Received: 4 September 2023 | Revised: 10 September 2023 | Accepted: 14 September 2023

DOI: 10.1002/msc.1826

WILEY

REVIEW ARTICLE

Effects of foot orthoses and footwear interventions on impairments and quality of life in people with hip pain: A systematic review

Rita Kinsella[1,2] | Anthony Nasser[3] | Hylton B. Menz[2] | Tania Pizzari[2] | Natalie J. Collins[4] | Adam I. Semciw[2,5]

[1]Department of Surgery, St Vincent's Hospital, Faculty Medicine, Dentistry & Health Sciences, The University of Melbourne, Melbourne, Victoria, Australia

[2]Department of Physiotherapy, Podiatry and Prosthetics and Orthotics, La Trobe University, Bundoora, Melbourne, Victoria, Australia

[3]Graduate School of Health, University of Technology Sydney, Ultimo, New South Wales, Australia

[4]School of Health and Rehabilitation Sciences, University of Queensland, Brisbane, Queensland, Australia

[5]Department of Allied Health, Northern Hospital, Melbourne, Australia

Correspondence

Rita Kinsella, Department of Surgery, St Vincent's Hospital, Faculty Medicine, Dentistry & Health Sciences, The University of Melbourne, Melbourne, VIC, Australia.
Email: rmkinsella@unimelb.edu.au

Abstract

Background: Foot orthoses and footwear interventions are advocated for the management of lower limb musculoskeletal conditions including the hip, but much of the research is focused on knee disorders. The aim of this systematic review was to synthesise the literature that investigates the use of foot orthoses or footwear in people with hip-related pain.

Methods: MEDLINE, EMBASE, CINAHL, AMED and SPORTDiscus were searched from inception to March 2023. Randomised controlled trials (RCT), cohort and pre-post studies reporting on footwear and foot orthoses interventions, in participants with hip-related pain, were eligible for inclusion. Outcomes included pain, physical function, and quality of life (QoL). Effect sizes were calculated where sufficient data were available. Reporting quality was assessed using the Cochrane Risk of Bias Tool (Rob-2) and the Joanna Briggs Institute Checklist. The overall quality of evidence was rated according to the Grading of Recommendations, Assessment, Development, and Evaluations framework.

Results: Of the seven included studies (n = 266 participants), there was one RCT, one cohort and five single-group pre-post designs. Interventions included customised and non-customised arch supports, heel lifts, and footwear modifications, used in the following hip conditions: trochanteric pain, non-specific hip pain, hip osteoarthritis, and leg length dysfunction following total hip arthroplasty. Meta-analysis was possible for outcomes in two studies, demonstrating moderate improvement in pain following foot orthoses use. Overall certainty of evidence ranged from very low to low.

Conclusion: Single-group pre-post study designs describe positive relationships between foot orthoses and footwear use and improvements in hip pain, function, and QoL. However, these results were not supported by the only available RCT. Given this is a relatively inexpensive and non-invasive treatment approach, further rigorous studies are warranted.

KEYWORDS
hip conditions, musculoskeletal, splinting and orthotics

1 | INTRODUCTION

Hip disorders are a leading cause of pain and disability and the second most common cause of lower limb musculoskeletal pain (Vos et al., 2014). Though common across all age groups, hip disorders affect 14% of people over 60 years of age (Christmas et al., 2002; Heerey et al., 2019). Hip pain in older adults is commonly associated with osteoarthritis, with the prevalence of this condition shown to increase steadily with age (Ackerman et al., 2017; Hoy et al., 2015). In young and middle-aged adults, femoro-acetabular impingement is the most common cause of anterior hip/groin symptoms (Mascarenhas et al., 2016), along with acetabular dysplasia and intra-articular soft-tissue lesions (Kemp et al., 2020). Lateral hip pain associated with gluteus medius/minimus tendinopathy, and trochanteric bursitis is termed *greater trochanteric pain syndrome* (GTPS) and has a prevalence of 23.5% in women and 8.5% in men aged 50–79 years. Hip pain and dysfunction can be recalcitrant to non-surgical and non-pharmacological treatment, causing a significant burden of disease for both individuals and society.

Variations in foot posture and dynamic foot function have long been identified as risk factors for the development of lower limb overuse injuries and are thought to affect proximal structures (Barwick et al., 2012). Pronated foot function is associated with increased knee valgus and internal rotation of the femur, with the resultant altered pelvis position hypothesised to place increased strain on the joints and soft tissues of the lumbar spine, hip and pelvic girdle (Barwick et al., 2012; Bird & Payne, 1999; Segal et al., 2007). Despite the growing body of evidence around associations between lower limb disorders and foot posture and/or function (Barwick et al., 2012), much of this research has been focused on patellofemoral pain and knee osteoarthritis (Barton et al., 2011; Collins et al., 2008; Matthews et al., 2020).

There does appear to be a relationship between foot function and hip pain. Evidence for an association between foot posture or function and lower extremity joint pain has been demonstrated in two studies using the large Framingham data set (Gross et al., 2007; Riskowski et al., 2013). Gross and colleagues (Gross et al., 2007) concluded that forefoot varus malalignment may be associated with ipsilateral hip pain or tenderness, and hip arthroplasty in older adults. Riskowski and colleagues (Riskowski et al., 2013) found a reduced risk of hip pain in those with supinated foot function. These findings may have implications for treatment since the risk factors identified (forefoot varus malalignment/supinated foot type) are potentially amenable to treatment with foot orthoses or footwear options.

Foot orthoses are in-shoe devices frequently used to prevent and manage a variety of lower limb musculoskeletal conditions (Van Gheluwe & Kirby, 2010). There is strong evidence that prefabricated foot orthoses are effective in reducing symptoms in the short term in people with patellofemoral pain (Collins et al., 2018) and some indications of benefit in those with patellofemoral osteoarthritis, in both the immediate (Collins et al., 2016) and short term (Tan et al., 2019). There is also moderate evidence of their beneficial effect on symptoms in foot disorders, including plantar heel pain (Whittaker et al., 2018) and first metatarsophalangeal joint osteoarthritis (Menz et al., 2016). The effectiveness of foot orthoses in the management of hip pain is less clear. There are no published systematic reviews that have synthesised and critiqued the use of footwear or foot orthoses as an intervention exclusively in the management of hip symptoms. Gelis and colleagues (Gélis et al., 2008), in their review focused on clinical practice guidelines for the use of foot orthoses for knee and hip osteoarthritis and found one study that evaluated foot orthoses interventions for hip osteoarthritis (Ohsawa & Ueno, 1997). This review was published over a decade ago and other studies, evaluating the use of footwear or foot orthoses interventions, may have been conducted since, across a broader range of hip conditions.

Given that more than a third of podiatrists surveyed across Australia, New Zealand and the United Kingdom prescribe foot orthoses for hip pain (Chapman et al., 2018), there is a clear need to provide a contemporary synthesis of the evidence. Therefore, the aim of this systematic review was to evaluate the evidence for the use of footwear or foot orthoses on impairment (pain, strength, function), quality of life (QoL), adherence and adverse event outcomes in people with hip-related pain.

2 | METHOD

The systematic review protocol was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Page et al., 2021) and prospectively registered on the PROSPERO international prospective register of systematic reviews (ID: CRD42020147372) (https://www.crd.york.ac.uk/PROSPERO/). No amendments were made to the original PROSPERO protocol.

2.1 | Search strategy

A systematic search of the literature was conducted for all relevant studies published in MEDLINE, EMBASE, CINAHL, AMED and SPORTDiscus from inception to March 2023. The search strategy was based on two main concepts relating to (i) population: hip and hip-related pathologies and (ii) intervention: foot orthoses and footwear. MeSH and key terms within each concept were combined using AND/OR Boolean Operators. A sample database search is presented in Supporting Information S1. PubMed and Google Scholar were searched for studies not yet indexed in the above databases. The reference lists of the included studies were reviewed, and citation tracking was undertaken via the Web of Science.

2.2 | Study selection

All yielded studies were imported into Endnote version X9 (Clarivate Analytics, Philadelphia, PA, USA) and then into Covidence (www.covidence.org). After the removal of duplicates, two reviewers (RK and AN) independently evaluated all identified titles and abstracts against predetermined eligibility criteria. Full-text articles for all remaining studies were then screened independently (RK and AN), with disagreements on inclusion resolved by a third reviewer (AS).

2.3 | Eligibility criteria

Participants: Studies of human participants (aged 18 and above) who presented with a diagnosis of musculoskeletal hip pain including but not limited to hip osteoarthritis, groin pain, or hip-related tendinopathy (e.g., GTPS) were eligible for inclusion. Studies evaluating populations with congenital or acquired non-musculoskeletal disorders were ineligible.

2.3.1 | Interventions and exposures

Studies using foot orthoses or footwear interventions were eligible for inclusion. For the purpose of this review, foot orthoses were defined as inserts used for the purpose of assisting foot posture, stability, or function (Bonanno et al., 2017). Those eligible for inclusion were any form of prefabricated, off-the-shelf, or customised orthoses and heel lifts. Foot orthoses ineligible for inclusion were ankle-foot orthoses or knee-ankle-foot orthoses. Footwear including supportive shoes or those specifically designed or modified (e.g., external modifications including medial or lateral flares) were also eligible for inclusion.

2.3.2 | Comparators and controls

Where studies used a comparator, they were eligible for inclusion if they evaluated a no-treatment control or any comparator intervention that did not involve contoured foot orthoses or footwear. For pre-post study designs, where there was no comparison group, baseline measures were used as the comparator. Studies using multimodal interventions where it was not possible to determine the effect of the footwear or foot orthoses alone were excluded.

2.3.3 | Outcomes

Studies reporting on primary outcomes relating to impairments such as pain, strength and function (objective testing or self-reported) were eligible for inclusion. Those solely using biomechanical outcomes were excluded. Secondary outcomes relating to adherence and adverse events associated with wearing foot orthoses or footwear were also included.

