additionally, individuals with CAI have shown neuromuscular impairments and dynamic stability deficits at the hip, which could explain how prior ankle/foot injuries contribute to hip pain.[32] Given that only 6.8% of individuals with lateral ankle sprains access physical therapy treatment afterwards, continued impairments as discussed above could likely explain why the foot/ankle came out as such an important factor in our analyses.[33] Together, these findings highlight the interdependence of foot/ankle and hip regions, emphasizing the need to account for distal injuries of the limb when evaluating and managing hip pain.

Beyond biomechanical factors, altered pain processing may also play a role in increased hip pain among individuals with prior non-hip lower extremity injuries. Continued sports participation despite injury can expose the body to repetitive noxious stimuli, leading to increased excitability of nociceptive pathways. This may result in pain hypersensitivity, characterized by an exaggerated response to non-noxious or subthreshold nociceptive input.[34] Over time, the pain may become more widespread, extending beyond the original site of injury to potentially affect adjacent regions.[34]

We observed a significant association (OR = 3.68, 95% CI: 1.31, 10.38) between current foot/ankle pain and impaired lower extremity function, as assessed by the LEFS. Increased knee pain trended towards significance in relation to reduced lower extremity function (p=0.052), while no such trend was found for hip pain. These findings suggest the significant role of foot/ankle pain in lower extremity function. Foot/ankle pain could have a more direct impact on self-reported lower limb function as they are the primary contact points with the ground during gait and weight-bearing activities.

The LEFS is a regional patient-reported outcome measure, evaluating function across the lower limb without being specific to any single joint. A 2016 systematic review reported moderate to excellent construct validity of the LEFS when compared to other regional-specific patient-reported outcome measures, such as the Knee Injury and Osteoarthritis Outcome Score, International Knee Documentation Committee Subjective Knee form, and Hip Injury and Osteoarthritis Outcome Score. However, it is important to note that these studies primarily involved older adults with knee or hip OA, after ACL reconstruction, or awaiting a total joint replacement.[35] In contrast, our study focused on a younger, more active cohort. This demographic difference may partially explain why current hip pain was not related to lower limb function in our results.

Strengths and limitations

To our knowledge, this is the first study demonstrating that a history of youth sports injuries at the foot/ankle and/or knee is linked to the occurrence of hip pain in young adulthood. Our analysis sample included individuals within the desired age range regardless of their current activity levels or sports participation, enhancing the external validity and generalizability of study findings. Furthermore, the narrow age range (18-24) of study participants minimizes the likelihood of current pain stemming from middle- or older-adult age-related conditions, like primary osteoarthritis. The use of sensitivity analyses with 2 different pain categorization strategies strengthened the robustness of study findings. Finally, the current study systematically examined multiple lower extremity regions and their interrelationships, providing a comprehensive understanding of how early injuries in one region may contribute to pain in adjacent areas during young adulthood.

It is important to acknowledge several limitations of the current study. Our study sample was predominantly female (70% in overall cohort), although the observed association between current hip pain and prior injury history was consistent across both sexes. Reliance on self-reported injury history may have introduced recall bias, potentially affecting the accuracy of injury history data. While the study adjusted for age, sex, and BMI, it did not account for several potential unmeasured confounders (e.g., current activity level, rehabilitation history following youth sports injuries) that could influence the

relationship between injury history and current pain. Additionally, variables that were not collected in the survey, such as the side of the prior injury, the injury type or severity, or the frequency of current pain could have provided more nuanced insights. No identifying information was collected regarding each respondent, which theoretically may have allowed some to access and respond to the survey more than once if they wished to do so. Finally, although the survey was distributed to the student body at a large university, only individuals who chose to respond, and participated in youth sports were included, which may limit the generalizability to others who may have current hip pain but did not participate in youth sports. Future prospective cohort studies that follow individuals over an extended period would enhance our understanding of the relationship between youth sport injury and future risk of hip pain. In addition, future research should document injury details, such as the specific injured structure(s), type (traumatic vs. overuse), severity, side (left vs. right), and management (no care, rehabilitation with a provider, surgery, etc.), to provide deeper insights into how prior youth sport injuries may contribute to hip pain in young adulthood.

