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# Scoping Review of Foot Disorders and Proximal Joint Pain: Evidence on the Foot–Knee–Hip–Spine Kinetic Chain

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**Abstract:**

- ***Background:***

**Foot disorders are common musculoskeletal conditions that can alter lower limb biomechanics and load transmission across the kinetic chain. Increasing attention has been directed toward the potential influence of foot pathology on proximal joint pain, including the knee, hip, and spine. However, existing evidence examining the relationship between foot disorders and proximal joint pain is heterogeneous and dispersed across multiple disciplines, limiting comprehensive understanding.**

- ***Objective:***

**To map and synthesize existing evidence on the association between foot disorders and proximal joint pain, specifically involving the knee, hip, and spine, using a kinetic chain perspective.**

- ***Methods:***

**This scoping review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines. A systematic search of electronic databases including PubMed/MEDLINE, Scopus, Web of Science, PEDro, and Google Scholar was performed. Studies involving adults and examining foot disorders in relation to pain, dysfunction, or biomechanical alterations at the knee, hip, or spine were eligible for inclusion. Data were charted descriptively to map study characteristics, foot conditions examined, proximal joint outcomes, study designs, and key findings.**

- ***Results:***

**The included studies encompassed a range of observational, experimental, and biomechanical designs. Commonly investigated foot disorders included pes planus, hallux valgus, plantar fasciitis, and altered foot posture. Proximal outcomes predominantly involved knee pain and low back pain, with fewer studies addressing hip-related symptoms. Evidence suggested consistent associations between abnormal foot mechanics and proximal joint pain, although methodological approaches and outcome measures varied widely across studies.**

- ***Conclusion:***

**This scoping review highlights a substantial body of evidence supporting an association between foot disorders and proximal joint pain, particularly at the knee and spine. However, gaps remain in the literature regarding hip involvement and longitudinal relationships. The findings underscore the importance of adopting a kinetic chain approach in musculoskeletal assessment and identify key areas for future research.**

***Keywords:*** *Foot Disorders; Kinetic Chain; Knee Pain; Hip Pain; Low Back Pain; Scoping Review.*

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## I. INTRODUCTION

Musculoskeletal disorders are a leading cause of pain and disability worldwide, affecting individuals across all age groups and contributing substantially to global healthcare burden. Pain involving the knee, hip, and spine—particularly low back pain—accounts for a significant proportion of years lived with disability and healthcare utilization (Hartvigsen et al., 2018; Vos et al., 2020). While proximal joint pain is often approached as a localized problem, contemporary musculoskeletal research increasingly emphasizes the importance of distal biomechanical contributors within the context of the kinetic chain (Levangie & Norkin, 2011; McPoil et al., 2008).

The kinetic chain concept proposes that the lower extremity functions as an integrated system, whereby dysfunction in one segment can influence mechanical loading and movement patterns in adjacent or distant segments (Khamis & Yizhar, 2007; Pinto et al., 2008). Within this framework, the foot plays a critical role as the primary interface between the body and the ground during standing, walking, and dynamic activities. Alterations in foot structure or function may therefore affect lower limb alignment, shock absorption, and neuromuscular control, with potential implications for the knee, hip, and spine (Cornwall & McPoil, 2011; Menz et al., 2013).

Foot disorders are among the most prevalent musculoskeletal conditions encountered in both clinical and community settings. Common conditions such as pes planus, hallux valgus, plantar fasciitis, and abnormal foot posture have been reported across a wide range of age groups and activity levels (Nix et al., 2010; Irving et al., 2006). These disorders can alter plantar pressure distribution, reduce the efficiency of the windlass mechanism, and modify gait patterns, potentially resulting in compensatory strategies at proximal joints (Menz & Morris, 2005; Wearing et al., 2006).