2.3.4 | Study design

Randomised, quasi-randomised and non-randomised controlled trials, cohort studies, single-group pre-post studies and case studies were eligible for inclusion. Reviews were excluded.

2.4 | Data extraction

Data were extracted from each study independently by two reviewers (RK and AN). This included study design, population details, eligibility criteria, participant demographics, intervention parameters, outcome measures, and results at all study time-points. Where insufficient data were provided, two attempts were made to contact the author(s) via e-mail. If the author(s) failed to respond, data extraction was confined to the published material only.

2.5 | Data synthesis

Means and standard deviations (SD) of continuous outcomes for studies comparing interventions were converted to standardised mean differences (SMD) with 95% confidence intervals (CI), using the RevMan software programme Version 5.3 (Review Manager [RevMan], The Cochrane Collaboration, 2020). For studies comparing interventions, where results between groups were reported as events or percentages/proportions, odds ratios (OR) were calculated. OR were interpreted as small ($\leq$1.5), medium (>1.5 and <5) and large ($\geq$5) (Chen et al., 2010). For the analysis of outcomes from studies that reported within-group changes over time (e.g., changes observed over time from wearing the foot orthoses intervention within a single-group), pre- and post-test means and SDs were converted to standardised mean change (SMC) using Metafor 'R' statistical software Version 4.0.2 (Viechtbauer, 2010). An additional requirement for these analyses is the correlation between pre-test and post-test scores. If this was not provided, a conservative estimate of $r = 0.50$ was used (Lawrenson et al., 2019). Where two or more clinically homogeneous studies were available, data were pooled in a meta-analysis (random effects model). SMDs and SMCs were interpreted as small ($\geq$0.2), medium ($\geq$0.5) and large ($\geq$0.8), based on Cohen descriptions (Cohen, 1988). Where sufficient data were not available to undertake these calculations, the analysis was confined to the published data and Grading of Recommendations Assessment, Development and Evaluation (GRADE) findings.

Studies that evaluated between-group outcomes were unable to be pooled in a meta-analysis due to heterogeneous study designs. SMCs from single-group, pre-post designs were pooled in a meta-analysis where there were two or more pre-post studies that

reported on similar participants, interventions, outcomes, and time-points. Random effects models were used for SMC meta-analyses (Lawrenson et al., 2019). I^2 values of 25%, 50% and 75% were considered low, moderate and high levels of heterogeneity, respectively (Higgins et al., 2003).

2.6 | Assessment of risk of bias

The risk of bias was assessed with two tools, depending on the study design (Higgins et al., 2023). The Cochrane Risk of Bias Tool, ROB-2, was used to assess the Randomised controlled trials (RCT) (Higgins et al., 2023). Each item was labelled as either low (+) or high (−) risk of bias or of some concern (?) (Higgins et al., 2023). Biases assessed by the ROB-2 relate to: randomisation and recruitment, deviations from intended intervention, missing outcome data, measurement of the outcome, and selection of reported results (Winters et al., 2013). The Joanna Briggs Institute (JBI) checklists were used to assess for risk of bias in the remaining studies, which were either cohort or single-group pre-post study designs (Aromataris & Munn, 2017). Each JBI checklist item was scored as 'yes (Y)', 'no (N)', 'unclear (U)' or 'not applicable (N/A)'. Studies scoring ≥65% 'yes (Y)/(+)' scores were considered at low risk of bias. Two independent reviewers (RK and AN) performed the risk of bias assessment, with any discrepancies in results discussed, and an independent reviewer (AS) provided final consensus.

2.7 | Appraisal of the quality of the body of evidence

The overall certainty of evidence was assessed according to the GRADE framework (Schünemann et al., 2022). A staged process was followed, with evidence from the RCT initially rated as high quality and the observational studies as low quality. Following this, the certainty of evidence was further assessed, with the potential of being downgraded by one level for each of the following factors: (i) limitations in design (≥25% of the participants from studies at high risk of bias), (ii) inconsistency of results (significant statistical heterogeneity [I^2 >40%]) or inconsistent findings across studies (≤75% of the participants report findings in the same direction), (iii) indirectness (i.e. generalisation of findings), (iv) imprecision (total participants <300 for each outcome; wide CI) and (v) other considerations (e.g. publication bias, large loss to follow-up) (Nasser et al., 2021; Schünemann et al., 2022).

3 | RESULTS

3.1 | Study selection and participant characteristics

The number of studies considered at each stage of the review is illustrated in the PRISMA flow diagram (Figure 1). From a database yield of 858 studies, full texts of 23 were assessed, with seven meeting the criteria for inclusion in the review. Study designs were RCT (n = 1) (Nakanowatari et al., 2016), cohort (n = 1) (Ferrari, 2012) and single-group pre-post studies (n = 5) (Landsman et al., 2009; Mulford et al., 2008; Ohsawa & Ueno, 1997; Segal et al., 2013; Solomonow-Avnon et al., 2017). A total of 243 participants with hip-related symptoms were evaluated, with 190 of these receiving a foot orthoses or footwear intervention and, the remaining 53, allocated to a control group. Mean age across participants ranged from 37 to 70 years. Hip conditions evaluated included trochanteric pain (1 study/68 participants) (Ferrari, 2012), hip osteoarthritis (2 studies, 54 participants) (Ohsawa & Ueno, 1997; Solomonow-Avnon et al., 2017), post-total hip arthroplasty (2 studies, 46 participants) (Nakanowatari et al., 2016; Segal et al., 2013) and non-specific hip pain (2 studies, 75 participants) (Landsman et al., 2009; Mulford et al., 2008). Characteristics of the included studies are presented in Table 1.

3.2 | Hip pain diagnostic criteria

The diagnostic criteria used across the studies for participant inclusion varied depending on the hip disorder being evaluated. For studies involving participants with hip osteoarthritis (Ohsawa & Ueno, 1997; Solomonow-Avnon et al., 2017) or post-hip arthroplasty (Nakanowatari et al., 2016; Segal et al., 2013), a combination of plain radiographs and clinical hip scores was used. For the diagnosis of trochanteric bursitis (Ferrari, 2012), the presence of pain over the greater trochanter and pain elicited on hip abduction was required. Two of the studies (Landsman et al., 2009; Mulford et al., 2008) used only patient-reported presence of hip pain.

3.3 | Interventions

Foot orthoses and footwear interventions included modified and non-modified arch supports (n = 3) (Ferrari, 2012; Landsman et al., 2009; Mulford et al., 2008), modified and non-modified heel lifts (n = 2) (Nakanowatari et al., 2016; Ohsawa & Ueno, 1997) and, customised footwear devices (n = 2) (Segal et al., 2013; Solomonow-Avnon et al., 2017). The single RCT included three arms, and for the purposes of this systematic review, the nil intervention was deemed the control group and the exercise intervention group, the comparator (Nakanowatari et al., 2016).

3.4 | Outcomes measures

Most studies used self-reported outcomes only, including pain and physical function although two studies (Segal et al., 2013; Solomonow-Avnon et al., 2017) also assessed objective physical measures including gait speed and the Timed Up and Go (TUG) test and two more (Ohsawa & Ueno, 1997; Segal et al., 2013) used clinical

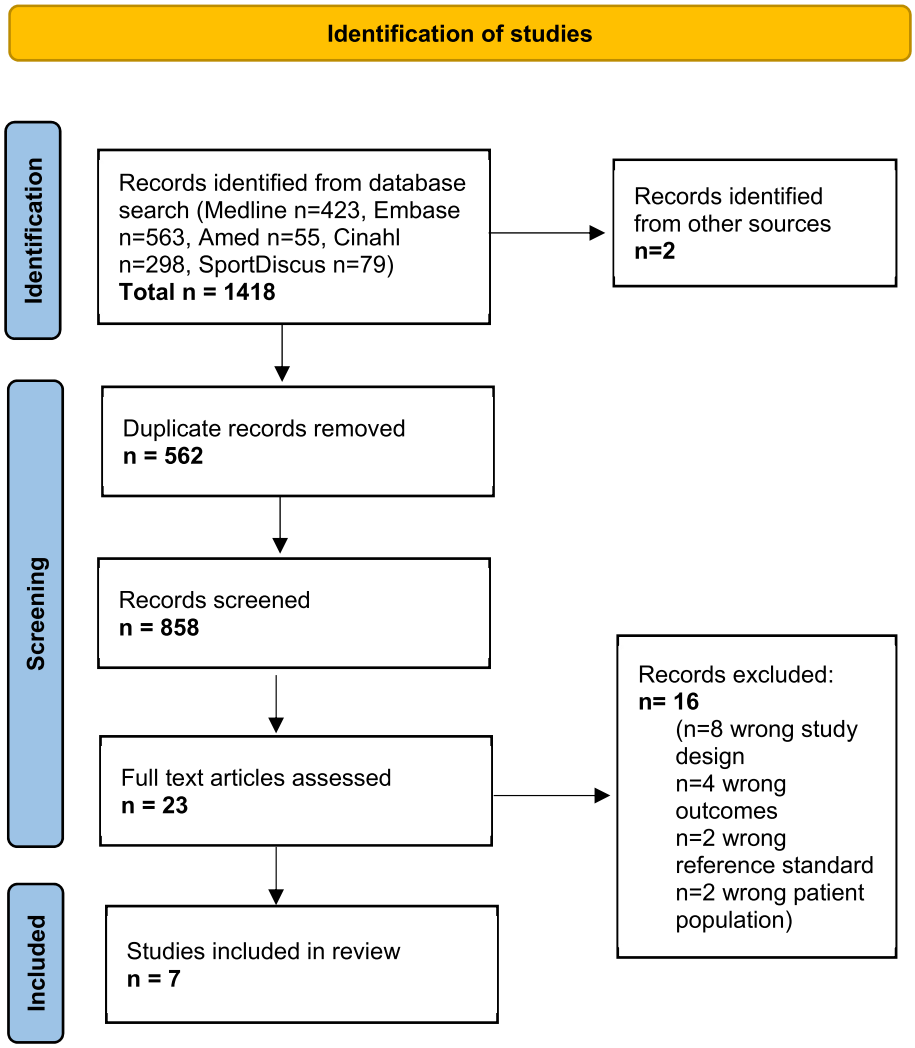


FIGURE 1 PRISMA study flow.

hip scores, such as the Harris Hip Score, that combined self-reported outcomes with objective physical tests. Follow-up time points ranged from immediately after fitting of foot orthoses (Mulford et al., 2008) to 23 months (Ohsawa & Ueno, 1997). Only one of the studies collected outcome data on adherence to orthoses use or adverse events (Segal et al., 2013), which was obtained via telephone interviews at regular study time points.