In conclusion, our study found that among 375 young adult respondents with no prior hip injury, those with a history of both foot/ankle and knee injury or a foot/ankle injury alone had increased odds of experiencing more severe hip pain. Clinical providers should consider assessing injury history beyond the directly affected joint region, especially in cases of foot/ankle injuries, when treating young adults with hip pain. In addition, individuals working with youth athletes should consider how current lower extremity injuries are managed or tracked to better identify and mitigate risks for future injuries.

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Figure legends:

Figure 1: Study sample derivation

Figure 2: The associations between injury history (Foot/ankle AND knee injury, Foot/ankle injury ONLY, and Knee injury ONLY) and current hip pain intensity. Both the 3-category (black) and 4-category (grey) pain intensity classifications are shown. Adjusted odds ratios (ORs) are represented by

solid symbols, with 95% confidence intervals (CIs) shown as bars. Statistically significant results are in **bold**. ORs greater than 1 (vertical dashed line) indicates increased odds of more severe hip pain.

Figure 3: Sex-stratified associations between injury history (Foot/ankle AND knee injury, Foot/ankle injury ONLY, and Knee injury ONLY) and current hip pain intensity for males (top panel) and females (bottom panel). Adjusted odds ratios (ORs) are represented by diamond (males) OR square (females) symbols, with 95% confidence intervals (CIs) shown as bars. Both 3-category (black) and 4-category (grey) pain intensity classifications are shown in each panel. Statistically significant results are in **bold**. ORs greater than 1 (vertical dashed line) indicates increased odds of more severe hip pain.

Individuals consented
(N=629)

Did not finish survey (N=79)

Did not meet eligibility criteria (N=126)

N=15: Not 18-24 years of age
N=15: Did not participate in sports during youth or high school
N=96: Current lower extremity injury

Total sample
(N=424)

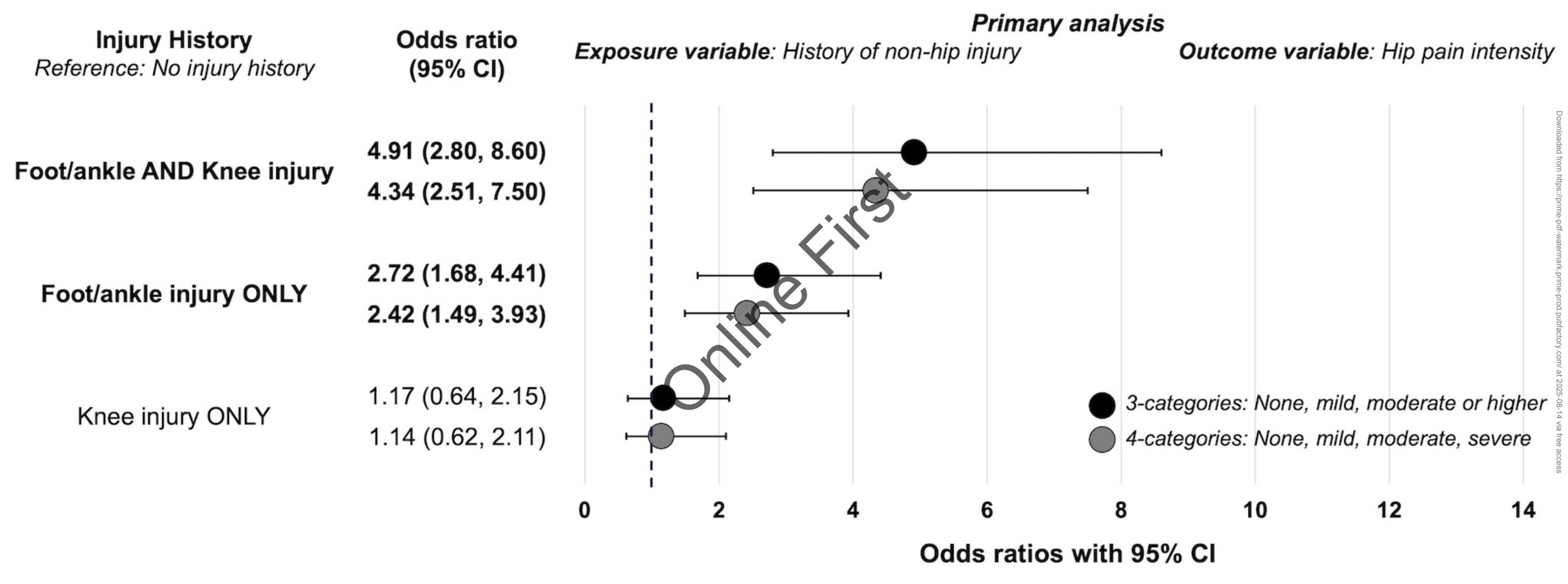
Reported prior hip injury (N=49)

