

## What are the Benefits of Five-Toed Socks? A Scoping Review

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### ABSTRACT

*Background.* The use of five-toed socks can be a valid prevention option against interdigital problems and a valuable sensory stimulus in walking. However, nowadays, they are hardly ever suggested because they are often little known or disregarded by clinicians dealing with podiatric problems.

*The aim.* This scoping review aims to map and summarise the literature to identify interventions using five-toed socks

*Methods.* Four databases were searched up to December 2022. Studies that considered the use of five-toed socks could be included. All interventions and contexts were considered. No restrictions were applied regarding language, study design and publication type. Grey literature and reference lists of included articles were not identified. The results were presented in numerical and thematic form.

*Results.* Out of 23 initially identified studies, only 4 met the inclusion criteria for this scoping review. The majority of the included articles were randomized controlled trials (RCTs) and involved participants of different ages, including both sporty and non-sporty individuals, who used five-toed socks as part of the intervention. It is worth noting that the authors focused solely on conservative interventions, with all 4 studies investigating the effects of wearing five-toed socks for more than one week.

*Conclusions.* This is the first scoping review to provide a comprehensive overview of the topic. The results revealed clear gaps in primary research, confirming that current management is based on knowledge of five-toed socks. This review may be useful for general management and may provide a starting point for future research.

**Keywords:** foot care, foot problems, five-toed socks, toes.

### INTRODUCTION

Socks are an indispensable garment in modern life and standard equipment in most forms of physical activity. There are many different types of footwear on the market today, such as shoes, orthotic insoles and ankle supports, to support individuals of various ages and pathological conditions during physical and non-physical activities (Nigg et al., 1999). However, limited attention has been paid to the influence of socks, and one particular type of sock of interest that may provide useful guidance is the five-toed sock. Over the years, five-toed socks with non-

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slip rubber on the sole of the foot have been marketed, and individuals practising yoga and/or Pilates seem to benefit from them by improving postural stability and balance during exercise due to their ability to open their toes in a radial pattern. Five-toed socks are very popular in Japan, especially among athletes and physical workers, for these same reasons (Shinohara & Gribble, 2013). Five-toed socks simulate a glove; some versions of the socks have multiple rubber tips on the non-slip material on the sole of the foot (Fig. 1). The multiple rubber spikes on the sole of the foot are believed to provide better balance by improving sensitivity and perception of the terrain, while offering a more stable foot grip; but there have been few controlled investigations to confirm these potential benefits. It is known that somatosensory inputs from the sole of the foot contribute to balance during standing (Meyer et al., 2004) and walking (Eils et al., 2004). It is known that reduced sensitivity of the sole of the foot, as a result of age-related degeneration or diabetic peripheral neuropathy, can produce significant instability in postural control with an increased risk of falling (Simmons et al., 1997). An initial investigation was conducted to examine the effect of wearing simple five-toed socks on static postural control among healthy young adults (Shinohara & Gribble, 2013). The authors hypothesized that static postural control would be improved due to the facilitated tactile sensation around the toes, but the five-toed socks did not provide a significant improvement in postural control compared to the use of plain socks and the no socks condition (Shinohara & Gribble, 2013). An initial investigation was conducted to examine the effect of wearing simple five-toed socks on static postural control among healthy young adults. One possible explanation for the lack of improvement in postural control with the use of simple five-toed socks is that the socks did not enhance tactile sensation enough to influence the CNS to improve postural control (Shinohara & Gribble, 2013); perhaps a larger area of the skin needs to be stimulated to alter the effects of postural control. While decreased sensitivity of the sole of the foot can negatively influence postural stability, several researchers have attempted to improve skin sensitivity of the sole of the foot by means of electrical stimulation and insoles to improve postural control.

Maki et al. (1999) reported that electrical stimulation applied to the sole of the foot improved postural control in healthy young adults and in elderly subjects. Priplata et al. (2003) suggest that subsensory mechanical noise applied to the sole of the foot via a vibrating insole can improve postural control in healthy and elderly individuals as well as in patients with diabetes and stroke (Priplata et al., 2006).

Corbin et al. (2007) reported an improvement in static postural control during bilateral stance using textured insoles in healthy subjects. The effectiveness of sandals with spiked insoles on postural control was studied by Palluel et al. (2008). They reported that the application of spiked insoles improved static postural

control in both elderly and young adults during two-legged stance tests. Similarly to these devices that are applied to the sole of the foot and toe area, potentially increasing the activation of skin receptors, five-toed socks with multiple rubber tips on the sole of the foot may be useful for improving balance by increasing the tactile sensation of the toes and sole of the foot, as well as improving grip on the ground. There is plenty of anecdotal evidence and speculative explanations to support the use of these socks (Corbin et al., 2007; Maki et al., 1999; Priplata et al., 2003). However, there is very limited scientific evidence of the efficacy of the socks to improve measures of performance, specifically postural control, as is the case for interdigital skin prevention.

