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The effects of customized orthopedic insoles on sickness absence and productivity among industrial employees

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Abstract

Musculoskeletal disorders are a leading cause of sickness absence and reduced productivity in industrial occupations, prompting widespread adoption of workplace health interventions. Individually customized orthopedic insoles (ICOIs) have become a recommended ergonomic solution to enhance comfort, mitigate biomechanical stress, and potentially reduce work-related disability. However, their actual impact on core organizational outcomes remains debated. This systematic review synthesized findings from 57 published studies to assess the effectiveness of ICOIs on sickness absence, productivity, and implementation in industrial employees.

A comprehensive literature search was retrospectively conducted across major databases, encompassing randomized controlled trials, cohort studies, clinical interventions, and systematic reviews addressing ICOIs or comparable interventions in occupational contexts. Studies varied broadly in design, population, intervention protocols, outcome definitions, and analytical rigor. The methodological quality of included studies was assessed using design-appropriate bias criteria. Heterogeneity of outcome measures and reporting methods precluded meta-analysis; thus, results were narratively synthesized across key outcomes.

The review found that ICOIs consistently provided subjective benefits such as improved physical comfort, pain reduction, and enhanced foot alignment. These advantages, though valued by workers and employers alike, did not translate into a concomitant reduction in sickness absence or a robust improvement in objective productivity measures. Only a minority of studies directly measured absenteeism or reported quantifiable organizational gains; most results were confounded by co-interventions, short follow-up periods, and inconsistent outcome reporting. Evidence comparing ICOIs to prefabricated or standard insoles showed negligible differences in absenteeism or work performance, although individual comfort and user satisfaction were often higher with customized devices. Adherence challenges, compatibility with safety footwear, and resource constraints were frequently cited as practical barriers to sustained effectiveness.

The current evidence does not support the use of ICOIs as standalone interventions for improving attendance or productivity in industrial workplaces. Instead, their value is maximized when integrated into broader ergonomic or occupational health strategies. Decision-makers should remain cautious, prioritizing multi-component interventions and considering cost-effectiveness, particularly given the comparable effectiveness of high-quality prefabricated insoles in many cases.

Major gaps persist, notably the lack of standardized outcome definitions for absenteeism and productivity, insufficient longitudinal real-world studies, and limited cost-effectiveness analyses. Future research should address these limitations to clarify under which conditions ICOIs yield clear, sustainable occupational benefits.

Keywords: sickness absence, customized orthopedic insoles, industrial workers, foot orthosis, workplace health, productivity

JEL codes: I1, M

1. Introduction

Investments in employee health have become an economic necessity in modern workplaces. Corporate health management (CHM) and workplace health promotion (WHP) not only aim to improve employee well-being but also yield measurable economic benefits. Employer spending on WHP in Germany rose from €1.2 billion in 2018 to €1.8 billion in 2022, an increase of 50% (Statistisches Bundesamt 2024). Statutory health insurance funds increased their WHP budgets from €150 million to €257.4 million in the same period (GKV Präventionsbericht 2024).

Diseases of the musculoskeletal system are among the most common causes of incapacity for work at just under 25 percent, and jobs are the second most common diagnostic group for pension payments due to reduced earning capacity at 16 percent (BMAS and BAUA 2023).

These pains or discomforts include diseases of the joints with inflammatory and non-inflammatory components. Diseases of the back, spine, connective and soft tissue as well as bones and cartilage. Back and joint diseases predominate. In addition to a reduction in physical performance, the consequences are above all costs due to long downtimes. For example, about two-thirds of the annual costs caused by work-related health impairments can be attributed to musculoskeletal disorders (Gröben et al 2004).

Long working hours in an industrial environment with safety shoes can increase the development of musculoskeletal complaints. In a previous study on occupational footwear was stated that prolonged standing and walking on hard floors might be the main causes of foot problems while wearing safety shoes. These safety shoes when not well stabled can cause fatigue and falling during working (Saeedi et al., 2024).

Here, especially in the area of the foot, there is a high number of orthopedic diagnoses that can be treated conservatively, preventively, so that they do not become structural deformities. This can prevent operations, inability to work or disability to work (Schräder 2015).

In modern industrial settings, musculoskeletal discomfort and work-related physical strain remain persistent challenges affecting employee well-being and productivity. Individually customized orthopedic insoles (ICOIs) have gained attention as a potential ergonomic intervention aimed at reducing biomechanical stress, improving posture, and mitigating occupational injuries (Thomas et al., 2022; Yurt et al., 2019; Almeida et al., 2009).

Although frequently recommended by practitioners and embedded in workplace health programs, there remains limited consensus on their effectiveness in directly improving workforce-related outcomes, such as reducing sickness absence or increasing productivity. Previous studies have yielded inconsistent results. Some report comfort and pain relief as dominant outcomes (Garcia-Hernandez et al., 2016; Tarrade et al., 2019; Goniewicz et al., 2024), while few provide measurable evidence of improved attendance or job performance (Ferrari, 2013; Arslan et al., 2020; Sowah et al., 2018).

Custom-made orthopedic insoles represent a low-cost but potentially high-impact intervention. They act directly on the biomechanical base of the body, influencing gait, posture, and overall physical function. Existing research, such as Grimani et al. (2018),

suggests that MSD-related interventions in CHM are among the most cost-effective. Still, very few studies have isolated the economic impact of orthopedic insoles, especially in small and medium-sized enterprises (SMEs), where financial resources for health programs are often limited.
Despite their widespread use—approximately 19% of the German population uses orthopedic insoles (Eurocom 2019)—scientific evidence on their economic effectiveness remains sparse. Most studies suffer from short follow-up durations, small sample sizes, and insufficient standardization of intervention methods. Additionally, the specific interaction of orthopedic insoles with safety footwear has rarely been investigated.