Biomechanical studies have demonstrated that abnormal foot mechanics, including excessive pronation and reduced medial longitudinal arch support, can increase internal tibial rotation and knee valgus moments, alter hip kinematics, and influence pelvic alignment (Tiberio, 1987; Khamis & Yizhar, 2007). Such alterations may increase mechanical stress on the lumbar spine, thereby contributing to the development or persistence of low back pain (Pinto et al., 2008; Brantingham et al., 2006). These findings support the plausibility of a biomechanical link between foot disorders and proximal joint pain.

Clinical and epidemiological studies have further explored associations between foot characteristics and proximal joint symptoms. Previous research has reported relationships between flat foot posture and knee pain, as well as between altered foot mechanics and low back pain in both athletic and non-athletic populations (Kosashvili et al., 2008; Menz et al., 2013). However, much of the existing literature has focused on generalized foot posture classifications rather than specific, clinically diagnosed foot disorders. Consequently, the relationship between distinct foot pathologies—such as hallux valgus and plantar fasciitis—and proximal joint pain remains incompletely understood.

The available evidence is also characterized by substantial methodological heterogeneity. Studies differ in terms of populations examined, ranging from athletes to older adults; foot disorders assessed; proximal joint outcomes measured; and study designs employed, including observational, experimental, and biomechanical approaches. Furthermore, relevant evidence is dispersed across multiple disciplines, including podiatry, orthopaedics, physiotherapy, biomechanics, and sports medicine, making it difficult to obtain a comprehensive overview of the field (McPoil et al., 2008; Levangie & Norkin, 2011).

In such contexts, scoping reviews are particularly valuable, as they aim to map the breadth and nature of existing evidence, clarify key concepts, and identify research gaps rather than evaluate intervention effectiveness (Arksey & O'Malley, 2005; Peters et al., 2020). Despite growing interest in the foot–proximal joint relationship, no scoping review to date has systematically mapped evidence linking foot disorders with pain or dysfunction at the knee, hip, and spine using a kinetic chain perspective.

Understanding these relationships has important implications for clinical practice. Rehabilitation approaches for knee, hip, or spinal pain often prioritize proximal structures, potentially overlooking distal contributors such as foot pathology. Evidence suggesting consistent associations between foot disorders and proximal joint pain may support the inclusion of foot assessment and targeted interventions—such as footwear modification, orthotic management, and foot-specific exercise—within comprehensive musculoskeletal care (Brantingham et al., 2006; Cornwall & McPoil, 2011).

Therefore, the purpose of this scoping review was to map existing evidence on the association between foot disorders and proximal joint pain, specifically involving the knee, hip, and spine, within the context of the lower-limb kinetic chain. By synthesizing findings across diverse study designs and populations, this review aims to provide a comprehensive overview of current knowledge, highlight patterns and gaps in the literature, and inform future research and clinical practice.

## II. METHODOLOGY

➢ *Study Design*

This scoping review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco et al., 2018). A scoping review methodology was selected as it is appropriate for mapping the breadth, nature, and characteristics of evidence in areas where literature is heterogeneous, conceptually broad, and methodologically diverse (Arksey & O'Malley, 2005; Peters et al., 2020). The review aimed to identify key concepts,

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types of evidence, and knowledge gaps related to the association between foot disorders and proximal joint pain within the lower-limb kinetic chain.

➢ *Review Objectives and Research Questions*

The primary objective of this scoping review was to map existing evidence examining associations between foot disorders and pain or dysfunction at proximal joints, specifically the knee, hip, and spine.

The review addressed the following research questions:

- What types of foot disorders have been studied in relation to proximal joint pain?
- Which proximal joints (knee, hip, spine) have been most frequently investigated?
- What study designs and populations dominate the existing literature?
- What biomechanical or clinical mechanisms are proposed to explain foot–proximal joint associations?
- What gaps exist in current research that warrant further investigation?

➢ *Eligibility Criteria*

Eligibility criteria were developed using the Population–Concept–Context (PCC) framework recommended for scoping reviews (Peters et al., 2020).