Therefore, which conservative and preventive interventions five-toed socks may be indicated based on the available evidence, to the knowledge of the authors, no review has been conducted to answer this study question and, consequently, there is no comprehensive overview for both clinicians and researchers. In the context of healthcare, interventions refer to any action or measure taken to prevent, diagnose, or treat a health condition. Examples of interventions may include medication prescriptions, surgical procedures, physical therapy sessions, lifestyle modifications, and various types of therapy. In the context of the specific study mentioned, interventions refer to conservative and preventive measures related to the use of five-toed socks.

This study aimed to highlight and begin to fill this gap using a scoping review design. The synthesis of clinical data could add significant information for the overall management of healthy and unhealthy adults and could stimulate further research in this field.

As recommended by the Joanna Briggs Institute (JBI) (Peters et al., 2015), the scoping review approach can be used to map and clarify key concepts, identify gaps in the research knowledge base, and report on the types of evidence that address and inform practice in the field. These aims correspond to the objectives of this project. For this reason, other types of review, such as systematic reviews, umbrella reviews or rapid reviews, were not considered methodologically effective.

**This scoping review aimed to:** (1) Present a comprehensive overview of all studies dealing with interventions on the use of five-toed socks; (2) Identify any gaps in knowledge on the subject.

## METHODS

The present scoping review was conducted following the JBI methodology (Peters: *Joanna Briggs Institute Reviewer's Manual, JBI – Google Scholar*, n.d.) for scoping reviews. The Preferred Reporting Items for Systematic reviews and Me-

ta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018) Checklist for reporting was used.

**Research team.** To support robust and clinically relevant results, the research team included authors with expertise in evidence synthesis, quantitative and qualitative research methodology, sport and musculoskeletal rehabilitation.

**Review question.** We formulated the following research question: “What is known from the existing literature on the use of five-digit socks?” In the present research, the “use” of five-toed socks refers to the utilization of these socks as a conservative or preventive intervention to improve foot health or prevent potential pathologies. The “benefit” refers to the effectiveness of this intervention in achieving such results, such as reducing pain, increasing foot stability, preventing injuries.

**Eligibility criteria.** Studies were eligible for inclusion if they met the following Population, Concept, and Context (PCC) criteria.

*Population.* Subjects of any age who used five-toed socks with any type of discontinuation were included. As we only wanted to focus on this particular population subgroup, the definition of “five-digit socks” used in a single study was taken as the main criterion.

*Concept.* Any intervention (preventive, conservative, pharmacological), except surgical, was considered.

*Context.* This review considered studies conducted in any context. Types of evidence sources. This scoping review included any study design or type of publication. No time, geographic, setting or language restrictions applied.

**Exclusion criteria.** Studies that did not meet the specific PCC criteria were excluded.

**Search strategy.** An initial limited search of MEDLINE was performed through the PubMed interface to identify articles on the topic and then the index terms used to describe the articles were used to develop a comprehensive search strategy for MEDLINE. The search strategy, which included all identified keywords and index terms, was adapted for use in Cochrane Central, Scopus, PEDro. In addition, grey literature (e.g., Google Scholar, direct contacts with experts in the field) and reference lists of all relevant studies were also searched. Searches were conducted on 9 December 2022 with no date limitation.

**Study selection.** Once the search strategy was completed, search results were collated and imported to EndNote V.X9 (Clarivate Analytics). Duplicates were removed using the EndNote deduplicator before the file containing a set of unique records is made available to reviewers for further processing. The selection process consisted of two levels of screening using Rayyan QCRI online software<sup>12</sup>: (1) a