Given this uncertainty, this research paper synthesizes evidence from 57 scientific studies covering a range of designs—including randomized controlled trials, controlled clinical trials, cohort studies, systematic reviews, and pilot trials. The aim is to assess whether ICOIs produce measurable benefits in reducing sickness absence and improving productivity, particularly in industrial work environments. The scope also includes the comparative effectiveness of custom versus prefabricated insoles, and factors influencing implementation in real-world contexts (Durak, 2016; Ishtiaque et al., 2022; Khaliliyan et al., 2025).

By providing a structured overview of current empirical findings, this Paper aims to support occupational health practitioners, HR departments, and policymakers in making evidence-based decisions regarding the adoption of customized orthopedic insoles in industrial environments.

2. Methods

This Research paper seeks to answer the following research question: To what extent do individually customized orthopedic insoles (ICOIs) reduce sickness absence and improve productivity among industrial employees?

To address this question, a structured literature search was conducted covering 57 peer-reviewed academic studies. Studies included a range of empirical designs, such as randomized controlled trials (RCTs), controlled clinical trials, cohort studies, and systematic reviews. The selection criteria focused on empirical relevance to workplace health, orthopedic insole interventions, and outcomes related to sickness absence, presenteeism, physical function, and productivity.

The studies were reviewed through a two-step analytical approach. First, a narrative synthesis was conducted, grouping findings thematically across five core domains: (1) sickness absence, (2) productivity, (3) comfort and pain relief, (4) comparative effectiveness of custom vs. standard insoles, and (5) implementation and adherence. This method allows integration of heterogeneous study outcomes, especially in contexts where meta-analytic aggregation is inappropriate due to diverse outcome measures, designs, and populations (Popay et al., 2006).

Second, a qualitative content analysis (Mayring, 2015) was used to categorize findings based on study design, population type, intervention protocol, reported effects, and theoretical grounding. This approach provided a structured means to identify patterns, inconsistencies,

and gaps within the current evidence base. Outcomes were synthesized descriptively and supported by in-text citations.
By integrating these two complementary methods, the review aims to present a robust and structured synthesis of current research on the occupational impact of customized orthopedic insoles.

A retrospective literature search was conducted, covering relevant publications from 2000 to October 2024. The databases searched included PubMed, Web of Science, Scopus, CINAHL, major publisher platforms, and Google Scholar. Included were studies on adult employees in industrial or high-physical-demand settings investigating the use of individually customized orthopedic insoles. The reconstructed search strategy used terms such as: (1) sickness absence, (2) productivity, (3) comfort and pain relief, (4) comparative effectiveness of custom vs. standard insoles, and (5) implementation and adherence. Screening for eligibility was performed by the author based on title, abstract, and full text; disagreements were resolved by consensus. Excluded were purely mechanical laboratory studies and research without occupational relevance. Selection bias and incomplete coverage may affect the robustness due to the retrospective reconstruction.

A total of approximately 900 records were identified through systematic database and literature searches. After removal of duplicates and initial title/abstract screening, 750 records remained for full-text review. Based on the eligibility criteria, 693 publications were excluded due to irrelevance to the review question, study design, or population. Of the 74 records meeting the thematic inclusion criteria, 17 were further excluded due to incomplete bibliographic data (missing author, title, or publication year; n = 12) or duplication (n = 5), yielding a final sample of 57 studies for qualitative synthesis. The selection process is illustrated in Appendix B.
Risk of bias and methodological quality of included studies were assessed retrospectively using suitable tools for study design (e.g., Cochrane RoB 2.0 for RCTs; quality checklists for observational studies). Overall study quality was considered when interpreting findings.

Data from eligible studies were extracted using a standardized form, capturing population, intervention details, outcomes, study design, and major results. When reporting was unclear, consensus was reached through iterative discussion.

Outcome variables were operationalized according to definitions used in the respective studies. Sickness absence was most often reported as days lost due to incapacity or return-to-work rates, while productivity included direct measures (e.g., units produced, time on task) as well as indirect proxies (e.g., self-reported work ability, activity levels). Considerable heterogeneity in outcome definition was noted among sources.

As the review methodology was reconstructed retrospectively, certain limitations may affect completeness, reproducibility, and risk of selection bias. No protocol was pre-registered and dual-independent screening was not performed.

3. Results

The synthesis included 57 studies spanning randomized controlled trials, controlled clinical trials, cohort studies, systematic reviews, and observational research. Characteristics of included studies were highly heterogeneous with respect to design, populations, follow-up,

and intervention protocols. For the principal outcomes (sickness absence, productivity, comfort or pain, comparative effectiveness, and implementation factors), the evidence base varied in quality and reporting consistency.

Of the 57 included studies, 12 (21%) were rated as low risk of bias, 36 (63%) as moderate risk, and 9 (16%) as high risk. Studies assessed as low risk were predominantly systematic reviews with meta-analyses and well-designed RCTs featuring adequate randomization and blinding. High-risk ratings were concentrated among observational, cross-sectional, and pilot studies, primarily due to the absence of control groups, lack of blinding, and reliance on self-report measures. A detailed risk-of-bias assessment for each study is provided in Appendix C. Notably, there was considerable heterogeneity in how primary endpoints such as sickness absence and productivity were operationalized, which restricts the comparability and meta-analysis of findings.

The results reflect both the diversity of existing research and the limitations inherent to study design, methods, and reporting standards in the field. Full details of methodological quality assessment and summary tables of study characteristics are available from the author upon reasonable request.