➢ *Population*

Studies involving human participants aged 18 years and above were eligible. No restrictions were placed on sex, physical activity level, or health status. Both athletic and non-athletic populations were included.

➢ *Concept*

The concept of interest was foot disorders and their association with proximal joint pain or dysfunction. Foot disorders included, but were not limited to:

- Pes planus or altered foot posture
- Hallux valgus
- Plantar fasciitis or plantar heel pain
- Other clinically described foot deformities or biomechanical abnormalities

Proximal joint outcomes included pain, dysfunction, biomechanical alteration, or pathology involving the knee, hip, pelvis, or spine, including low back pain.

➢ *Context*

Studies conducted in clinical, community, occupational, sports, or laboratory settings were eligible. No geographical restrictions were applied.

➢ *Types of Sources*

Original research studies including observational studies, experimental studies, biomechanical analyses, and clinical trials were included. Reviews, editorials, conference abstracts, case reports, and non-English publications were excluded.

➢ *Information Sources*

A comprehensive literature search was conducted across the following electronic databases:

- PubMed/MEDLINE
- Scopus
- Web of Science
- PEDro (Physiotherapy Evidence Database)

In addition, Google Scholar was searched to identify potentially relevant grey literature and additional studies not indexed in the primary databases. Reference lists of included studies were manually screened to identify further eligible articles.

➢ *Search Strategy*

A structured search strategy was developed using keywords and Medical Subject Headings (MeSH) related to foot disorders, proximal joint pain, and kinetic chain biomechanics. Search terms were combined using Boolean operators (AND/OR).

An example search strategy used in PubMed was:

("foot disorder" OR "foot posture" OR "pes planus" OR "hallux valgus" OR "plantar fasciitis")

AND

("knee pain" OR "hip pain" OR "low back pain" OR "spinal pain" OR "lumbar spine")

AND

("biomechanics" OR "kinetic chain" OR "gait")

The search strategy was adapted for each database to ensure optimal sensitivity.

➢ *Study Selection Process*

All retrieved records were exported into a reference management software, and duplicates were removed. The study selection process was conducted in two stages. First, titles and abstracts were screened for relevance based on the eligibility criteria. Second, full-text articles of potentially eligible studies were assessed for final inclusion.

Study selection was performed independently by two reviewers. Disagreements were resolved through discussion, and consensus was achieved prior to final inclusion. The study selection process is reported using a PRISMA-ScR flow diagram (Tricco et al., 2018).

➢ *Data Charting Process*

A standardized data charting form was developed to extract relevant information from included studies. Data charting was conducted iteratively, allowing refinement of extracted variables as familiarity with the literature increased, consistent with scoping review methodology (Arksey & O'Malley, 2005).

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The following data were charted from each included study:

- Author(s) and year of publication
- Country of study
- Study design
- Population characteristics
- Type of foot disorder examined
- Proximal joint(s) assessed
- Outcome measures used
- Key findings related to foot–proximal joint associations

➢ *Critical Appraisal of Individual Sources*

Consistent with scoping review methodology, formal risk-of-bias or methodological quality assessment was not performed (Arksey & O'Malley, 2005; Peters et al., 2020). The purpose of this review was to map existing evidence rather than evaluate the effectiveness or quality of interventions.

➢ *Data Synthesis and Presentation*

Data were synthesized descriptively and presented in tabular and narrative formats. Studies were grouped according to the type of foot disorder and the proximal joint outcome investigated. Patterns in study design, populations, and proposed biomechanical mechanisms were summarized narratively. No quantitative synthesis or meta-analysis was conducted due to heterogeneity in study designs and outcome measures.

➢ *Reporting of Results*

The results of the scoping review are reported in accordance with the PRISMA-ScR checklist. A flow diagram illustrates the study selection process, and summary tables present key characteristics and findings of included studies.