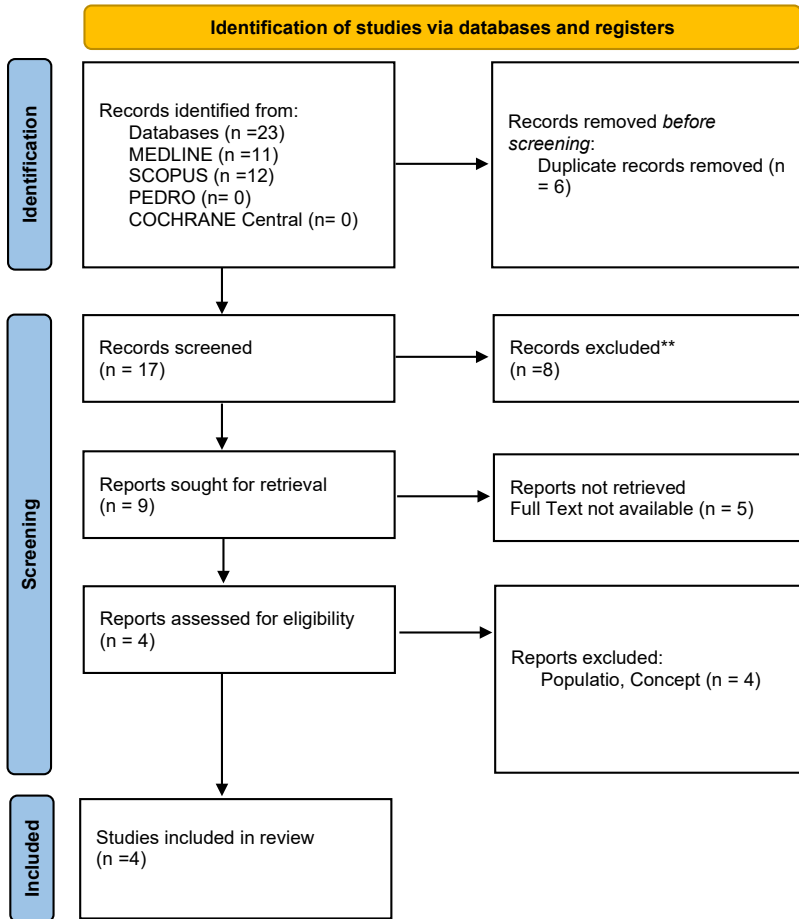
title and abstract screening and (2) a full-text selection. For both levels, two authors independently screened the articles with conflicts resolved by a third author.

The entire selection process and reasons for the exclusion were recorded and reported according to the latest published version of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA 2020) flow diagram.

**Data extraction and data synthesis.** Data extraction was conducted using an ad-hoc data extraction form which was developed a priori, based on the JBI data extraction tool. Key information (authors, country, year of publication, study design, patients characteristics, PFD, type of intervention and related procedures) on the selected articles were collected. Descriptive analyses were performed, and the results were presented in one way: numerically. Studies identified and included were reported as frequency and percentage, and the description of the search decision process was mapped. In addition, extracted data were summarized in tabular form according to the main characteristics.

## RESULTS

As presented in the PRISMA 2020-flow diagram (Figure 1), from 23 records identified by the initial literature searches, 19 were excluded and 4 articles were included.



**Figure 1 Preferred reporting items for systematic reviews and meta-analyses 2020 (PRISMA) flow-diagram**

Main characteristics of the included studies are presented in table 1. Three studies were performed in Japan, and one in Spain.

**Table 1. Main characteristics of the included studies**

No	Author	Title	Year	Country	Study design	Source of evidence	Level of performance
1	Shinoha J et al.	Effects of Five-Toed Socks on Static Postural Control Among Physically Active Young Adults	2011	Japan	Trial	Traditional	Not reported
2	Itano K	The Effects of Five-Toed Socks on Motor Neuron Pool Excitability in the Lower Leg	2011	Spain	Trial	Traditional	Not reported
3	Shinoha J et al.	Effects of five-toed socks with multiple rubber bits on the foot sole on static postural control in healthy young adult	2013	Japan	Trial	Traditional	Not reported
4	<a href="#">Fujii K</a>	Effect of foot care interventions for older adults using day care services	2019	Japan	Quasi-experimental study	Traditional	Not reported

Table 2. summarizes the data on subjects of different age groups who used the five-digit socks. In all articles, the authors defined the participants as active subjects, but the level of performance was not clearly reported. With regard to the use of the five-toed socks, postural stability was the most investigated. The quality of the skin, in the interdigital areas, was assessed by the study of Fujii K. (2019).