Primary cohort
(N=375)

Table 1. Cohort demographics, injury history, lower extremity region pain, and Lower Extremity Functional Scale (LEFS) scores

Characteristic	Participants	
	Overall cohort N=424	Primary cohort (no hip injury) N=375
Age, mean (SD), years	20.2 (1.5)	20.1 (1.5)
Sex, number (%)		
Male	127 (30.0)	117 (31.2)
Female	297 (70.0)	258 (68.8)
Body mass index (BMI), mean (SD), kg/m^2	24.0 (4.1)	24.1 (4.2)
Sport, number (%)		
Soccer	110 (25.9)	95 (25.3)
Basketball	37 (8.7)	31 (8.3)
Lacrosse	33 (7.8)	29 (7.7)
Football	30 (7.1)	28 (7.5)
Swimming	29 (6.8)	28 (7.5)
Softball	25 (5.9)	22 (5.9)
Baseball	25 (5.9)	23 (6.1)
Volleyball	22 (5.2)	20 (5.3)
Other	22 (5.2)	19 (5.1)
Gymnastics	18 (4.2)	14 (3.7)
Track and Field	17 (4.0)	14 (3.7)
Cheerleading	17 (4.0)	17 (4.5)
Field Hockey	15 (3.5)	12 (3.2)
Cross Country	8 (1.9)	8 (2.1)
Tennis	6 (1.4)	6 (1.6)
Ice Hockey	6 (1.4)	5 (1.3)
Wrestling	4 (0.9)	4 (1.1)
Race, number (%)		
American Indian/Alaska Native	5 (1.2)	3 (0.8)
Asian or Asian American	14 (3.3)	13 (3.5)
Black/African American	29 (6.8)	25 (6.7)
Native Hawaiian/Other Pacific Islander	1 (0.2)	1 (0.3)
White/Caucasian	371 (87.5)	329 (87.7)
Other	4 (0.9)	4 (1.1)
Ethnicity, number (%)		
Hispanic/Latinx	32 (7.5)	28 (7.5)
Not Hispanic Latinx	392 (92.5)	347 (92.5)
Injury history, number (%)		
Foot/ankle	214 (50.5)	186 (49.6)
Knee	154 (36.3)	129 (34.4)
Hip	49 (11.6)	N/A

Current lower extremity region pain intensity:		
Visual analog scale (0-10 cm), mean (SD)		
Foot/ankle	1.29 (2.09)	1.24 (2.02)
Knee	1.45 (2.12)	1.44 (2.10)
Hip	1.99 (2.40)	1.96 (2.35)
Categories of pain intensity defined as none, mild, moderate or higher, % in each category		
Foot/ankle		
None (=0)	50.0	50.4
Mild (>0, <2)	27.8	28.0
Moderate or higher (≥2)	22.2	21.6
Knee		
None (=0)	45.0	45.6
Mild (>0, <2)	29.2	28.8
Moderate or higher (≥2)	25.7	25.6
Hip		
None (=0)	33.5	33.9
Mild (>0, <2)	31.1	31.2
Moderate or higher (≥2)	35.4	34.9
LEFS score, mean (SD)	72.2 (9.4)	72.8 (9.3)