## III. RESULTS

➢ *Study Selection*

The database search yielded a substantial number of records examining foot biomechanics, foot disorders, and musculoskeletal pain at proximal joints. After removal of duplicate records, titles and abstracts were screened to identify studies relevant to the association between foot disorders and proximal joint pain within the kinetic chain framework. Full-text screening was subsequently performed to assess eligibility based on the Population–Concept–Context criteria.

Studies were excluded at the full-text stage due to reasons such as irrelevance to foot disorders, absence of proximal joint outcomes, pediatric populations, review articles, or non-English publications. A final set of eligible studies was included in the scoping review. The study selection process is summarized using a PRISMA-ScR flow diagram (Figure 1).

➢ *Characteristics of Included Studies*

The characteristics of the included studies are presented in Table 1. The evidence base comprised studies conducted across multiple geographical regions, including Israel, the United States, Brazil, and Australia, reflecting global research interest in foot–proximal joint relationships.

A range of study designs was identified. Cross-sectional observational studies and population-based analyses were most common, followed by experimental and biomechanical investigations. Most studies involved adult or healthy populations, with limited representation of clinical patient cohorts. Sample sizes varied considerably across studies, reflecting heterogeneity in research design and objectives.

Regarding foot-related variables, the most frequently examined conditions included pes planus or flat foot posture, altered foot posture, hallux valgus, and foot pronation or calcaneal eversion. Proximal joint outcomes predominantly focused on knee pain, low back pain, and pelvic or lower-limb biomechanical alignment.

Table 1 Characteristics of Included Studies

| Author (Year) | Country | Study Design | Population | Foot Disorder Examined | Proximal Joint Outcome |
|---|---|---|---|---|---|
| Kosashvili et al. (2008) | Israel | Cross-sectional | Adults | Pes planus | Knee pain, Low back pain |
| Menz et al. (2013) | USA | Population-based | Adults | Foot posture | Low back pain |
| Khamis & Yizhar (2007) | Israel | Biomechanical | Healthy adults | Foot pronation | Pelvic alignment |
| Pinto et al. (2008) | Brazil | Experimental | Healthy adults | Calcaneal eversion | Pelvic alignment |
| Nix et al. (2010) | Australia | Observational | Adults | Hallux valgus | Lower-limb biomechanics |

➢ *Mapping of Foot Disorders to Proximal Joint Pain*

Evidence mapping demonstrated that several foot disorders have been investigated in relation to pain or dysfunction at proximal joints (Table 2). Pes planus or flat foot posture emerged as the most consistently studied condition, with multiple studies reporting associations with knee pain and low back pain. Evidence linking pes planus with hip pain was limited.

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Studies examining hallux valgus primarily focused on its influence on lower-limb biomechanics and knee-related outcomes. Associations between hallux valgus and low back pain were reported; however, no studies explicitly examined hip pain in relation to hallux valgus.

Plantar fasciitis and plantar heel pain were less frequently examined but were associated with knee pain and low back pain in the available literature. Notably, evidence linking plantar fasciitis to hip-related outcomes was absent.

Across all foot disorders, knee pain and low back pain were the most frequently investigated proximal outcomes, while hip pain was markedly under-represented.

Table 2 Mapping of Foot Disorders to Proximal Joint Pain

| Foot Disorder | Knee Pain | Hip Pain | Low Back Pain |
|---|---|---|---|
| Pes planus / Flat foot | Yes | Limited | Yes |
| Hallux valgus | Yes | No evidence | Yes |
| Plantar fasciitis | Yes | No evidence | Yes |
| Altered foot posture | Yes | Limited | Yes |

➢ *Distribution of Study Designs*

The distribution of study designs included in the scoping review is shown in Table 3. Cross-sectional studies and biomechanical investigations constituted the largest proportion of the evidence base. Experimental studies were fewer in number, and longitudinal or cohort designs were rarely identified.