3.5 | Assessment of bias and appraisal of overall quality of evidence

The risk of bias assessments are presented in Figure 2. Four of the seven included studies were assessed as high risk of bias (Ferrari, 2012; Landsman et al., 2009; Mulford et al., 2008; Ohsawa & Ueno, 1997), while two of the single-group pre-post studies (Segal et al., 2013; Solomonow-Avnon et al., 2017) and the single RCT (Nakanowatari et al., 2016) were deemed low risk. Shortcomings observed in the cohort and single-group pre-post studies deemed at high risk were items relating to clear reporting of participant inclusion, participant clinical information, participant demographics, and reporting of follow-up results. The certainty of the body of evidence ranged from very low to low and is presented in the summary of findings table (Table 2).

3.6 | Foot orthoses interventions–Arch supports (customised and non-customised)

Three of the included studies evaluated the use of arch supports in participants with hip pain, with the results presented in Table 3 (Ferrari, 2012; Landsman et al., 2009; Mulford et al., 2008). There was very low certainty of evidence from a single cohort study that customised foot orthoses compared with no orthoses had greater odds of improved self-reported recovery and reduced analgesic use in people diagnosed with trochanteric bursitis. These findings were evident at 8 weeks, with OR (95% CI) 3.25 (1.15–9.19) and 1.13 (0.43–2.91), respectively, and at 4 months, with OR (95% CI) 47.14

TABLE 1 Characteristics of included studies.

Study (year)	Study design	Hip disorder/ population	Intervention/control treatment dosage	n baseline (F), mean age ± SD (range) in years	Compliance	Adverse events
Nakanowatari et al. (2016)	RCT	Hospital orthopaedic patients. 1-week post-THA surgery for unilateral hip OA.	Intervention (group 1): Modifiable insole type heel lift (MHL) to address functional LLD. Dose: Wear all day until discharge. Control (group 2): Nil intervention Specific exercise approach (SEA) (group 3): To address functional LLD consisting of post-isometric muscle relaxation techniques. Dose 1 session per day until discharge. All groups also received once-daily individually supervised PT sessions (ROM and strengthening exercises) and functional re-training (sit-stand, walking and stair ambulation).	MHL: *n* = 10 (8F) 63.6 ± 8.6 years Control: *n* = 10 (8F) 61.4 ± 7.2 years SEA: *n* = 10 (10F) 64.3 ± 5.8 years	NR	NR
Ferrari (2012)	Non-RCT	Adult patients presenting to two community clinics with hip pain and diagnosed with trochanteric bursitis.	Intervention: Customised insole type foot orthoses, with heel lift if LLD ≥1.5 cm. Control: Nil intervention Dose: NR	Intervention: *n* = 34 (31F) 40.8 ± 11.4 (21–68) years Control: *n* = 34 (29F) 37.1 ± 11.6 (19–66) years	NR	NR
Landsman et al. (2009)	Single-group pre-post	Adult patients with self-reported non-specific hip pain.	Intervention: Prefabricated, non-customised insoles. Dose: NR	*n* = 13 (M/F NR for the *n* = 13 hip participants) age NR for the *n* = 13 hip participants.	NR	NR
Mulford et al. (2008)	Single-group pre-post	Sample of convenience, older adults in community setting, able to self-ambulate, with self-reported hip pain.	Intervention: Prefabricated non-modified arch supports. Dose: NR	*n* = 67 (44F) 69.9 (60–87) years	NR	NR

TABLE 1 (Continued)

Study (year)	Study design	Hip disorder/ population	Intervention/control treatment dosage	n baseline (F), mean age ± SD (range) in years	Compliance	Adverse events
Ohsawa and Ueno (1997)	Single-group pre-post	Orthopaedic clinic patients with symptomatic hip OA but refused surgery.	Intervention: Heel lift (to ipsi- or contra-lateral leg depending on need for valgus or varus correction. Lift height ≤1.5 cm. Dose: NR but reported majority still wearing at follow-up.	*n* = 33 (31F) 51 years	NR	NR
Segal et al. (2013)	Single-group pre-post	Orthopaedic clinic patients post-operative elective unilateral THA for hip OA.	Intervention: Customisable biomechanical device with adjustable elements under forefoot/rearfoot. Dose: 10 min of indoor walking per day, gradually increased to 30 min of daily outdoor walking after 12 weeks.	*n* = 19 (9F) 63.0 ± 9.8 years	Patients received a telephone call to verify compliance at weeks 1, 2, 10, 16 and 20. Full compliance.	Nil reports of imbalance, tripping or any other adverse events during the study period.
Solomonow-Avnon et al. (2017)	Single-group pre-post	Orthopaedic clinic patients with symptomatic hip OA (unilateral or bilateral).	Intervention: Customisable biomechanical device with adjustable elements under forefoot/rearfoot. Dose: Walk daily and gradually increase over the 1-year intervention period from 10 min to 2 h or more. (No information on progression schedule).	*n* = 26 (26F) 61.4 ± 6.7 years (unilateral OA) 63.0 ± 7.4 years (bilateral OA)	NR	NR

Abbreviations: F, female; LLD, leg length dysfunction; M, Male; MHL, Modified heel lift; NR, not reported; OA, osteoarthritis; PT, physiotherapy; RCT, randomised controlled trial; SD, standard deviation; SEA, Specific exercise approach; THA, total hip arthroplasty.

(5.75–386.29) and 0.15 (0.05–0.49), respectively (Figure 3). Adherence to the orthoses intervention and adverse events were not reported.

Two single-group pre-post studies described the use of non-modified off-the-shelf arch supports in older participants with non-specific hip pain (Landsman et al., 2009; Mulford et al., 2008).

Risk of bias in randomised controlled trials (Cochrane ROB-2)	Nakanowatari (2016)
Bias from randomisation/recruitment	+
Bias due to deviations from intended intervention	?
Bias due to missing outcome data	+
Bias in measurement of the outcome	+
Bias in the selection of reported results	?
Overall bias	+

Note: – indicates high risk of bias, + indicates low risk of bias; ? indicates some concern
Studies scoring ≥ 65% "yes (+)" scores considered at low risk of bias.

Risk of bias in cohort trials (Joanna Briggs Institute)	Ferrari (2012)
Were the two groups similar and recruited from the same population?	Y
Exposures measured similarly to assign people to both exposed and unexposed groups?	Y
Exposures measured in a valid and reliable way?	Y
Confounding factors identified?	U
Strategies to deal with confounding factors stated?	U
Groups/participants free of the outcome at the start of the study (or at moment of exposure)?	Y
Outcomes measured in a valid and reliable way?	N
Time reported and sufficient to be long enough for outcomes to occur?	Y
Follow up complete, and if not, were the reasons to loss to follow up described and explored?	N
Strategies to address incomplete follow up utilised?	N
Appropriate statistical analysis used?	N

Note: Items 1-11 scored as Y = yes, N = no or U = unclear or not applicable = N/A
Studies scoring ≥ 65% "yes (Y)" scores considered at low risk of bias.

Risk of bias in single group pre-post studies (Joanna Briggs Institute)	Mulford (2008)	Landsman (2009)	Solomonow (2017)	Ohsawa (1997)	Segal (2013)
Clear criteria for inclusion?	N	N	Y	N	Y
Condition measured in a standard, reliable way for all participants?	N	N	Y	N	Y
Valid methods used for identification of condition for all participants?	N	U	Y	N	Y
Consecutive inclusion of participants?	U	U	U	U	U
Complete inclusion of participants?	U	N	N	Y	Y
Clear reporting of the demographics of the participants in the study?	N	N	Y	N	Y
Clear reporting of clinical information of the participants?	N	N	Y	N	N
Outcomes or follow-up results clearly reported?	N	Y	N	N	Y
Clear reporting of site(s)/clinic(s) demographic information?	U	U	Y	N	N
Statistical analysis appropriate?	Y	Y	Y	N	Y

Note: Items 1-10 scored as Y = yes, N = no or U = unclear or not applicable = N/A
Studies scoring ≥ 65% "yes (Y)" scores considered at low risk of bias.

FIGURE 2 Results of risk of bias assessment.

TABLE 2 GRADE summary of findings.