Building on the methodological foundation established in the previous chapter, this section presents the findings of the literature analysis. The 57 studies identified were analyzed along multiple dimensions, including their methodological approaches, theoretical frameworks, study designs, and core empirical outcomes. In the following subsections, we systematically synthesize the insights obtained from this body of research, structured around the key analytical categories developed during the review process.

3.1 Characteristics of Included Studies

The 57 studies included in this review cover a broad range of research designs, populations, and orthopedic insole interventions. Their methodological diversity provides a comprehensive view of the empirical landscape regarding the occupational relevance of individually customized orthopedic insoles (ICOIs).

Among these studies, randomized controlled trials (RCTs) constitute approximately 12% (e.g., Thomas et al., 2022; Saeedi et al., 2024a), while controlled clinical trials, quasi-experimental designs, and prospective cohort studies form the majority. Several systematic reviews were also included to provide overarching theoretical and contextual insight (Moisan et al., 2022; Sowah et al., 2018). Pilot studies and observational research were reviewed with a critical lens and included for illustrative depth (Almeida et al., 2009; Ishtiaque et al., 2022).

Populations varied significantly: some studies focused explicitly on industrial or standing occupations (e.g., Durak, 2016; Khaliliyan et al., 2025), while others examined broader working adults, military personnel, or clinical populations with conditions such as plantar fasciitis, flatfoot, or osteoarthritis (Yurt et al., 2019; Saeedi et al., 2024b; Zafar et al., 2019). This diversity enriches the dataset but complicates generalizability to purely industrial contexts.

Intervention protocols included custom-made insoles fabricated through CAD/CAM systems, 3D printing, or podiatric assessments (Jonnala et al., 2023; Hajizadeh et al., 2021),

as well as prefabricated or semi-custom devices used as comparators. Some studies assessed insoles in combination with other ergonomic tools (e.g., smart boots, mats, or exercise regimens) (Dobson et al., 2020; Mousavi et al., 2009). Follow-up durations ranged from two weeks to seven years (Saeedi et al., 2024a; Durak, 2016), with many studies failing to report duration clearly.

This heterogeneous evidence base supports a broad and multidimensional analysis, though it limits meta-analytic synthesis due to inconsistencies in outcome definitions, intervention fidelity, and reporting practices.

3.2 Impact on Sickness Absence

Sickness absence, defined as work time lost due to health-related incapacity, is a key indicator in evaluating the effectiveness of workplace ergonomic interventions. Despite the hypothesized benefits of ICOIs in reducing biomechanical strain and improving musculoskeletal health, the evidence regarding their impact on sickness absence remains limited and inconclusive.

Only a small subset of the reviewed studies explicitly measured absenteeism. Among them, Ferrari (2013) and Arslan et al. (2020) found no statistically significant reduction in sickness absence or return-to-work rates following insole use. Similarly, Saeedi et al. (2024a) tracked pain and posture improvements but did not observe corresponding changes in work attendance. One study reported reduced low-back-related absenteeism, though the intervention included physical training alongside insole use, making attribution difficult (Tarrade et al., 2019).

Other studies referenced absenteeism only indirectly or qualitatively. For instance, Almeida et al. (2009) noted anecdotal reports of improved physical well-being, but did not link this to attendance data. Moisan et al. (2022) noted that despite improved comfort, ICOIs alone are unlikely to yield measurable changes in absenteeism without broader ergonomic support structures.

Furthermore, many studies failed to define or measure absenteeism consistently. Some relied on self-reporting, while others used ambiguous constructs like 'time away from work' or 'limited duty days' without clarifying definitions (Durak, 2016; Thomas et al., 2022). These inconsistencies hinder comparability and diminish the robustness of absenteeism-related findings.

In sum, the current body of literature does not provide sufficient empirical support to assert that ICOIs reduce sickness absence among industrial workers. Although improvements in comfort and biomechanical alignment are frequently observed, their translation into measurable reductions in absenteeism remains empirically unsubstantiated.

3.3 Impact on Productivity

Productivity, understood as the output or efficiency of employees during working hours, is a central metric in occupational health and organizational performance. Interventions like

individually customized orthopedic insoles (ICOIs) are often promoted on the premise that they reduce fatigue and discomfort, potentially enabling workers to focus better and sustain performance. However, empirical evidence for this link remains weak and scattered.

Among the reviewed studies, few explicitly addressed productivity. In the few that did, outcome definitions varied widely. Some assessed return-to-work time (Ferrari, 2013; Arslan et al., 2020), while others measured perceived work ability or activity-related energy expenditure (Jonnala et al., 2023). Yurt et al. (2019), for instance, observed improvements in foot pain and comfort, which were theorized to reduce work disruption, yet direct productivity outcomes were not reported.

One study (Ishtiaque et al., 2022) examined smart insole systems in industrial safety boots and reported increased step counts and user satisfaction—potential proxies for physical engagement—but did not link these to objective performance or output metrics. Similarly, Hajizadeh et al. (2021) explored walking biomechanics and balance, suggesting enhanced workplace readiness but without tracking task-based performance.

In most cases, the evidence on productivity is indirect. Several studies (e.g., Moisan et al., 2022; Sowah et al., 2018) argued that ICOIs may contribute to comfort and physical resilience, which in turn support performance sustainability, especially in prolonged standing jobs. However, these links remain theoretical and are not substantiated by longitudinal, workplace-based productivity data.

Moreover, many studies were conducted outside industrial settings, limiting transferability to high-demand physical occupations. The lack of standard productivity metrics—such as units produced, error rates, or time-on-task—further impairs cross-study comparisons and evidence synthesis.

Overall, while ICOIs are frequently associated with improved comfort and pain reduction, their direct impact on productivity remains underexplored. The current literature does not offer robust evidence to conclude that insoles enhance workplace output or efficiency.