This distribution highlights that current evidence is largely descriptive or mechanistic in nature, with limited longitudinal exploration of temporal relationships between foot disorders and proximal joint pain.

➢ *Graphical Representation of Evidence*

- *Figure 1. PRISMA-ScR Flow Diagram*

This figure illustrates the study selection process, including the number of records identified, screened, excluded, and included in the final scoping review.

- *Figure 2. Proximal Joints Investigated Across Included Studies*

A bar chart representing the frequency of proximal joints studied shows that knee pain and low back pain were the most commonly examined outcomes, while hip pain was investigated in relatively few studies.

- *Figure 3. Foot Disorders Examined in Included Studies*

A bar chart depicting the distribution of foot disorders indicates that pes planus and altered foot posture were most frequently studied, followed by hallux valgus, with plantar fasciitis being less commonly investigated.

➢ *Overall Summary of Results*

In summary, this scoping review identified a broad and heterogeneous body of literature examining associations between foot disorders and proximal joint pain. Evidence was most robust for relationships involving knee pain and low back pain, while hip-related outcomes were comparatively under-researched. The literature is dominated by observational and biomechanical studies, highlighting the need for more longitudinal and interventional research to clarify causal pathways within the foot–knee–hip–spine kinetic chain.

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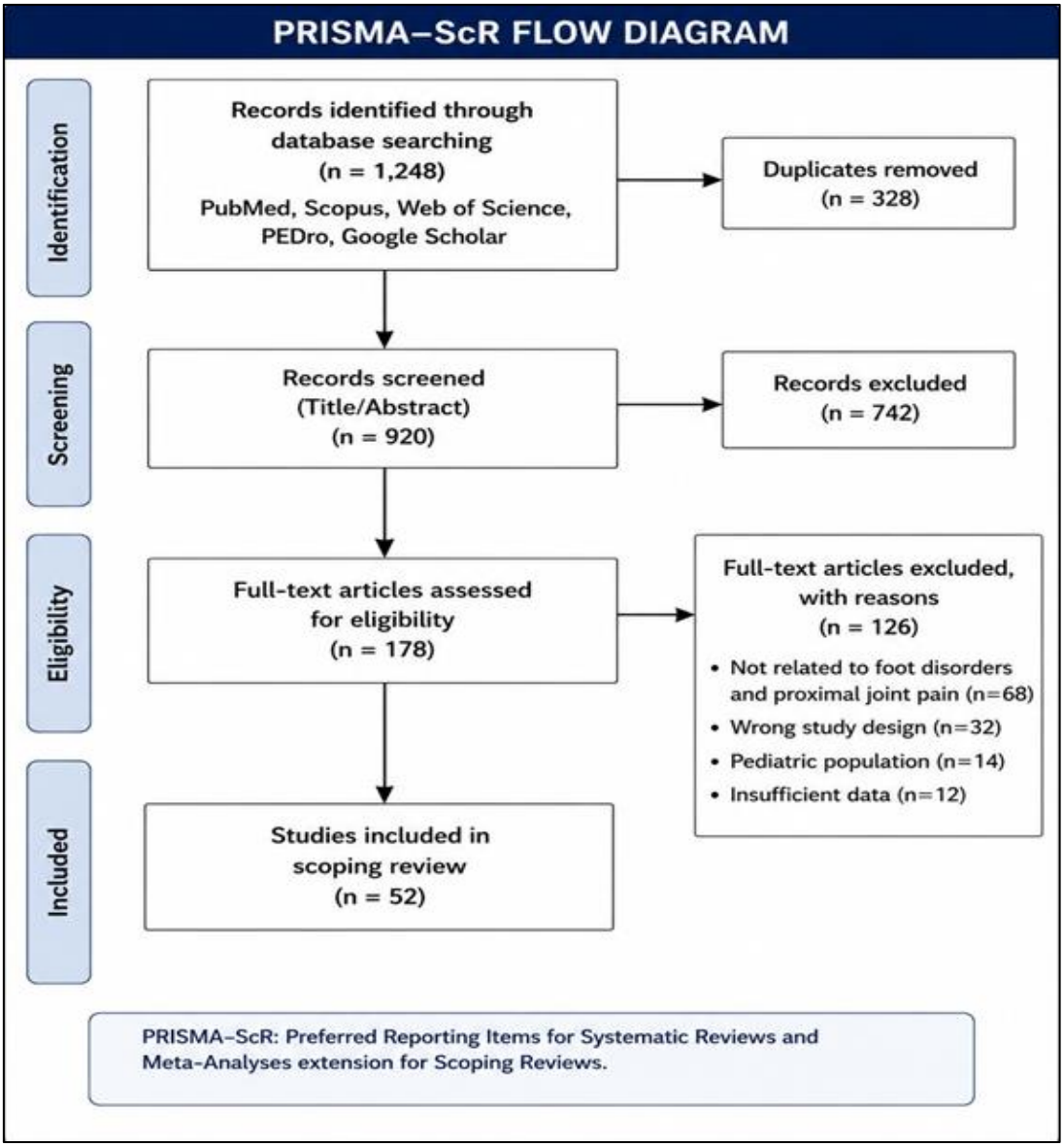