No. of patients/ studies	Limitations in design	Inconsistency	Indirectness	Imprecision	Publication bias	Effect estimate ORs: Interpreted as small (≤1.5), medium (>1.5 and <5) and large (≥5). SMD/SMC interpreted as small (≥0.2), medium (≥0.5) and large (≥0.8)	Certainty of evidence
Arch support interventions							
Cohort studies							
Customised arch support versus no arch support (trochanteric pain) self-reported recovery (pain); follow up 8 weeks							
68/1	Serious[a]	Serious[b]	Not serious	Serious[b]	Not assessed	Medium	⨁◯◯◯ VERY LOW
Customised arch support versus no arch support (trochanteric pain) self-reported recovery (pain); follow up 4 months							
68/1	Serious[a]	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised arch support versus no arch support (trochanteric pain) self-reported analgesic use; follow up 8 weeks							
68/1	Serious[a]	Serious[b]	Not serious	Serious[b]	Not assessed	Small	⨁◯◯◯ VERY LOW
Customised arch support versus no arch support (trochanteric pain) self-reported analgesic use; follow up 4 months							
68/1	Serious[a]	Serious[b]	Not serious	Serious[b]	Not assessed	Small	⨁◯◯◯ VERY LOW
Non-customised arch support (non-specific hip pain)–self-reported pain; follow up 4–6 weeks							
75/2	Serious[a]	Serious[c]	Not serious	Serious[c]	Not assessed	Medium	⨁◯◯◯ VERY LOW
Heel lift interventions							
Randomised controlled trials							
Modified heel lift versus no heel lift (post-THA) pain (VAS 0–100)); follow up 3 weeks							
17/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Minimal	⨁⨁◯◯ LOW
Modified heel lift versus no heel lift (post-THA) objective physical function (TUG); follow up 3 weeks							
17/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Small	⨁⨁◯◯ LOW
Modified heel lift versus no heel lift (post-THA) self-report function (WOMAC); follow up 3 weeks							
17/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Medium	⨁⨁◯◯ LOW
Modified heel lift versus no heel lift (post-THA) self-report pain (WOMAC); follow up 3 weeks							
17/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Small	⨁⨁◯◯ LOW
Modified heel lift versus exercise (post-THA) pain (VAS 0–100); follow up 3 weeks							
18/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Medium	⨁⨁◯◯ LOW
Modified heel lift versus exercise (post-THA) objective physical function (TUG); follow up 3 weeks							
18/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Medium	⨁⨁◯◯ LOW
Modified heel lift versus exercise (post-THA) self-reported physical function (WOMAC); follow up 3 weeks							
18/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Small	⨁⨁◯◯ LOW
Modified heel lift versus exercise (post-THA) self-reported pain (WOMAC); follow up 3 weeks							
18/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Small	⨁⨁◯◯ LOW
Single-group pre-post studies							
Modifiable heel lift (hip OA) clinical outcome score; average follow-up 23 months							
33/1	Serious[a]	Serious[b]	Not serious	Serious[b]	Not assessed	Not computed	⨁◯◯◯ VERY LOW

(Continues)

TABLE 2 (Continued)

No. of patients/ studies	Limitations in design	Inconsistency	Indirectness	Imprecision	Publication bias	Effect estimate ORs: Interpreted as small (≤1.5), medium (>1.5 and <5) and large (≥5). SMD/SMC interpreted as small (≥0.2), medium (≥0.5) and large (≥0.8)	Certainty of evidence
Footwear interventions							
Single group pre-post study designs							
Customised footwear device (unilateral hip OA) objective physical function (gait speed); follow up 3 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Minimal	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) objective physical function (gait speed); follow up 6 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Small	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) objective physical function (gait speed); follow up 12 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Minimal	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) self-reported pain (WOMAC); follow up 3 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) self-reported pain (WOMAC); follow up 6 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) self-reported pain (WOMAC); follow up 12 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) self-reported physical function (WOMAC); follow up 3 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) self-reported physical function (WOMAC); follow up 6 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) self-reported physical function (WOMAC); follow up 12 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) self-reported QoL (SF-36 physical function); follow up 3 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) self-reported QoL (SF-36 physical function); follow up 6 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (unilateral hip OA) self-reported QoL (SF-36 physical function); follow up 12 months							
21/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) objective physical function (TUG); follow up 4 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW

TABLE 2 (Continued)

No. of patients/ studies	Limitations in design	Inconsistency	Indirectness	Imprecision	Publication bias	Effect estimate ORs: Interpreted as small (≤1.5), medium (>1.5 and <5) and large (≥5). SMD/SMC interpreted as small (≥0.2), medium (≥0.5) and large (≥0.8)	Certainty of evidence
Customised footwear device (post-unilateral THA) objective physical function (TUG); follow up 12 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) objective physical function (TUG); follow up 26 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported pain (WOMAC); follow up 4 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Medium	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported pain (WOMAC); follow up 12 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Medium	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported pain (WOMAC); follow up 26 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Medium	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA) self-reported function (WOMAC); follow up 4 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported physical function (WOMAC); follow up 12 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported function (WOMAC); follow up 26 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA); self-reported QoL/function (SF-36 physical function) follow up 4 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Medium	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported QoL/function (SF-36 physical function); follow up 12 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported QoL/function (SF-36 physical function); follow up 26 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported QoL/mental health (SF-36 mental); follow up 4 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Medium	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported QoL/mental health (SF-36 mental); follow up 12 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) self-reported QoL/mental health (SF-36 mental); follow up 26 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW

(Continues)

TABLE 2 (Continued)

No. of patients/ studies	Limitations in design	Inconsistency	Indirectness	Imprecision	Publication bias	Effect estimate ORs: Interpreted as small (≤1.5), medium (>1.5 and <5) and large (≥5). SMD/SMC interpreted as small (≥0.2), medium (≥0.5) and large (≥0.8)	Certainty of evidence
Customised footwear device (post-unilateral THA) clinical outcome score (Harris hip score); follow up 4 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) clinical outcome score (Harris hip score); follow up 12 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW
Customised footwear device (post-unilateral THA) clinical outcome score (Harris hip score); follow up 26 weeks							
19/1	Not serious	Serious[b]	Not serious	Serious[b]	Not assessed	Large	⨁◯◯◯ VERY LOW

Note: (i) Limitations in design (≥25% of the participants from studies with a high risk of bias as determined by the risk of bias tool), (ii) inconsistency of results (significant statistical heterogeneity) (I^2 > 40%) or inconsistent findings across studies (≤75% of the participants report findings in the same direction), (iii) indirectness (i.e. generalisation of the findings), (iv) imprecision (total number of participants <300 for each outcome and wide confidence intervals) and (v) other considerations (e.g. publication bias, massive loss to follow-up). I^2 > 40%.

[a]≥25% of the participants from studies with a high risk of bias.

[b]Single studies (n < 300) were considered inconsistent and imprecise.

[c]Pooled data with <300 participants for an outcome.

Changes in pain over time was able to be pooled in a meta-analysis with results presented in Figure 4 and Table 4. This provided very low certainty evidence of a moderate decrease in average pain (visual analogue scale) at 4–6 weeks follow-up (SMC 0.48, 95% CI 0.24–0.72, p < 0.01).

3.7 | Foot orthoses interventions–Heel lifts

Two studies evaluated the use of modifiable heel lifts in participants with hip pain, primarily related to the correction of associated functional leg length discrepancy (LLD). The results are presented in Table 5. They included an RCT evaluating patients post-hip arthroplasty (Nakanowatari et al., 2016) and a single-group pre-post study evaluating patients with mild to severe hip osteoarthritis who had declined surgery (Ohsawa & Ueno, 1997). The RCT was 3-armed, consisting of a modifiable heel lift group, an exercise group, and a no intervention control group (Nakanowatari et al., 2016). The height of the heel lift used was based on achieving the elimination of the LLD. The study provided low certainty evidence that the modifiable heel lift was less effective than specific exercises on the TUG functional score at 3 weeks post-hip arthroplasty (SMD 0.68, 95% CI 0.13–1.23). There were no differences between the three groups for any other outcomes (pain at rest, self-reported Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC] physical function, WOMAC pain) (Figure 5).

The single-group pre-post study reported average change scores over time in people with hip osteoarthritis without any measure of variance and were not included in the effect size calculations for this review (Ohsawa & Ueno, 1997). The authors presented the self-reported pain component of the Merle d'Aubign Score, with pain reduced in 51.5% of participants, completely relieved in 39.4% and unchanged in 15.2% of participants following heel lift use; the time required for reduction or abolition of pain increased with disease severity.

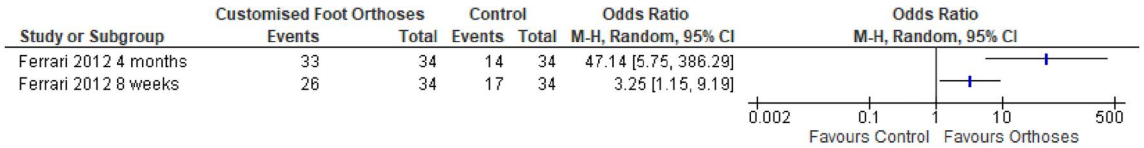
3.8 | Footwear interventions

Two of the single-group pre-post studies reported the effects of a customised footwear device, documenting changes in self-reported symptoms and objective physical measures over time (Segal et al., 2013; Solomonow-Avnon et al., 2017). The results are presented in Table 6. The biomechanical device was mounted beneath the forefoot and rearfoot regions of the shoe and calibrated to individual participants. Unlike the foot orthoses studies, device wear was intermittent and limited to walking, gradually increasing over the duration of one study to a maximum of 30 min (Segal et al., 2013) and to the other, 2 h or more (Solomonow-Avnon et al., 2017). Outcomes could not be pooled due to heterogeneity in the study populations. Following hip arthroplasty, there was very low certainty evidence that the use of the customised footwear device was associated with significant improvement over time (SMC at 4, 12 and 26 weeks) for objective physical function (TUG) (ranging from 1.19 to 1.54), self-reported physical function (WOMAC) (ranging from 1.05 to 1.42), and health-related QoL (SF-

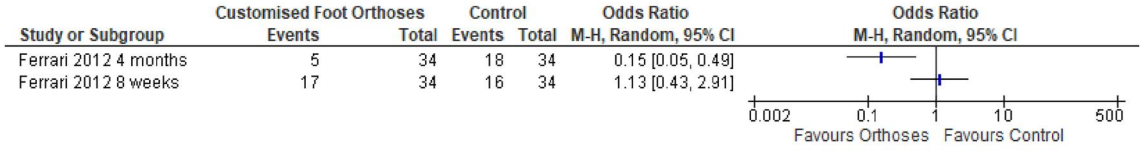
TABLE 3 Study results—arch support interventions.