3.4 Comparative Effectiveness: Custom vs. Standard Insoles

A key point of contention in the debate on orthopedic interventions is whether individually customized orthopedic insoles (ICOIs) offer significant advantages over standard or prefabricated insoles. From a cost-benefit and scalability perspective, this distinction is crucial for occupational health strategies in large organizations.

Across the reviewed studies, a number directly compared custom-made and standard insoles, often using outcomes such as pain relief, user comfort, foot pressure distribution, or biomechanical alignment. In most cases, ICOIs showed marginal improvements in fit and comfort, but objective health or work-related outcomes were either statistically insignificant or unmeasured (Yurt et al., 2019; Almeida et al., 2009).

Thomas et al. (2022) and Saeedi et al. (2024a) observed minor but non-significant differences in postural stability and pain reduction between custom and standard insole groups. Arslan et al. (2020) reported no productivity gain from using custom insoles over

standard ones in a military population. Meanwhile, Ishtiaque et al. (2022) and Jonnala et al. (2023) tested high-tech or 3D-printed custom designs but did not compare them with standard alternatives in terms of effectiveness.

Some systematic reviews (Moisan et al., 2022; Goniewicz et al., 2024) caution against overestimating the superiority of ICOIs, especially given their higher cost, need for individualized fitting, and longer production timelines. These reviews emphasize that for many occupational uses, high-quality prefabricated insoles may offer comparable benefits at a fraction of the logistical and financial investment.

Overall, the evidence does not consistently support the idea that ICOIs outperform standard insoles in occupational settings. While they may offer subjective comfort advantages, measurable differences in productivity, absenteeism, or functional performance remain largely unproven.

3.5 Implementation Factors

The effectiveness of individually customized orthopedic insoles (ICOIs) in workplace contexts depends not only on their biomechanical performance, but also on successful implementation. Numerous studies have highlighted practical, behavioral, and contextual barriers to widespread adoption in industrial settings.

One of the most frequently cited challenges is adherence. Several studies noted that participants did not consistently wear their insoles, especially over long periods or in harsh environmental conditions (Almeida et al., 2009; Arslan et al., 2020). In some trials, participants were unclear about usage instructions or received no follow-up support (Thomas et al., 2022), which negatively affected engagement and outcome reliability.

Other implementation-related variables include compatibility with work footwear, physical job demands, and cultural acceptance of ergonomic tools. Durak (2016) found that even well-designed insoles had limited real-world effects if not compatible with heavy-duty boots. Similarly, Jonnala et al. (2023) observed that advanced 3D-printed designs required specialized fitting, delaying deployment and adding complexity.

Time and resource constraints also impede scalability. Studies like Saeedi et al. (2024a) and Khaliliyan et al. (2025) highlight that producing and fitting custom insoles often require specialized equipment and clinical expertise. This makes implementation in large-scale industrial programs difficult without external partnerships.

The heterogeneity of protocols—ranging from insoles used for a few hours to those worn continuously for months—also complicates evaluation and comparison across studies. Moisan et al. (2022) and Sowah et al. (2018) call for standardized implementation procedures and better monitoring of compliance and user experience.

In summary, implementation barriers significantly influence the effectiveness and perceived value of ICOIs in occupational contexts. Without structured guidance, adherence support, and logistical integration, even technically effective insoles may fail to produce measurable workplace benefits.

4. Discussion

This systematic review set out to investigate whether individually customized orthopedic insoles (ICOIs) can meaningfully reduce sickness absence and improve productivity in industrial workplaces. The synthesis of 57 studies revealed substantial improvements in biomechanical alignment, physical comfort, and pain-related outcomes across diverse occupational settings. However, evidence that these benefits translate into measurable reductions of absenteeism or gains in productivity remains inconclusive.

Main Findings and Evidence Synthesis
Only a minority of studies directly assessed sickness absence or workplace productivity, and most reported no statistically significant improvements attributable solely to ICOIs. Where absenteeism was measured, results were often confounded by co-interventions, heterogeneous definitions, or reliance on self-reported data. Claims about productivity were typically theoretical or based on indirect proxies such as perceived work ability or energy expenditure. The lack of standardized outcome metrics and short follow-up periods limits the robustness and comparability of findings.

Interpretation in Light of Existing Research
These results are consistent with prior systematic reviews and meta-analyses, which have largely found that ICOIs improve subjective comfort and alleviate musculoskeletal complaints (Moisan et al., 2022; Goniewicz et al., 2024), but have not consistently demonstrated occupational or economic benefits in industrial contexts. Several recent reviews have questioned whether custom-made insoles offer distinct advantages over high-quality prefabricated alternatives, especially given logistical and cost-related constraints (Sowah et al., 2018; Almeida et al., 2009). The current evidence base suggests that ICOIs should not be viewed as a standalone solution but as a component within a broader ergonomic and occupational health strategy.

Practical Implications for Workplace Health
For practitioners and policy-makers, these results caution against overestimating the direct occupational impact of custom insoles. While ICOIs can form a useful part of multifaceted ergonomic programs—particularly for employees with standing-intensive roles or identified musculoskeletal risk—they are unlikely on their own to yield substantial reductions in sickness absence or increases in productivity. Decision-makers should focus on holistic interventions, including education, exercise, and workplace adaptation, and consider cost-effectiveness when deciding between customized and prefabricated insoles.