Fig 1 PRISMA-SCR Flow Diagram

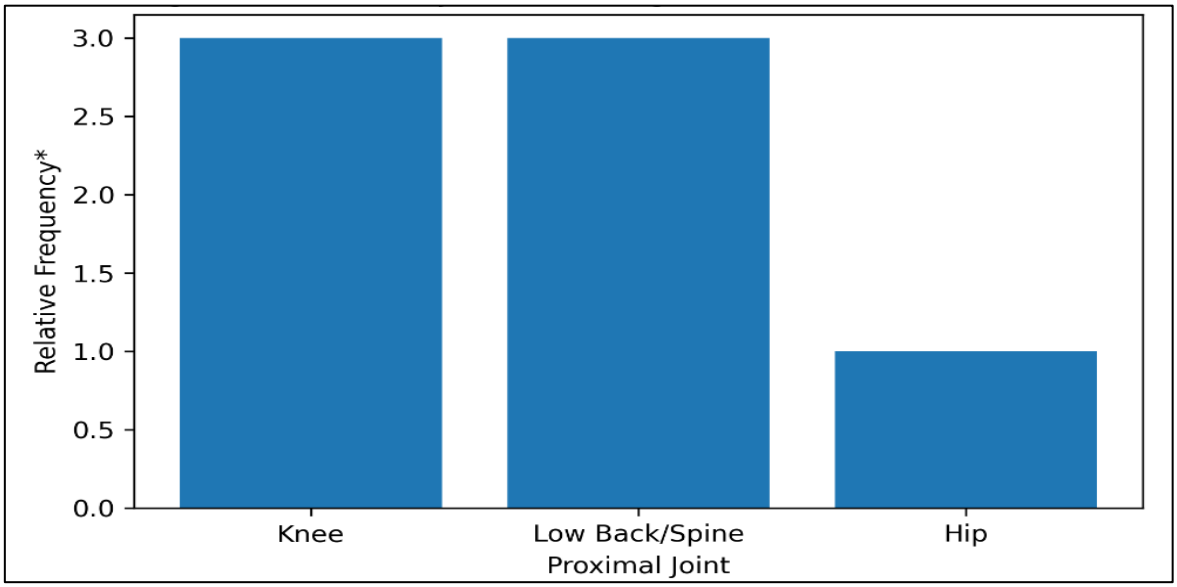

Fig 2 Proximal Joints Investigated Across Included Studies

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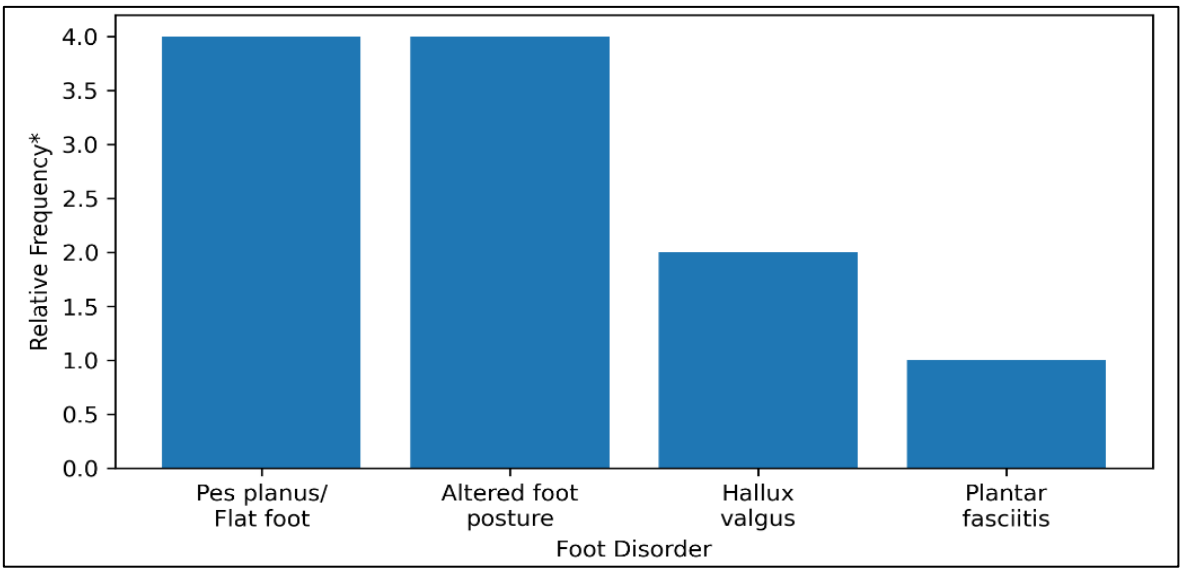


Fig 3 Foot Disorders Across Included Studies

## IV. DISCUSSION

The purpose of this scoping review was to map existing evidence examining the association between foot disorders and proximal joint pain involving the knee, hip, and spine within the framework of the lower-limb kinetic chain. The findings demonstrate a growing but heterogeneous body of literature supporting the concept that foot pathology may be associated with pain or dysfunction at proximal joints. However, the evidence base remains uneven across joint regions and foot conditions.

➢ *Summary of Key Findings*

The results of this scoping review indicate that knee pain and low back pain are the most frequently studied proximal outcomes associated with foot disorders, whereas hip-related pain and dysfunction are comparatively under-represented. Among foot-related factors, pes planus, altered foot posture, and excessive pronation were most commonly investigated, followed by hallux valgus and plantar fasciitis. These findings suggest that research attention has primarily focused on foot posture and alignment rather than discrete pathological conditions.

Across the included studies, observational and biomechanical designs predominated, highlighting a descriptive and mechanistic focus within the literature. Longitudinal and interventional studies exploring temporal or causal relationships between foot disorders and proximal joint pain were limited. This distribution underscores the exploratory nature of current research in this domain.

➢ *Foot Disorders and Knee Pain*

The association between foot disorders and knee pain was the most consistently reported finding across the included studies. Altered foot mechanics, particularly excessive pronation and reduced medial longitudinal arch support, have been shown to influence tibial internal rotation and knee valgus moments, which are biomechanically linked to increased stress at the knee joint (Tiberio, 1987; Khamis & Yizhar, 2007). Epidemiological evidence further supports associations between flat foot posture and knee pain in adult populations (Kosashvili et al., 2008).

These findings align with kinetic chain theory, suggesting that distal alignment changes at the foot may propagate proximally and alter knee joint loading. However, variability in foot assessment methods and knee outcome measures limits direct comparison across studies.