Comparison	Outcome	Time-point	Participants/ studies	Risk of bias High	Risk of bias Low	Effect of intervention OR/ SMC [95% CI] ↓lesser/↑greater effect	Certainty of evidence
Cohort studies							
Customised arch support versus no arch support (trochanteric pain)	Self-reported recovery (pain)	8 weeks	68/1	Ferrari, 2012		**↑OR = 3.25 [1.15, 9.19]**	⊕◯◯◯ VERY LOW
Customised arch support versus no arch support (trochanteric pain)	Self-reported recovery (pain)	4 months	68/1	Ferrari, 2012		**↑OR = 47.14 [5.75, 386.29]**	⊕◯◯◯ VERY LOW
Customised arch support versus no arch support (trochanteric pain)	Self-reported analgesic use	8 weeks	68/1	Ferrari, 2012		**↑OR = 1.13 [0.43, 2.91]**	⊕◯◯◯ VERY LOW
Customised arch support versus no arch support (trochanteric pain)	Self-reported analgesic use	4 months	68/1	Ferrari, 2012		**↑OR = 0.15 [0.05, 0.49]**	⊕◯◯◯ VERY LOW
Single-group pre-post studies							
Non-customised arch support (non-specific hip pain)	Self-reported pain (VAS)	6 weeks	62/1	Mulford et al., 2008		**↑ SMC = 0.47 [0.20, 0.73]**	⊕◯◯◯ VERY LOW
Non-customised arch support (non-specific hip pain)	Self-reported average pain (VAS)	2 weeks	13/1	Landsman et al., 2009		SMC = −0.14 [−0.68, 0.41]	⊕◯◯◯ VERY LOW
Non-customised arch support (non-specific hip pain)	Self-reported average pain (VAS)	4 weeks	13/1	Landsman et al., 2009		SMC = −0.55 [−0.03, 1.14]	⊕◯◯◯ VERY LOW

Note: Bold denotes a significant clinical effect with the arrow indicating a greater or lesser effect of the foot orthoses or footwear intervention.
Abbreviations: CI, Confidence Interval; OR, Odds Ratio; SMC, Standard Mean Change; VAS, Visual Analogue Scale for Pain.



A: Customised foot orthoses vs control (no foot orthoses) at 8 weeks for self-reported recovery GTPS.



B: Customised foot orthoses vs control (no foot orthoses) at 8 weeks for self-reported analgesic use.

FIGURE 3 Customised arch supports for trochanteric pain.

36, mental and physical function) (ranging from −9.60 to −1.27) (Segal et al., 2013).

For participants with unilateral hip osteoarthritis, there was very low certainty evidence that the use of the customised footwear device was associated with significant improvement over time (SMC at 3, 6 and 12 months) for self-reported physical function (WOMAC) (ranging from −1.41 to −1.72), pain (WOMAC) (ranging from −1.14 to −1.17), and QoL (SF-36 Physical Function) (ranging from 1.40 to

1.36) (Solomonow-Avnon et al., 2017). For bilateral symptoms, significant improvement was reported over the same time-points for self-reported physical function (WOMAC) (ranging from −0.70 to −0.63) (Solomonow-Avnon et al., 2017).

4 | DISCUSSION

The aim of this systematic review was to evaluate the effect of foot orthoses and footwear interventions on outcomes including pain, strength, function, QoL, adherence, and adverse events in people with hip pain. Our review identified seven studies, with only one RCT (Nakanowatari et al., 2016), which provided low certainty evidence that heel lifts were inferior to exercise, and no better than no intervention for reduction in self-reported pain or physical function in participants following hip arthroplasty. Other interventions reported in the cohort and single-group pre-post studies included customised arch supports for participants with trochanteric bursitis (Ferrari, 2012) non-customised arch supports for community-dwelling older adults with non-specific hip pain (Landsman et al., 2009; Mulford et al., 2008) and a biomechanical (beneath shoe) footwear device for participants with unilateral/bilateral hip osteoarthritis (Solomonow-Avnon et al., 2017) or following hip arthroplasty (Segal et al., 2013). These studies provided very low certainty evidence for improvement over time.

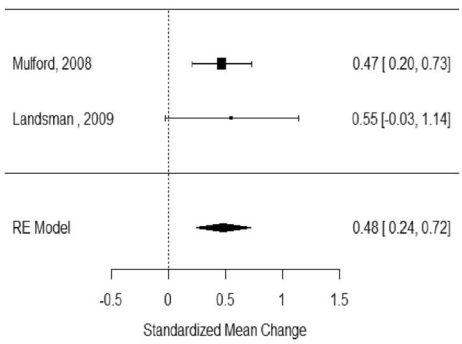


FIGURE 4 Meta-analysis–non-customised arch supports for non-specific hip pain.

4.1 | Foot orthoses interventions

The results of this systematic review indicate that arch supports may be associated with improvements in pain over time in older people with non-specific hip pain (Landsman et al., 2009; Mulford et al., 2008) and provide benefit over no orthoses for improvement in self-reported pain and analgesic use in people with GTPS (Ferrari, 2012). However, these outcomes are based on cohort and single-group pre-post designs rather than RCTs and are therefore subject to inflated effect estimates and bias. The potential benefit of arch supports in these hip conditions is biologically plausible, as walking with foot orthoses is associated with an immediate reduction in glutaeal muscle activity (Semciw et al., 2021). However, more rigorous RCTs are required before further definitive conclusions can be drawn.

The role of heel lifts as an intervention for people with hip pain remains unclear as their effect on pain, function and QoL has only been investigated in one hip-related clinical population. When used to 'correct' functional and perceived LLD following hip arthroplasty, heel lifts are less effective than exercises for improving physical outcomes (TUG) and no different from exercises or no intervention for alleviating pain at rest or self-reported physical function. However, this is based on a single RCT with a small sample size and an intervention spanning a 3-week inpatient post-operative period.

4.2 | Footwear interventions

The only footwear modifications identified in this systematic review were based on an externally applied, adjustable biomechanical device aimed at improving 'impaired' muscle function (Segal et al., 2013; Solomonow-Avnon et al., 2017). Both study protocols involved patients wearing the footwear device for a limited period each day for walking and, as such, could be considered a rehabilitation device rather than a permanent footwear modification. This is a very different approach to the usual footwear and foot orthoses prescription. Although suited to experimental situations, the device did not appear to lend itself to everyday wear. Furthermore, all participants were female, reducing study generalisability.

TABLE 4 Results of meta-analysis.

Comparison	Outcome	Time-point	Participants/ studies	Risk of bias		Effect of intervention SMC [95% CI] ↓lesser effect/↑greater effect	Certainty of evidence
				High	Low		
Single group pre-post study designs							
Non-customised arch support (non-specific hip pain)	Self-reported pain (VAS) (subacute pain)	4–6 weeks	75/2	Mulford et al., 2008/ Landsman et al., 2009		**↑ SMC = 0.48 [0.24, 0.72]**	⨁◯◯◯ VERY LOW

Note: Bold denotes a significant clinical effect with the arrow indicating a greater or lesser effect of the foot orthoses or footwear intervention.
Abbreviations: CI, Confidence Interval; SMC, Standard Mean Change; VAS, Visual Analogue Scale.

TABLE 5 Study results–heel lift interventions.

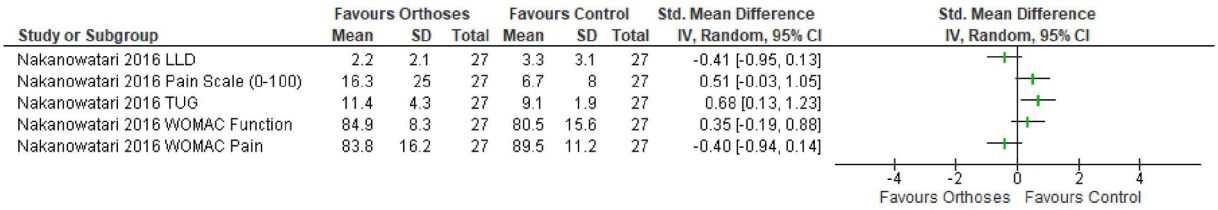
Comparison	Outcome	Time-point	Participants/ studies	Risk of bias		Effect of intervention SMD/SMC [95% CI] ↓lesser/ ↑greater effect	Certainty of evidence
				High	Low		
Randomised controlled trials							
Modified heel lift versus no heel lift (post-THA)	Pain (VAS 0–100)	3 weeks	17/1		Nakanowatari et al., 2016	SMD = 0.00 [−0.54,0.53]	⊕⊕◯◯ LOW
Modified heel lift versus no heel lift (post-THA)	Objective physical function (TUG)	3 weeks	17/1		Nakanowatari et al., 2016	SMD = 0.21 [−0.75, 0.32]	⊕⊕◯◯ LOW
Modified heel lift versus no heel lift (post-THA)	Self-reported physical function (WOMAC)	3 weeks	17/1		Nakanowatari et al., 2016	SMD = 0.54 [−0.01, 1.08]	⊕⊕◯◯ LOW
Modified heel lift versus no heel lift (post-THA)	Self-reported pain (WOMAC)	3 weeks	17/1		Nakanowatari et al., 2016	SMD = 0.31 [−0.23, 0.85]	⊕⊕◯◯ LOW
Modified heel lift versus exercise (post-THA)	Pain (VAS 0–100)	3 weeks	18/1		Nakanowatari et al., 2016	SMD = 0.51 [−0.03,1.05]	⊕⊕◯◯ LOW
Modified heel lift versus exercise (post-THA)	Objective physical function (TUG)	3 weeks	18/1		Nakanowatari et al., 2016	**↓SMD = 0.68 [0.13, 1.23]**	⊕⊕◯◯ LOW
Modified heel lift versus exercise (post-THA)	Self-reported physical function (WOMAC)	3 weeks	18/1		Nakanowatari et al., 2016	SMD = 0.35 [−0.19, 0.88]	⊕⊕◯◯ LOW
Modified heel lift versus exercise (post-THA)	Self-reported pain (WOMAC)	3 weeks	18/1		Nakanowatari et al., 2016	SMD = 0.40 [−0.94, 0.14]	⊕⊕◯◯ LOW
Single-group pre-post studies							
Modifiable heel lift (hip OA)	Clinical outcome score (merle D'Aubigne score)	Average f/u 23 months	33/1	Ohsawa and Ueno, 1997		Pain reduced = 51.5% (<1.6 months). Pain disappeared = 39.4% (<3.6 months). Pain unchanged = 15.2%.	⊕◯◯◯ VERY LOW

Note: TUG and WOMAC: lower score = improved outcome. Bold denotes a significant clinical effect with the arrow indicating a greater or lesser effect of the foot orthoses or footwear intervention.