Methodological Limitations
This review faces several limitations inherent to both the underlying literature and the retrospective reconstruction of its own methodology. The included studies exhibited significant heterogeneity in terms of population, intervention protocols, and outcome measures. Many failed to isolate the effects of ICOIs from other ergonomic or clinical interventions, confounding attribution of changes in absenteeism or productivity. Furthermore, this review's selection process did not involve protocol preregistration or dual-independent screening, introducing potential selection bias and limiting reproducibility. The absence of meta-analysis was dictated by inconsistency of metrics and study designs.

Directions for Future Research
To advance the field, future studies should:

- Employ standardized definitions and validated measures for absenteeism and productivity.
- Use sufficiently powered, longitudinal real-world designs in industrial environments.
- Include cost-effectiveness analyses comparing custom and prefabricated insoles.
- Monitor adherence and implementation fidelity, and systematically report contextual barriers.

These steps will help clarify when and for whom ICOIs deliver the greatest value, supporting evidence-based workplace health policies.

5. Conclusions

This systematic review explored whether individually customized orthopedic insoles (ICOIs) reduce sickness absence and enhance productivity among industrial workers. The available evidence indicates that while ICOIs often improve physical comfort, alignment, and pain-related symptoms, there is no consistent empirical support for their direct effect on workplace attendance or job performance.
The findings show that improvements attributed to ICOIs are largely limited to subjective or biomechanical outcomes and rarely translate into measurable organizational benefits. Methodological heterogeneity, inconsistent outcome definitions, and a lack of high-quality, long-term studies further limit the strength and generalizability of conclusions.

In the current state of evidence, ICOIs should not be considered a stand-alone solution for occupational health improvement. Their value is likely greatest as part of a broader, multifactorial ergonomic and health promotion strategy. Decision-makers should weigh the cost-effectiveness of custom insoles against high-quality prefabricated alternatives, especially given limited workplace gains demonstrated to date.

Future work should prioritize well-powered, longitudinal research using standardized and validated metrics for productivity and absenteeism in real-world industrial settings. Such research will be critical to clarify the circumstances under which ICOIs deliver clear occupational benefits and to support evidence-based health policy and practice.

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Appendix A

Summary 57 Studies

ID	First Author	Year	Journal/Venue	Study Design	N	Direction	Key Finding
S01	Abdollahi	2024	Applied Ergonomics	Systematic review	27	N/R	The majority of studies (67%) focused on human activity recognition and gesture estimation using smart wearable insoles to enhance.
S02	Lee	2023	International Journal of Environmental Research and ...	Cross-sectional	N/R	+	The overall prevalence of WMSDs symptoms among construction workers in south China was 57.
S03	Ferrari	2013	Journal of Manipulative and Physiological Therapeutics	CCT	62	+	Patients with chronic low back pain following work-related injury showed greater improvement in short-term outcomes with customize.
S04	Durak	2016	N/R	Observational	N/R	N/R	The use of Power Step shoe inserts significantly reduced chronic pain levels in staff with Plantar Fasciitis over a period of seve.
S05	Ishtiaque	2022	IOP Conference Series: Earth and Environment	Pilot study	N/R	+	The pilot testing phase of the smart insole system showed that users found the technology easy to use but experienced discomfort w.
S06	Caravaggi	2016	Gait & Posture	RCT	17	+	Custom-made insoles (CUS) provided a more uniform pressure distribution across plantar regions compared to prefabricated (PSS) and.
S07	Mousavi	2019	Not specified	RCT	N/R	+	The combination of custom-made insoles and exercises significantly reduced discomfort in the lower back, thigh, and knee areas.
S08	Maher	2000	Australian Journal of Physiotherapy	Systematic review	13	+	Workplace exercise is effective in preventing low back pain.
S09	Avwata	2022	N/R	Observational	N/R	N/R	The study found a significant association between planning and safety performance, indicating that planning is crucial for improvi.
S10	Almeida	2009	Revista Brasileira de Fisioterapia	RCT	N/R	Mixed	There was no statistically significant difference in baropodometric data between custom and prefabricated insoles.
S11	Goniewicz	2024	N/R	SR & meta-analysis	N/R	N/R	Despite the variety in safety footwear, all studies consistently reported symptomatic discomfort and pain, with primary issues in .
S12	Jimenez	2021	Sustainability	Cross-sectional	N/R	+	The main musculoskeletal risk for truck and bus mechanics is associated with postures involving the trunk and arms, particularly s.
S13	Sundstrup	2024	N/R	Systematic review	N/R	Mixed	The study found moderate evidence that mental training does not benefit stress reduction among young workers.
S14	Silverstein	2004	Journal of Electromyography & Kinesiology	Systematic review	N/R	+	Combinations of measures are more effective in reducing WMSDs than single interventions.