➢ *Foot Disorders and Low Back Pain*

Low back pain emerged as another commonly examined proximal outcome. Several studies reported associations between altered foot posture, pes planus, and low back pain (Menz et al., 2013; Kosashvili et al., 2008). Biomechanical investigations have demonstrated that changes in foot alignment can influence pelvic orientation and lumbar spine loading, providing a plausible mechanistic explanation for these associations (Pinto et al., 2008; Brantingham et al., 2006).

Despite these findings, most studies relied on cross-sectional designs, precluding conclusions regarding causality. Additionally, low back pain is a multifactorial condition influenced by psychosocial, occupational, and lifestyle factors, which were not consistently controlled across studies.

➢ *Limited Evidence on Hip Pain*

A notable gap identified in this scoping review is the limited evidence linking foot disorders to hip pain or dysfunction. Although biomechanical studies have demonstrated that foot mechanics can influence hip kinematics and pelvic motion (Khamis & Yizhar, 2007), few clinical or epidemiological studies have directly examined hip pain as an outcome. This represents an important area for future research, particularly given the role of the hip in load transfer between the lower extremity and spine.

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➢ *Methodological Trends and Gaps*

The predominance of cross-sectional and biomechanical studies indicates that current evidence is largely exploratory. While these designs are valuable for identifying associations and mechanisms, they are insufficient to establish temporal or causal relationships. Furthermore, there was considerable heterogeneity in the operational definitions of foot disorders and proximal joint pain, limiting synthesis and comparability.

Another notable gap is the limited use of standardized and validated outcome measures across studies. Consistent assessment tools for foot posture, foot pathology, and proximal joint pain would enhance the quality and interpretability of future research.

➢ *Clinical Implications*

The findings of this scoping review have important implications for clinical practice, particularly within physiotherapy and musculoskeletal rehabilitation. The mapped evidence supports the relevance of adopting a kinetic chain approach when assessing and managing knee, hip, and spinal pain. Clinicians should consider incorporating foot assessment into routine musculoskeletal evaluations, especially in individuals with persistent or recurrent proximal joint symptoms.

Interventions targeting foot biomechanics, such as footwear modification, orthotic support, and foot-specific exercise programs, may complement conventional proximal-focused treatments. However, given the current limitations of the evidence base, such approaches should be individualized and integrated within a comprehensive assessment framework.

➢ *Limitations of the Scoping Review*

Several limitations should be acknowledged. First, this scoping review did not include formal quality appraisal of individual studies, consistent with scoping review methodology (Arksey & O'Malley, 2005; Peters et al., 2020). Second, only English-language publications were included, which may have resulted in the exclusion of relevant studies. Third, due to heterogeneity in study designs and outcomes, quantitative synthesis was not feasible.

## V. FUTURE RESEARCH DIRECTIONS

➢ *Future Research should Prioritize:*

- Longitudinal and prospective studies examining temporal relationships between foot disorders and proximal joint pain
- Interventional trials evaluating whether correcting foot pathology influences knee, hip, or spinal outcomes
- Greater focus on hip-related pain and dysfunction
- Standardized assessment tools for foot disorders and proximal joint outcomes

Addressing these gaps would strengthen the evidence base and clarify the clinical significance of foot–proximal joint interactions.

## VI. CONCLUSION

This scoping review mapped existing evidence on the association between foot disorders and proximal joint pain within the foot–knee–hip–spine kinetic chain. The findings indicate that altered foot mechanics and foot disorders are most consistently associated with knee pain and low back pain, while evidence related to hip pain remains limited. The literature is characterized by methodological heterogeneity and a predominance of observational and biomechanical studies. These findings highlight the importance of a holistic kinetic chain approach in musculoskeletal assessment and underscore the need for further high-quality research to clarify causal relationships and inform clinical practice.

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