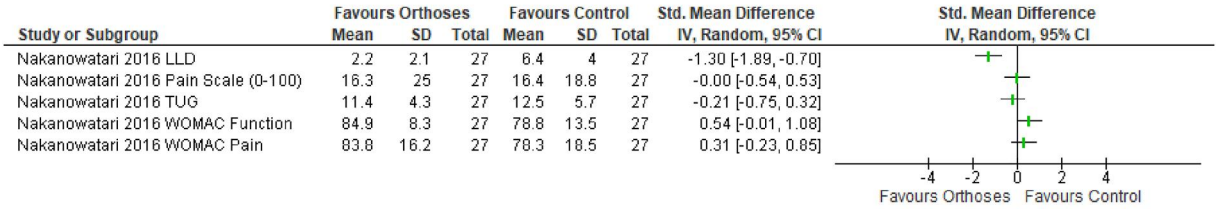
Abbreviations: CI, Confidence Interval; OA, Osteoarthritis; QoL, Quality of Life; SF-36: Short Form-36 SMC, Standard Mean Change; SMD, Standard Mean Difference; THA, Total Hip Arthroplasty; TUG, Timed Up and Go; VAS, Visual Analogue Scale for Pain; WOMAC, Western Ontario and McMasters Universities Osteoarthritis Index.

To date, no studies have investigated the use of permanent footwear modifications, or different types of footwear on impairments or QoL, in people with hip pain. Improvements in pain and function have been reported in people with knee osteoarthritis when using flexible/minimalist shoes (Sacco et al., 2012); hence, further evaluation of footwear interventions for people with hip pain is warranted.

Neither adherence to the intervention, nor adverse events were well reported across the studies, impeding the evaluation of these



A: SMD (±95% CI) for modified heel lift v control (specific exercises)



B: SMD (±95% CI) for modified heel lift v control (nil intervention)

FIGURE 5 Heel lifts following total hip arthroplasty.

outcomes. Based on previous research evaluating foot orthoses interventions in the lower limb (Bonanno et al., 2017), only minor adverse events, such as blisters, would be anticipated. Nevertheless, this is yet to be confirmed in people with hip pain.

Dosage and dose response were also not well-explored across the included studies, and there has been little research published on this in hip pain. Three studies utilised a heel lift (Ferrari, 2012; Nakanowatari et al., 2016; Ohsawa & Ueno, 1997), the height of which was based on reducing LLD. However, none of the studies evaluated whether altering the height of the arch support or heel lift led to more or less benefit in pain or functional outcomes. The footwear studies included in this review utilised a short daily intervention dosage, with use of the device not increased to regular all-day use.

4.3 | Indications for further research

This study highlights that evaluating the correction of abnormal foot alignment through the use of foot orthoses or footwear in people with hip disorders is warranted. To date, no studies have provided sub-group analyses to describe whether specific clinical subgroups, such as those with specific types of foot posture, are more likely to benefit from foot orthoses or footwear interventions.

Although adherence was poorly addressed in the included studies, it is an important consideration as it may provide insight into whether people with hip pain believe that using a footwear or foot orthoses intervention is credible. None of the included studies investigated credibility as an outcome, although this has been evaluated in recent trials evaluating foot orthoses and footwear interventions (Bonanno et al., 2018; Jerilyn et al., 2016). Given that people are more likely to wear foot orthoses or prescribed footwear if they believe them to be a credible pain-relieving intervention, consumer co-designed research to establish the credibility and acceptability of this intervention for people with hip pain should be a priority for future studies.

This systematic review evaluated the effect of foot orthoses and footwear interventions on outcomes including pain, function and QoL in people with symptomatic hip disorders. Studies that were limited to an evaluation of footwear or foot orthoses on biomechanical effects alone were not included.

Such studies, along with the results of this systematic review, highlight the need for future robust clinical trials in this area. Understanding the effects of foot orthoses or footwear use in symptomatic individuals, both in terms of pain, function and QoL as well as on the activity of glutaeal muscles, may help inform clinical decision-making with regard to their prescription for people where these muscles are impaired, sore, or fatigued, such as glutaeal tendinopathy (Ganderton et al., 2017) or hip osteoarthritis (Zacharias et al., 2019).

5 | CONCLUSION

The findings of this systematic review demonstrate that although foot orthoses and footwear interventions are increasingly recommended for people with hip pain, with plausible theories to justify their use, there remains a lack of convincing empirical evidence to favour their widespread adoption into clinical practice. Although previous research has shown an association between altered foot biomechanics and hip pain, very few high-quality studies have evaluated the use of footwear or foot orthoses to address symptoms in patients with hip-related disorders. Given that foot orthoses or footwear use is a relatively inexpensive and non-invasive treatment approach, further high-quality research is warranted in this area, to provide more robust evidence to support their use in people with often severe and debilitating hip conditions.

TABLE 6 Study results–footwear interventions.

Comparison	Outcome	Time-point	Participants/ studies	Risk of bias		Effect of intervention SMD/ SMC [95% CI] ↓lesser/↑greater effect	Certainty of evidence
				High	Low		
Single group pre-post study designs							
Customised footwear device (for hip OA)	Objective physical function (gait speed)	3 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA 0.12 [−0.31, 0.55] Bilateral OA **↑0.61 [0.15, 1.08]**	⊕◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Objective physical function (gait speed)	6 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA 0.18 [−0.26, 0.61] Bilateral OA **↑0.7 [0.22, 1.18]**	⊕◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Objective physical function (gait speed)	12 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA 0.14 [−0.29, 0.57] Bilateral OA **↑0.61 [0.15, 1.08]**	⊕◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Self-reported pain (WOMAC)	3 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA **↑SMC = −1.14 [−1.69, −0.59]** Bilateral OA **SMC = −0.59 [−1.06, −0.13]**	⊕◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Self-reported pain (WOMAC)	6 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA **↑SMC = −1.43 [−2.04, −0.82]** Bilateral OA SMC = −0.34 [−0.78, 0.10]	⊕◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Self-reported pain (WOMAC)	12 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA **↑SMC = −1.17 [−1.73, −0.62]** Bilateral OA **↑SMC = −0.62 [−1.09, −0.16]**	⊕◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Self-reported physical function (WOMAC)	3 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA **↑SMC = −1.41 [−2.02, −0.81]** Bilateral OA **↑SMC = −0.70 [−1.18, −0.23]**	⊕◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Self-reported physical function (WOMAC)	6 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA **↑SMC = −1.99 [−2.73, −1.25]** Bilateral OA **↑SMC = −0.47 [−0.93, −0.02]**	⊕◯◯◯ VERY LOW

(Continues)

TABLE 6 (Continued)

Comparison	Outcome	Time-point	Participants/ studies	Risk of bias		Effect of intervention SMD/ SMC [95% CI] ↓lesser/↑greater effect	Certainty of evidence
				High	Low		
Customised footwear device (for hip OA)	Self-reported physical function (WOMAC)	12 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA **↑SMC = −1.72 [−2.39, −1.04]** Bilateral OA **↑SMC = −0.63 [−1.09, −0.16]**	⨁◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Self-reported QoL (SF-36 function)	3 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA **↑SMC = 1.40 [0.80, 2.00]** Bilateral OA SMC = 0.34 [−0.10, 0.78]	⨁◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Self-reported QoL (SF-36 function)	6 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA **↑SMC = 1.56 [0.92, 2.19]** Bilateral OA SMC = 0.04 [−0.39, 0.46]	⨁◯◯◯ VERY LOW
Customised footwear device (for hip OA)	Self-reported QoL (SF-36 function)	12 months	21/1		Solomonow-Avnon et al., 2017	Unilateral OA **↑SMC = 1.36 [0.77. 1.95]** Bilateral OA SMC = 0.35 [−0.09, 0.79]	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Objective physical function (TUG)	4 weeks	19/1		Segal et al., 2013	**↑SMC = 1.19 [0.60, 1.77]**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Objective physical function (TUG)	12 weeks	19/1		Segal et al., 2013	**↑SMC = 1.31 [0.69, 1.92]**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Objective physical function (TUG)	26 weeks	19/1		Segal et al., 2013	**↑SMC = 1.54 [0.88, 2.21]**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported pain (WOMAC)	4 weeks	19/1		Segal et al., 2013	SMC = 0.46 [−0.02, 0.93]	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported pain (WOMAC)	12 weeks	19/1		Segal et al., 2013	**↑SMC = 0.59 [0.10, 1.08]**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported pain (WOMAC)	26 weeks	19/1		Segal et al., 2013	**↑SMC = 0.67 [0.17, 1.17]**	⨁◯◯◯ VERY LOW

TABLE 6 (Continued)