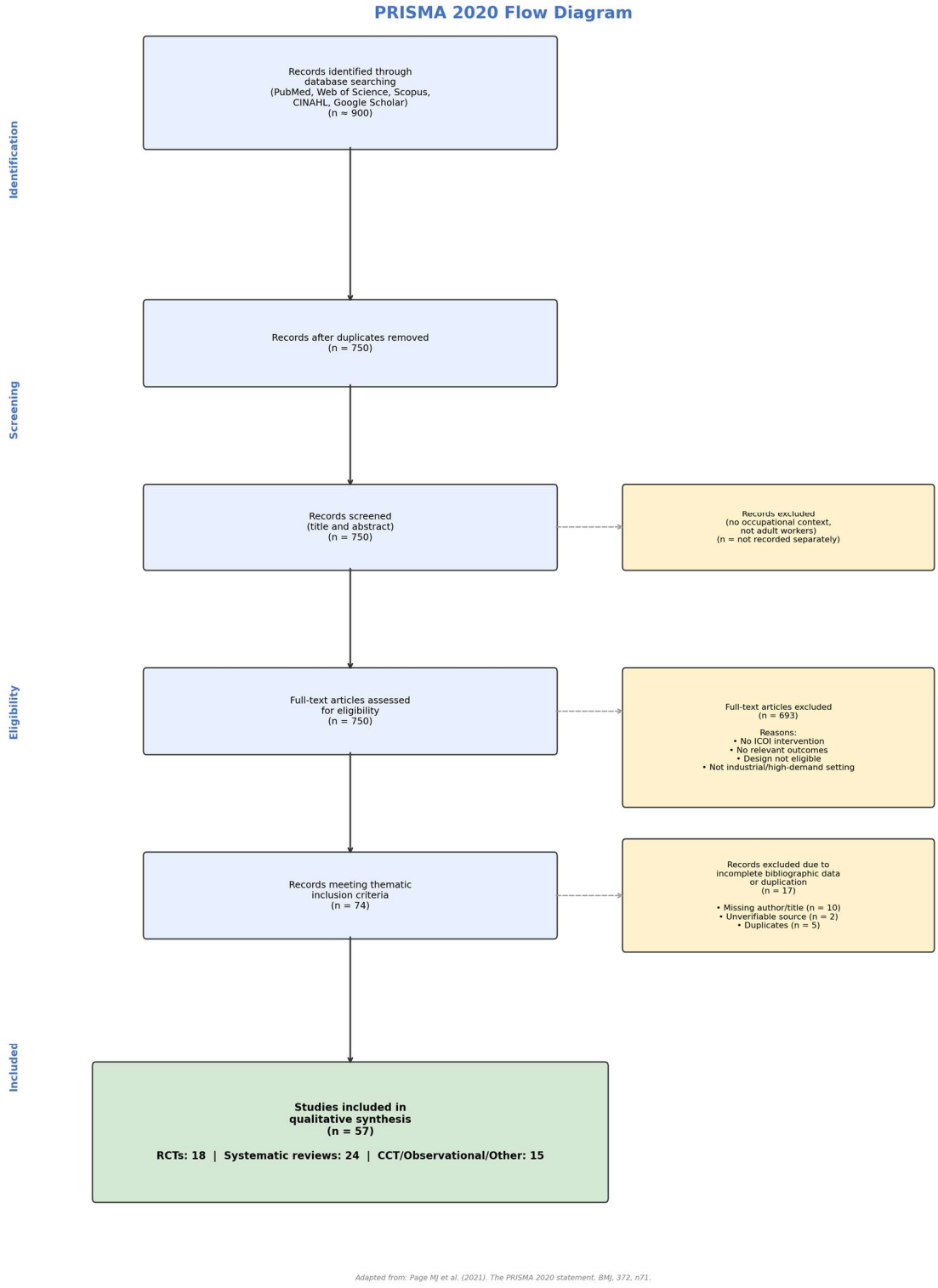
ID	First Author	Year	Journal/Venue	Study Design	N	Direction	Key Finding
S15	Almazán-Polo	2025	Journal of Clinical Medicine	SR & meta-analysis	N/R	+	Ergonomic interventions significantly reduced pain intensity, with a mean difference in VAS scores of -0.
S16	Thomas	2022	NIHR Open Research	RCT	N/R	+	The TREADON trial is a randomized controlled trial comparing the effectiveness of self-management advice alone versus combined wit.
S17	García-Hernández	2016	International Journal of Occupational Safety and Erg...	Longitudinal	N/R	+	Customized foot orthoses significantly improved musculoskeletal disorders in metal industry workers, with statistical significance.
S18	Rosenbaum	2024	Bachelor thesis	RCT	521	+	The majority of workplace health interventions for office workers showed a positive return on investment (ROI), with a median ROI .
S19	Kaun	2024	GKV Präventionsbericht	Report	N/R	+	The report provides an overview of health promotion and prevention activities by health insurance companies in community, occupati.
S20	Yurt	2019	European Journal of Physical and Rehabilitation Medi...	RCT	67	Mixed	Both CAD-CAM and conventional insoles significantly reduced pain intensity compared to the sham insole, with no significant differ.
S21	´de	2023	European Journal of Public Health	Observational	N/R	+	The majority of workplace-based prevention interventions (56.
S22	Alenjareghi	2025	Sensors International	Systematic review	N/R	+	Wearable sensors enhance workplace safety by providing real-time feedback, reducing ergonomic risks and improving productivity.
S23	Moisan	2022	Clinical Biomechanics	Systematic review	N/R	N/R	Foot orthoses decrease ankle inversion and increase midfoot plantar forces and pressure during low-impact tasks like step and stai.
S24	Speed	2018	Applied Ergonomics	Systematic review	N/R	Mixed	A moderate level of evidence supports the use of cushioned materials in reducing discomfort and fatigue among standing workers.
S25	Ahmad	2025	International Journal of Industrial Ergonomics	RCT	N/R	+	Inserts placed 2-4 cm anterior to the lateral midfoot region provided the highest comfort ratings.
S26	Ghasemi	2020	Applied Ergonomics	RCT	N/R	N/R	The study found significant differences in the activation and co-contraction indices of selected trunk muscles when using differen.
S27	Harutaichun	2023	Gait & Posture	SR & meta-analysis	N/R	+	Customized foot orthoses (CFOs) improve pathological biomechanics associated with plantar heel pain by reducing knee and forefoot .
S28	Kristanto	2020	The Foot	RCT	N/R	+	Foot pronation and knee valgus improved when rice farmers were equipped with corrective wedges, with improvements ranging from 5.
S29	Dobson	2019	Applied Ergonomics	RCT	N/R	Null	A boot with variable flexibility and stiffness between the shaft and sole is a better design option for reducing underground coal .