Sex-stratified analyses

***Exposure variable**: History of non-hip injury* ***Outcome variable**: Hip pain intensity*

Injury History *Reference: No injury history*	**Odds ratio (95% CI)**
Males	
Foot/ankle AND Knee injury	**4.89 (1.73, 13.81)**
	5.42 (1.88, 15.61)
Foot/ankle injury ONLY	**3.60 (1.49, 8.70)**
	3.01 (1.24, 7.32)
Knee injury ONLY	1.28 (0.37, 4.40)
	1.31 (0.38, 4.55)
Females	
Foot/ankle AND Knee injury	**4.78 (2.43, 9.40)**
	3.92 (2.06, 7.47)
Foot/ankle injury ONLY	**2.41 (1.34, 4.31)**
	2.25 (1.26, 4.04)
Knee injury ONLY	1.14 (0.57, 2.30)
	1.10 (0.54, 2.22)

3-categories: None, mild, moderate or higher

4-categories: None, mild, moderate, severe

0 2 4 6 8 10 12 14 16

Odds ratios with 95% CI

Table 2. Associations between prior foot/ankle and/or hip injury history and current knee pain and between prior knee and/or hip injury history and current foot/ankle pain

Variables *Reference: no injury history*	**Pain intensity model**[a]	**Adjusted odds ratio**	**95% CI lower limit**	**95% CI upper limit**	**p-value**[b]
Participants without a history of knee injury (N=270) Exposure variables: history of non-knee injury; Outcome variable: knee pain intensity					
Foot/ankle AND hip injury	*3-category model*	**4.48**	**1.52**	**13.20**	**0.007**
	4-category model	**5.97**	**2.02**	**17.70**	**0.001**
Foot/ankle injury ONLY	*3-category model*	**2.95**	**1.79**	**4.85**	**<0.001**
	4-category model	**2.60**	**1.57**	**4.29**	**<0.001**
Hip injury ONLY	*3-category model*	1.10	0.32	3.81	0.884
	4-category model	1.01	0.29	3.58	0.984
Participants without a history of foot/ankle injury (N=210) Exposure variables: history of non-foot/ankle injury; Outcome variable: foot/ankle pain intensity					
Knee AND hip injury	*3-category model*	1.24	0.36	4.26	0.729
	4-category model	1.12	0.32	3.93	0.855
Knee injury ONLY	*3-category model*	1.25	0.66	2.36	0.493
	4-category model	1.27	0.67	2.40	0.468
Hip injury ONLY	*3-category model*	0.84	0.24	2.92	0.787
	4-category model	0.65	0.18	2.39	0.516

[a]3-category pain model: none, mild, moderate or higher; 4-category pain model: none, mild, moderate, severe.
[b]Statistically significant results are in **bold**.

Table 3. Associations between current lower extremity pain (3 categories) and current impaired self-reported lower extremity function (N=424)

Variables	Category[a]	Adjusted odds ratio	95% CI lower limit	95% CI upper limit	p-value[b]
Foot/ankle pain	No pain (reference group)				
	Mild pain	1.90	0.95	3.81	0.070
	Moderate or higher pain	**3.68**	**1.31**	**10.38**	**0.014**
Knee pain	No pain (reference group)				
	Mild pain	1.46	0.68	3.13	0.332
	Moderate or higher pain	3.07	0.99	9.52	0.052
Hip pain	No pain (reference group)				
	Mild pain	1.00	0.36	2.75	0.993
	Moderate or higher pain	1.93	0.47	7.92	0.364
Covariates					
Sex	Male (reference group)				
	Female	**2.76**	**1.61**	**4.70**	**<0.001**
Age (per year)		0.88	0.76	1.03	0.104
BMI (per kg/m^2)		1.04	0.98	1.10	0.185

Results are reported as adjusted odds ratio and upper and lower limits of the 95% confidence interval (CI).
[a]Mild pain: >0, <2; Moderate or higher pain: ≥2
[b]Statistically significant results are in **bold**.