Table 2. Types of interventions

No.	Author, year	Intervention	
		PREVENTIVE	MORE DETAILS
1	Shinoha et al., 2011	Twelve men (mean age, 25.2±2.9 years; mean height, 177.0±8.6 cm; mean weight, 79.1±15.2 kg) and 9 women (mean age, 25.9±2.4 years; mean height, 162.5±2.4 cm; mean weight, 67.3±10.3 kg). Participants were physically active young adults, defined as individuals between the ages of 18 and 30 years who performed at least 30 minutes of moderate to high intensity physical activity, such as walking and jogging, more than twice a week.	All subjects were aged between 18 and 30 years, were physically active and had no history of musculoskeletal injuries neurological problems, vestibular disorders, concussions in the last 6 months, or any other condition that may affect postural control.
2	Itano K, 2011	14 subjects (5 males, 9 females; age 22.9±3.4 years; height 170.1±7.3 cm, weight 67.6±9.5 kg; BMI 23.4±3.5) performed the pre-condition balance test, pre-condition MNPE test, post-condition balance test and post-condition MNPE test. They repeated the trial on different days with randomly assigned sock conditions: five-finger socks with texture (FSG), five-finger socks without texture (FS), normal socks (RS) and no socks (NS).	The percentage changes in the H:M ratio between the previous and the next condition and the percentage changes in the center of pressure (COP) velocity between the previous and the next condition were analyzed.



No.	Author, year	Intervention	
		PREVENTIVE	MORE DETAILS
3	Shinoha et al., 2013	26 healthy adults (9 males, 17 females; $22.8 \pm 3.1$ years, $169.8 \pm 9.2$ cm, $68.2 \pm 12.0$ kg) were recruited. All subjects were aged between 18 and 30 years, were physically active and had no history of musculoskeletal injuries neurological problems, vestibular disorders, concussions in the last 6 months, or any other condition that may affect postural control.	The subjects presented themselves in the lab on three separate test days, one week apart. Each day involved one of three sock conditions: wearing five-toed socks with multiple toes on the sole of the foot (FS), normal socks (RS) and no socks (NS), in a randomized order. Static postural control was assessed on the force plate with subjects assuming a single-limb posture with eyes open (EO) and eyes closed and shut (EC) and with hands on the iliac crests.
4	Fujii K, 2019	18 subjects recruited, divided into three groups: medical foot care intervention, combined intervention and control. The experimental group received treatment once a week. The control group received regular treatment. The combined intervention group received foot care twice a month. After bathing, the participants wore five-toed socks, which were applied with the assistance of nurses.	Medical foot care was provided by the author and included nail care with a nail grinder and nail clipper, removal of calluses with a nail grinder, a foot bath, foot and toe massages and application of ointments. The author acquired the methods used in the process of obtaining a German foot care method known as <i>Fußpflege</i> . The entire process took about 20 minutes and was conducted twice a month. The gentle massage, which focused on the flexibility of the toes and ankles, took 5–10 minutes and was carried out once a week.

Table 3 summarizes the main characteristics of the studies. They are almost all randomized controlled trials, except for one which is a quasi-experimental study. However, most of the subjects were female and the intervention was always, the wearing of five-toed socks. To date, there are no active study protocols. The subjects of the studies and the studies themselves for the most part were recruited in Japan, only one in Spain.

Table. 3. **Summary of main characteristics of included studies**

<b>Variable</b>	<b>No of Studies</b>
<b>Year of Publication</b>	
2011	1
2011	1
2013	1
2019	1
<b>Study design</b>	
Randomized controlled trial	3
Quasi experimtal study	1
<b>Interventions</b>	
Preventive	4
<b>Sex</b>	
Female	52
Male	27
<b>Use of five-toed socks</b>	4

## DISCUSSION

In this study, the authors conducted a scoping review to summarize the available literature on the use of five-toed socks in both healthy and unhealthy individuals engaged in various sports and non-sports activities. Out of the four articles included in the review, the majority of them focused on the effect of wearing five-toed socks on postural stability.

As other authors have already pointed out, numerous studies have been published on the importance of shoes or orthotics to improve postural stability (Eils et al., 2002, 2004) and how intact skin on the feet is very important for preventive purposes (Flint & Cain, 2014; Havlickova et al., 2008) making these one of the most frequent forms of infection. Pathogens responsible for skin mycoses are primarily anthropophilic and zoophilic dermatophytes from the genera *Trichophyton*

(T.). However, research on the use of five-toed socks is still scarce. The present scoping review confirmed that only a few authors have evaluated the effectiveness of using five-toed socks. In particular, only four primary studies evaluating the effectiveness of the preventive approach are currently available. The studies analyzed indicate that the use of five-toe socks could improve postural stability. Shinoha et al. (2011) did not show that socks with five toes and grip under the sole improved dynamic postural stability compared to subjects using normal socks or no socks, this measured by comparing the three groups with the Star Excursion Balance Test (SEBT) and force plate, with non-significant values in all directions of the test.

Itano K. (2011) conducted a study with a similar population and measures to Shinoha et al. (2011), and found no significant results. However, Shinoha et al. (2013) increased the sample size and used Matlab Software to calculate pressure center excursion and speed, and found that healthy young adults had improved static postural control with the use of five-toed socks with rubber tips under the plant. Fujii K. (2019) evaluated 18 elderly subjects and found that the socks were effective in preventing skin problems caused by humidity and adhesion between the toes, and improved blood flow and joint range of motion.