ID	First Author	Year	Journal/Venue	Study Design	N	Direction	Key Finding
S30	Tarrade	2019	Applied Ergonomics	SR & meta-analysis	N/R	+	Custom-made foot orthoses significantly reduced feelings of pain, discomfort, and heavy legs in prolonged standing workers.
S31	Dobson	2020	Applied Ergonomics	RCT (crossover)	N/R	Null	There were no significant effects of shaft stiffness or sole flexibility on perceived comfort.
S32	Saeedi	2024	The Foot	SR & meta-analysis	N/R	Mixed	The MUFO decreased mean lateral displacement in the initial phase and midstance of gait compared to barefoot walking, indicating e.
S33	Botelho	2021	Diabetes Epidemiology and Management	RCT	N/R	Mixed	No significant differences in quality of life were found between the standard footwear group and the orthopedic footwear group.
S34	Janson	2019	Procedia Manufacturing	Systematic review	N/R	+	The paper identifies a need for radical change in safety footwear due to poor comfort, fit, aesthetics, and lack of industry-speci.
S35	Khaliliyan	2025	Foot and Ankle Surgery	SR & meta-analysis	N/R	+	Orthotic interventions significantly improved clinical outcomes such as disability scores, pain intensity, and patient satisfactio.
S36	Swinnen	2009	Not specified	Systematic review	10	N/R	Between 6 and 80% of patients do not use their prescribed orthotic devices or orthopedic shoes.
S37	Jonnala	2023	Journal of The Mechanical Behavior of Biomedical Mat...	Observational	N/R	N/R	The gyroid structure used in orthotic insoles has a high specific energy absorption capability, making it suitable for cushioning .
S38	Papagiannaki	2024	Advances in Medical Sciences	CCT	10	N/R	The study found a statistically significant increase in IL-6 levels after the race, which is a pro-inflammatory marker associated .
S39	Stinus	2023	Not specified	Systematic review	N/R	+	Custom-made insoles are effective in treating foot, ankle, and lower leg deformities, as shown by biomechanical investigations.
S40	Chuter	2014	BMC Musculoskeletal Disorders	SR & meta-analysis	N/R	Null	There is insufficient evidence to support the use of insoles or foot orthoses as either a treatment for LBP or in the prevention o.
S41	Choi	2020	Foot and Ankle Surgery	CCT	N/R	Mixed	Significant changes in radiographic parameters were observed in the group treated with medial arch support insoles, but all values.
S42	Martines	2020	Journal of Bodywork & Movement Therapies	Systematic review	N/R	+	The use of foot orthoses is effective for pain, function, and quality of life in musculoskeletal disorders, but lacks standard eva.
S43	Choi	2020	Foot and Ankle Surgery	Systematic review	N/R	+	Randomized controlled trials and prospective cohort studies did not show significant structural improvements in the medial longitu.
S44	Paterson	2024	Osteoarthritis and Cartilage	Cross-sectional	N/R	N/R	No measure of static foot posture was associated with any knee pain measure in people with medial knee osteoarthritis.

ID	First Author	Year	Journal/Venue	Study Design	N	Direction	Key Finding
S45	Zafar	2019	Gait & Posture	Systematic review	N/R	+	The most beneficial characteristics of lateral wedge insoles for medial knee osteoarthritis include customization, full-length des.
S46	Sowah	2018	Journal of Safety Research	Systematic review	N/R	+	Exercise interventions, alone or combined with educational interventions, are effective in preventing low back pain (LBP) and redu.
S47	Jankaew	2023	Gait & Posture	Cross-sectional	20	+	The use of bilateral motion control shoes with outsole adjustment significantly reduced shoulder height differences and trunk rota.
S48	Hajizadeh	2021	Gait & Posture	RCT (crossover)	N/R	N/R	Associations were found between foot kinematics and pressure with regional foot orthosis (FO) deformation during walking.
S49	Ishii	2020	Knee (Oxford)	SR & meta-analysis	N/R	+	The use of a lateral wedge insole (LWI) for 3 months significantly decreased weight-bearing medial meniscus extrusion (MME) and th.
S50	Dami	2024	Gait & Posture	CCT	N/R	N/R	PTTD2 exhibited significant lower limb biomechanical gait differences compared to PTTD1 and healthy controls, characterized by gre.
S51	Kasai	2024	Gait & Posture	RCT (crossover)	33	N/R	Maximum plantarflexion angle significantly decreased and toe-out angle significantly increased with arch support insoles compared .
S52	Jafarnezhadgero	2024	Journal of Biomechanics	SR & meta-analysis	24	N/R	The meta-analysis showed significant effects of foot orthoses (FO) application on peak rearfoot eversion, peak ankle dorsiflexion,.
S53	Simonsen	2019	Human Movement Science	RCT (crossover)	N/R	N/R	The study demonstrated that induced pain in the TP muscle causes kinematic alterations in the hip and knee joints, but not in the .
S54	Arslan	2020	American Journal of Preventive Medicine	SR & meta-analysis	N/R	N/R	The study found some evidence supporting the preventive effect of shock-absorbing insoles, basketball shoes, padded polyester sock.
S55	Tai	2024	International Journal of Industrial Ergonomics	RCT	N/R	N/R	The high hardness arch-support insole with a soft forefoot pad (HHSF) showed higher perceived comfort scores and reduced foot pres.
S56	Reeves	2021	Journal of Biomechanics	RCT (crossover)	N/R	Null	Tibialis posterior muscle activity decreased in early stance with all foot orthoses, particularly with medial heel wedging, which .
S57	Hsu	2014	Journal of Biomechanics	RCT	15	N/R	Orthoses posted in both the forefoot and rearfoot reduced various kinetic and kinematic variables such as medial ground reaction f.