Comparison	Outcome	Time-point	Participants/ studies	Risk of bias		Effect of intervention SMD/ SMC [95% CI] ↓lesser/↑greater effect	Certainty of evidence
				High	Low		
Customised footwear device (post-THA)	Self-reported physical function (WOMAC)	4 weeks	19/1		Segal et al., 2013	↑**SMC = 1.05 [0.49, 1.61]**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported physical function (WOMAC)	12 weeks	19/1		Segal et al., 2013	↑**SMC = 1.19 (0.61, 1.78)**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported physical function (WOMAC)	26 weeks	19/1		Segal et al., 2013	↑**SMC = 1.42 (0.78, 2.06)**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported QoL/function (SF-36)	4 weeks	19/1		Segal et al., 2013	SMC = −0.47 (−0.94, 0.01)	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported QoL/function (SF-36)	12 weeks	19/1		Segal et al., 2013	↑**SMC = −0.96 (−1.50, −0.42)**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported QoL/function (SF-36)	26 weeks	19/1		Segal et al., 2013	↑**SMC = −1.27 (−1.87, −0.67)**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported QoL/mental health (SF-36)	4 weeks	19/1		Segal et al., 2013	↑**SMC = −0.57 (−1.05, −0.08)**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported QoL/mental health (SF-36)	12 weeks	19/1		Segal et al., 2013	↑**SMC = −1.14 (−1.71, −0.56)**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Self-reported QoL/mental health (SF-36)	26 weeks	19/1		Segal et al., 2013	↑**SMC = −1.20 (−1.79, −0.61)**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Clinical score (Harris hip score)	4 weeks	19/1		Segal et al., 2013	↑**SMC = 3.38 (2.21, 4.54)**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Clinical score (Harris hip score)	12 weeks	19/1		Segal et al., 2013	↑**SMC = −1.23 (−1.82, −0.63)**	⨁◯◯◯ VERY LOW
Customised footwear device (post-THA)	Clinical score (Harris hip score)	26 weeks	19/1		Segal et al., 2013	↑**SMC = −1.47 (−2.12, −0.82)**	⨁◯◯◯ VERY LOW

Note: Harris Hip Score and SF-36: higher score = improved outcome; TUG and WOMAC: lower score = improved outcome. Bold denotes a significant clinical effect with the arrow indicating a greater or lesser effect of the foot orthoses or footwear intervention.

Abbreviations: CI, Confidence Interval; OA, Osteoarthritis; QoL, Quality of Life; SF-36, Short Form-36; SMC, Standard Mean Change; SMD, Standard Mean Difference; THA, Total Hip Arthroplasty; TUG, Timed Up and Go; VAS, Visual Analogue Scale; WOMAC, Western Ontario and McMasters Universities Osteoarthritis Index.

AUTHOR CONTRIBUTIONS

All authors made substantial contributions to this work: Conception and design of the work: Rita Kinsella, Adam I, Semciw, Hylton B. Menz, Natalie J. Collins, Tania Pizzari. Acquisition, analysis, and interpretation of data: Rita Kinsella, Anthony Nasser, Adam I. Semciw, Hylton B. Menz, Natalie J. Collins, Tania Pizzari. Draughting the manuscript and revising it critically for intellectual content: Rita Kinsella, Anthony Nasser, Adam I. Semciw, Hylton B. Menz, Natalie J. Collins, Tania Pizzari. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: Rita Kinsella, Anthony Nasser, Adam I. Semciw, Hylton B. Menz, Natalie J. Collins, Tania Pizzari.

ACKNOWLEDGEMENTS

No specific funding was received for this research from any agency in the public, commercial, or not-for-profit sectors.

Open access publishing facilitated by The University of Melbourne, as part of the Wiley - The University of Melbourne agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data underlying this article will be shared upon request by the corresponding author.

ETHICS STATEMENT

This manuscript is a systematic review and did not involve human participants; hence, no ethical approval was required.

PROTOCOL REGISTRATION

Prospectively registered in PROSPERO (ID: CRD42021224118). Registration date: 6th February 2021.

ORCID

Rita Kinsella https://orcid.org/0000-0002-7981-6293

REFERENCES

Ackerman, I. N., Kemp, J. L., Crossley, K. M., Culvenor, A. G., & Hinman, R. S. (2017). Hip and knee osteoarthritis affects younger people, too. *Journal of Orthopaedic & Sports Physical Therapy*, *47*(2), 67–79. https://doi.org/10.2519/jospt.2017.7286

Aromataris, E., & Munn, Z. (2017). *Joanna Briggs Institute reviewer's manual*. The Joanna Briggs Institute.

Barton, C., Menz, H. B., & Crossley, K. M. (2011). Clinical predictors of foot orthoses efficacy in Individuals with patellofemoral pain. *Journal of Medicine & Science in Sports & Exercise*, *43*(9), 1603–1610. https://doi.org/10.1249/MSS.0b013e318211c45d

Barwick, A., Smith, J., & Chuter, V. (2012). The relationship between foot motion and lumbopelvic–hip function: A review of the literature. *The Foot*, *22*(3), 224–231. https://doi.org/10.1016/j.foot.2012.03.006

Bird, A. R., & Payne, C. B. (1999). Foot function and low back pain. *The Foot*, *9*(4), 175–180. https://doi.org/10.1054/foot.1999.0563

Bonanno, D. R., Murley, G. S., Munteanu, S. E., Landorf, K. B., & Menz, H. B. (2018). Effectiveness of foot orthoses for the prevention of lower limb overuse injuries in naval recruits: A randomised controlled trial. *British Journal of Sports Medicine*, *52*(5), 298–302. https://doi.org/10.1136/bjsports-2017-098273

Bonanno, D. R., Landorf, K. B., Munteanu, S. E., Murley, G. S., & Menz, H. B. (2017). Effectiveness of foot orthoses and shock-absorbing insoles for the prevention of injury: A systematic review and meta-analysis. *British Journal of Sports Medicine*, *51*(2), 86–96. https://doi.org/10.1136/bjsports-2016-096671

Chapman, L. S., Redmond, A. C., Landorf, K. B., Rome, K., Keenan, A.-M., Waxman, R., Alcacer-Pitarch, B., Siddle, H. J., & Backhouse, M. R. (2018). A survey of foot orthoses prescription habits amongst podiatrists in the UK, Australia and New Zealand. *Journal of Foot and Ankle Research*, *11*(1), 64. https://doi.org/10.1186/s13047-018-0304-z

Chen, H., Cohen, P., & Chen, S. (2010). How big is a big odds ratio? Interpreting the magnitudes of odds ratios in epidemiological studies. *Communications in Statistics - Simulation and Computation*, *39*(4), 860–864. https://doi.org/10.1080/03610911003650383

Christmas, C., Crespo, C. J., Franckowiak, S. C., Bathon, J. M., Bartlett, S. J., & Andersen, R. E. (2002). How common is hip pain among older adults? Results from the third national health and nutrition examination survey. *Journal of Family Practice*, *51*(4), 345.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). L. Erlbaum Associates.

Collins, N., Crossley, K. M., Beller, E., Darnell, R., McPoil, T., & Vicenzino, B. (2008). Foot orthoses and physiotherapy in the treatment of patellofemoral pain syndrome. *BMJ*, *337*(7677), 1034–1036.

Collins, N. J., Barton, C., van Middelkoop, M., Callaghan, M., Rathleff, M. S., Vicenzino, B., Davis, I. S., Powers, C. M., Macri, E. M., Hart, H. F., de Oliveira Silva, D., & Crossley, K. M. (2018). 2018 Consensus statement on exercise therapy and physical interventions (orthoses, taping and manual therapy) to treat patellofemoral pain: Recommendations from the 5th International Patellofemoral Pain Research Retreat, Gold Coast, Australia, 2017. *British Journal of Sports Medicine*, *52*(18), 1170–1178. https://doi.org/10.1136/bjsports-2018-099397

Collins, N. J., Hinman, R. S., Menz, H. B., & Crossley, K. M. (2016). Immediate effects of foot orthoses on pain during functional tasks in people with patellofemoral osteoarthritis: A cross-over, proof of concept study. *The Knee*, *24*(1), 76–81. https://doi.org/10.1016/j.knee.2016.09.016

Ferrari, R. (2012). A cohort-controlled trial of customized foot orthotics in trochanteric bursitis. *The Journal of Practical Orthodontics*, *24*(3), 107–110. https://doi.org/10.1097/jpo.0b013e3182627659

Ganderton, C., Pizzari, T., Harle, T., Cook, J., & Semciw, A. I. (2017). A comparison of gluteus medius, gluteus minimus and tensor facia latae muscle activation during gait in post-menopausal women with and without greater trochanteric pain syndrome. *Journal of Electromyography and Kinesiology*, *33*, 39–47. https://doi.org/10.1016/j.jelekin.2017.01.004

Gélis, A., Coudeyre, E., Hudry, C., Pelissier, J., Revel, M., & Rannou, F. (2008). Is there an evidence-based efficacy for the use of foot orthotics in knee and hip osteoarthritis? Elaboration of French clinical practice guidelines. *Joint Bone Spine*, *75*(6), 714–720. https://doi.org/10.1016/j.jbspin.2008.02.013

Gross, K. D., Niu, J., Zhang, Y. Q., Felson, D. T., McLennan, C., Hannan, M. T., Holt, K. G., & Hunter, D. J. (2007). Varus foot alignment and hip conditions in older adults. *Arthritis & Rheumatism*, *56*(9), 2993–2998. https://doi.org/10.1002/art.22850

Heerey, J. J., Kemp, J. L., Mosler, A. B., Jones, D. M., Pizzari, T., Scholes, M. J., Agricola, R., & Crossley, K. M. (2019). What is the prevalence of

hip intra-articular pathologies and osteoarthritis in active athletes with hip and groin pain compared with those without? A systematic review and meta-analysis. *Sports Medicine*, *49*(6), 951–972. https://doi.org/10.1007/s40279-019-01092-y

Higgins, J. P., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (2023). *Cochrane handbook for systematic reviews of interventions version 6.4 (updated August 2023)*. The Cochrane Collaboration. www.training.cochrane.org/handbook