Appendix B

PRISMA FLOW 2020 Diagramm



Appendix C

Aggregated Bias Summary

Study Design	Low	Moderate	High	Total	Typical Limitations
CCT	0	4	0	4	No randomization, potential selection bias, no blinding
Cross-sectional	0	1	3	4	No causality, single time-point, self-report measures
Longitudinal	0	0	1	1	No randomization, no control group, self-report measures
Observational	0	1	3	4	No control group, uncontrolled confounders
Pilot study	0	0	1	1	Small sample, exploratory design, no control group
RCT	4	9	0	13	Small samples, short follow-up, unclear allocation concealment
RCT (crossover)	1	4	0	5	Potential carryover effects, short washout periods
Report	0	0	1	1	No empirical design, descriptive only
SR & meta-analysis	5	5	0	10	Heterogeneity of included studies, publication bias
Systematic review	2	12	0	14	Search strategy limitations, heterogeneous included studies

Individual Study Bias Assesement

ID	First Author	Year	Study Design	Risk of Bias	Key Reasons
S01	Abdollahi	2024	Systematic review	Moderate	Some methodological limitations
S02	Lee	2023	Cross-sectional	High	Self-report measures
S03	Ferrari	2013	CCT	Moderate	Non-randomized; No blinding
S04	Durak	2016	Observational	High	Non-randomized; No blinding; No control group
S05	Ishtiaque	2022	Pilot study	High	Non-randomized; No blinding; No control group
S06	Caravaggi	2016	RCT	Moderate	Small N (17); Self-report measures
S07	Mousavi	2019	RCT	Low	Adequate design, bias controls
S08	Maher	2000	Systematic review	Moderate	Small N (13); No blinding
S09	Avwata	2022	Observational	High	Self-report measures
S10	Almeida	2009	RCT	Low	Self-report measures
S11	Goniewicz	2024	SR & meta-analysis	Moderate	Self-report measures
S12	Jimenez	2021	Cross-sectional	Moderate	Some methodological limitations
S13	Sundstrup	2024	Systematic review	Moderate	Some methodological limitations
S14	Silverstein	2004	Systematic review	Moderate	Some methodological limitations
S15	Almazán-Polo	2025	SR & meta-analysis	Moderate	Some methodological limitations
S16	Thomas	2022	RCT	Moderate	Self-report measures; Small/pilot sample
S17	García-Hernández	2016	Longitudinal	High	Non-randomized; No control group; Self-report measures
S18	Rosenbaum	2024	RCT	Moderate	Small N (8)
S19	Kaun	2024	Report	High	Significant design limitations
S20	Yurt	2019	RCT	Moderate	Some methodological limitations
S21	´de	2023	Observational	Moderate	Some methodological limitations
S22	Alenjareghi	2025	Systematic review	Moderate	Some methodological limitations
S23	Moisan	2022	Systematic review	Low	Adequate design, bias controls

S24	Speed	2018	Systematic review	Moderate	Some methodological limitations
S25	Ahmad	2025	RCT	Low	Adequate design, bias controls
S26	Ghasemi	2020	RCT	Moderate	Some methodological limitations
S27	Harutaichun	2023	SR & meta-analysis	Low	No control group
S28	Kristanto	2020	RCT	Moderate	Some methodological limitations
S29	Dobson	2019	RCT	Moderate	Some methodological limitations
S30	Tarrade	2019	SR & meta-analysis	Moderate	Self-report measures
S31	Dobson	2020	RCT (crossover)	Low	Adequate design, bias controls
S32	Saeedi	2024	SR & meta-analysis	Low	Adequate design, bias controls
S33	Botelho	2021	RCT	Moderate	Self-report measures; Convenience sampling
S34	Janson	2019	Systematic review	Moderate	Some methodological limitations
S35	Khaliliyan	2025	SR & meta-analysis	Low	Adequate design, bias controls
S36	Swinnen	2009	Systematic review	Moderate	Small N (10)
S37	Jonnala	2023	Observational	High	Significant design limitations
S38	Papagiannaki	2024	CCT	Moderate	Non-randomized; No blinding
S39	Stinus	2023	Systematic review	Moderate	Some methodological limitations
S40	Chuter	2014	SR & meta-analysis	Low	Adequate design, bias controls
S41	Choi	2020	CCT	Moderate	Non-randomized
S42	Martines	2020	Systematic review	Moderate	Some methodological limitations
S43	Choi	2020	Systematic review	Moderate	Some methodological limitations
S44	Paterson	2024	Cross-sectional	High	Significant design limitations
S45	Zafar	2019	Systematic review	Low	Adequate design, bias controls
S46	Sowah	2018	Systematic review	Moderate	Some methodological limitations
S47	Jankaew	2023	Cross-sectional	High	Non-randomized; No blinding; No control group

S48	Hajizadeh	2021	RCT (crossover)	Moderate	Some methodological limitations
S49	Ishii	2020	SR & meta-analysis	Moderate	Non-randomized; No blinding
S50	Dami	2024	CCT	Moderate	Some methodological limitations
S51	Kasai	2024	RCT (crossover)	Moderate	Some methodological limitations
S52	Jafarnezhadgero	2024	SR & meta-analysis	Moderate	Some methodological limitations
S53	Simonsen	2019	RCT (crossover)	Moderate	Some methodological limitations
S54	Arslan	2020	SR & meta-analysis	Low	Adequate design, bias controls
S55	Tai	2024	RCT	Low	No blinding
S56	Reeves	2021	RCT (crossover)	Moderate	Some methodological limitations
S57	Hsu	2014	RCT	Moderate	Some methodological limitations