Higgins, J. P., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *BMJ*, *327*(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557

Hoy, D. G., Smith, E., Cross, M., Sanchez-Riera, L., Blyth, F. M., Buchbinder, R., Woolf, A. D., Driscoll, T., Brooks, P., & March, L. M. (2015). Reflecting on the global burden of musculoskeletal conditions: Lessons learnt from the Global Burden of Disease 2010 Study and the next steps forward. *Annals of the Rheumatic Diseases*, *74*(1), 4–7. https://doi.org/10.1136/annrheumdis-2014-205393

Jerilyn, T. X., Menz, H. B., Murley, G. S., & Munteanu, S. E. (2016). Effectiveness of shoe stiffening inserts for first metatarsophalangeal joint osteoarthritis: A proof-of-concept study. *American Journal of Physical Medicine & Rehabilitation*, *95*(2), 103–111. https://doi.org/10.1097/PHM.0000000000000350

Kemp, J. L., Risberg, M. A., Mosler, A., Harris-Hayes, M., Serner, A., Moksnes, H., Bloom, N., Crossley, K. M., Gojanovic, B., Hunt, M. A., Ishøi, L., Mathieu, N., Mayes, S., Scholes, M. J., Gimpel, M., Friedman, D., Ageberg, E., Casartelli, N. C., & Agricola, R. (2020). Physiotherapist-led treatment for young to middle-aged active adults with hip-related pain: Consensus recommendations from the International Hip-related Pain Research Network, Zurich 2018. *British Journal of Sports Medicine*, *54*(9), 504–511. https://doi.org/10.1136/bjsports-2019-101458

Landsman, A., Defronzo, D., Anderson, J., & Roukis, T. (2009). Scientific assessment of over-the-counter foot orthoses to determine their effects on pain, balance, and foot deformities. *Journal of the American Podiatric Medical Association*, *99*(3), 206–215. https://doi.org/10.7547/0980206

Lawrenson, P. R., Crossley, K. M., Vicenzino, B. T., Hodges, P. W., James, G., Croft, K. J., King, M., & Semciw, A. I. (2019). Muscle size and composition in people with articular hip pathology: A systematic review with meta-analysis. *Osteoarthritis and Cartilage*, *27*(2), 181–195. https://doi.org/10.1016/j.joca.2018.10.008

Mascarenhas, V. V., Rego, P., Dantas, P., Morais, F., McWilliams, J., Collado, D., Marques, H., Gaspar, A., Soldado, F., Consciência, J. G., & Consciência, J. G. (2016). Imaging prevalence of femoroacetabular impingement in symptomatic patients, athletes, and asymptomatic individuals: A systematic review. *European Journal of Radiology*, *85*(1), 73–95. https://doi.org/10.1016/j.ejrad.2015.10.016

Matthews, M., Rathleff, M. S., Claus, A., McPoil, T., Nee, R., Crossley, K. M., Kasza, J., & Vicenzino, B. T. (2020). Does foot mobility affect the outcome in the management of patellofemoral pain with foot orthoses versus hip exercises? A randomised clinical trial. *British Journal of Sports Medicine*, *54*(23), 1416–1422. https://doi.org/10.1136/bjsports-2019-100935

Menz, H. B., Auhl, M., Tan, J. M., Levinger, P., Roddy, E., & Munteanu, S. E. (2016). Effectiveness of foot orthoses versus rocker-sole footwear for first metatarsophalangeal joint osteoarthritis: A randomized trial. *Arthritis Care & Research*, *68*(5), 581–589. https://doi.org/10.1002/acr.22750

Mulford, D., Taggart, H. M., Nivens, A., & Payrie, C. (2008). Arch support use for improving balance and reducing pain in older adults. *Applied Nursing Research*, *21*(3), 153–158. https://doi.org/10.1016/j.apnr.2006.08.006

Nakanowatari, T., Suzukamo, Y., & Izumi, S. I. (2016). The effectiveness of specific exercise approach or modifiable heel lift in the treatment of functional leg length discrepancy in early post-surgery inpatients after total hip arthroplasty: A randomized controlled trial with a PROBE design. *Physical Therapy Research*, *19*(1), 39–49. https://doi.org/10.1298/ptr.e9892

Nasser, A. M., Vicenzino, B. T., Grimaldi, A., Anderson, J., & Semciw, A. I. (2021). Proximal hamstring tendinopathy: A systematic review of interventions. *International Journal of Sports Physical Therapy*, *16*(2), 288–305. https://doi.org/10.26603/001c.21250

Ohsawa, S., & Ueno, R. (1997). Heel lifting as a conservative therapy for osteoarthritis of the hip based on the rationale of Pauwels' intertrochanteric osteotomy. *Prosthetics and Orthotics International*, *21*(2), 153–158. https://doi.org/10.3109/03093649709164544

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., …, & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Review Manager (RevMan)[Computer program]. Version 5.4. The Cochrane Collaboration, 2020.

Riskowski, J. L., Dufour, A. B., Hagedorn, T. J., Hillstrom, H. J., Casey, V. A., & Hannan, M. T. (2013). Associations of foot posture and function to lower extremity pain: Results from a population-based foot study. *Arthritis Care & Research*, *65*(11), 1804–1812. https://doi.org/10.1002/acr.22049

Sacco, I. C. N., Trombini-Souza, F., Butugan, M. K., Pássaro, A. C., Arnone, A. C., & Fuller, R. (2012). Joint loading decreased by inexpensive and minimalist footwear in elderly women with knee osteoarthritis during stair descent. *Arthritis Care & Research*, *64*(3), 368–374. https://doi.org/10.1002/acr.20690

Schünemann, H. J., Higgins, J. P. T., Vist, G. E., Glasziou, P., Akl, E. A., Skoetz, N., & Guyatt, G. H. (2022). Chapter 14: Completing 'Summary of findings' tables and grading the certainty of the evidence. In J. P. T. Higgins, J. Thomas, J. Chandler, M. Cumpston, T. Li, M. J. Page, & V. A. Welch (Eds.), *Cochrane handbook for systematic reviews of interventions version 6.4*. (updated March 2022). www.training.cochrane.org/handbook

Segal, G., Bar-Ziv, Y., Velkes, S., Benkovich, V., Stanger, G., Debbi, E. M., Debi, R., Mor, A., & Elbaz, A. (2013). A non-invasive biomechanical device and treatment for patients following total hip arthroplasty: Results of a 6-month pilot investigation. *Journal of Orthopaedic Surgery and Research*, *8*(1), 13. https://doi.org/10.1186/1749-799X-8-13

Segal, N., Felson, D. T., Torner, J. C., Zhu, Y., Curtis, J. R., Niu, J., & Nevitt, M. C. (2007). Greater trochanteric pain syndrome: Epidemiology and associated factors. *Archives of Physical Medicine and Rehabilitation*, *88*(8), 988–992. https://doi.org/10.1016/j.apmr.2007.04.014

Semciw, A. I., Visvalingam, V. N., Ganderton, C., Lawrenson, P., Hodges, P. W., Kemp, J., & Collins, N. J. (2021). The immediate effect of foot orthoses on gluteal and lower limb muscle activity during overground walking in healthy young adults. *Gait & Posture*, *89*, 102–108. https://doi.org/10.1016/j.gaitpost.2021.07.003

Solomonow-Avnon, D., Herman, A., Levin, D., Rozen, N., Peled, E., & Wolf, A. (2017). Positive outcomes following gait therapy intervention for hip osteoarthritis: A longitudinal study. *Journal of Orthopaedic Research*, *35*(10), 2222–2232. https://doi.org/10.1002/jor.23511

Tan, J. M., Menz, H. B., Crossley, K. M., Munteanu, S. E., Hart, H. F., Middleton, K. J., Smith, A. J., & Collins, N. J. (2019). The efficacy of foot orthoses in individuals with patellofemoral osteoarthritis: A randomised feasibility trial. *Pilot and Feasibility Studies*, *5*(1), 90. https://doi.org/10.1186/s40814-019-0469-7

Van Gheluwe, B., & Kirby, K. (2010). Research and clinical synergy in foot and lower extremity biomechanics. *Footwear Science*, *2*(3), 111–122. https://doi.org/10.1080/19424280.2010.497169

Viechtbauer, W. (2010). Conducting meta-analyses in R with the Metafor package. *Journal of Statistical Software*, *36*(3), 1–48. https://doi.org/10.18637/jss.v036.i03

Vos, T., Flaxman, A., & Naghavi, M. (2014). Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: A systematic analysis for the global burden of disease study 2010 (vol 380, pg 2163, 2012). *Lancet*, *384*(9943), 582.

Whittaker, G. A., Munteanu, S. E., Menz, H. B., Tan, J. M., Rabusin, C. L., & Landorf, K. B. (2018). Foot orthoses for plantar heel pain: A systematic review and meta-analysis. *British Journal of Sports Medicine*, *52*(5), 322–328. https://doi.org/10.1136/bjsports-2016-097355

Winters, M., Eskes, M., Weir, A., Moen, M. H., Backx, F. J. G., & Bakker, E. W. P. (2013). Treatment of medial tibial stress syndrome: A systematic review. *Sports Medicine*, *43*(12), 1315–1333. https://doi.org/10.1007/s40279-013-0087-0

Zacharias, A., Pizzari, T., Semciw, A. I., English, D. J., Kapakoulakis, T., & Green, R. A. (2019). Comparison of gluteus medius and minimus activity during gait in people with hip osteoarthritis and matched controls. *Scandinavian Journal of Medicine & Science in Sports*, *29*(5), 696–705. https://doi.org/10.1111/sms.13379

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Kinsella, R., Nasser, A., Menz, H. B., Pizzari, T., Collins, N. J., & Semciw, A. I. (2023). Effects of foot orthoses and footwear interventions on impairments and quality of life in people with hip pain: A systematic review. *Musculoskeletal Care*, 1–22. https://doi.org/10.1002/msc.1826