Overall, the findings of this scoping review suggest that the use of socks with separated toes may have potential benefits in certain populations, such as those with balance issues or skin maceration. However, the limited number of studies and the heterogeneity of the populations and interventions included in this review highlight the need for further research in this area. Future studies should aim to include larger sample sizes, standardized outcome measures, and control groups in order to better understand the effectiveness and potential limitations of using socks with separated toes for various conditions. Clinicians should also consider individual patient factors and preferences when recommending these socks as an intervention. Ultimately, while the current evidence suggests potential benefits of using socks with separated toes, further research is needed to fully establish their effectiveness and guide clinical practice.

Patients with mild imbalance and individuals experiencing skin maceration and increased humidity on their toes may benefit from using socks with separated toes to prevent and improve these issues. However, it is crucial to conduct an individual evaluation and develop a personalized intervention plan based on the patient's specific needs. The management should be tailored to the individual, and further high-quality research is needed to provide better guidance for clinical practice and address current gaps in knowledge. It is important to note that the suggestions provided are not recommendations or tests. Scoping reviews are not intended to

develop reliable clinical guidelines or recommendations, but rather offer practical implications based on a clinical perspective.

As far as we know, this is the first study to map and summarize literature to identify the interventions that use socks with the five fingers as an integrated treatment. We used a discovery review design. We responded to a relevant research application by identifying the volume and distribution of the test base. We also mapped the key concepts and research priorities within literature.

Although it is for different reviews (11), we have not evaluated the methodological quality of the individual studies and it is not possible to draw conclusions on the interventions of the effects of the use of the socks with the five fingers, we provided an overview, the most complete, it should be emphasized that this is a tool that can be used by any person and that its content is not further defined. Consequently, the results of the previous existing studies cannot be verified independently.

## CONCLUSIONS

Based on the findings of this scoping review, it can be concluded that the use of socks with five fingers may have potential benefits in preventing and managing foot-related issues such as blisters, ulcers, and pressure points. However, there is a lack of high-quality research on this topic, and the existing studies have several limitations, including small sample sizes, variations in study design and methodology, and inadequate reporting of results. Therefore, further research is needed to determine the effectiveness and optimal use of socks with five fingers for preventive and therapeutic purposes. Additionally, a multidisciplinary approach that takes into account individual characteristics and sport-related variables is essential for effective management of foot-related issues in athletes and non-athletic populations. Ultimately, more research is needed to better understand the potential benefits and limitations of socks with five fingers in clinical practice.

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## CONFLICT OF INTERESTS

The authors are doctoral students, clinicians, who have no financial relationships with organisations that might have an interest in the work presented in the last

3 years and have no other relationships or activities that might influence the work presented.

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## Kuo naudingos pirštuotos kojinės? Literatūros apžvalga

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### SANTRAUKA

*Ivadas.* Pirštuotų kojinių naudojimas gali būti tinkama tarpupirščių problemų prevencijos priemonė ir vertingas jutimo stimuliavimas vaikstant. Tačiau pastaruoju metu šios kojinės pacientams siūlomos retai, nes gydytojai, dirbantys su podiatrijos problemomis, dažnai neturi žinių apie šias kojines arba šių žinių nepaiso.

*Tikslas* – sudaryti ir apibendrinti literatūrą, kad būtų galima nustatyti intervencijas naudojant pirštuotas kojines.

*Metodai.* Duomenų iki 2022 m. gruodžio mėnesio buvo ieškoma keturiuose duomenų bazėse. Įtraukti tyrimai, kuriuose buvo aprašomas pirštuotų kojinių naudojimas. Buvo atsižvelgta į visas intervencijas ir kontekstus. Kalbos, studijų dizaino ir publikacijos tipo apribojimai nebuvo taikomi. Literatūra, kuri parengta ne komercinių leidėjų, ir įtrauktų straipsnių nuorodų sąrašai nebuvo aprašyti. Rezultatai buvo pateikti skaitine ir temine forma.

*Rezultatai.* Iš 23 iš pirmųjų nustatytų tyrimų tik keturi atitiko įtraukimo kriterijus į šią apimties apžvalgą. Dauguma įtrauktų straipsnių buvo atsitiktinių imčių kontroliniai tyrimai (RCT), kuriuose dalyvavo įvairaus amžiaus dalyviai, įskaitant sportuojančius ir nesportuojančius asmenis, kurie kaip intervencijos dalį nešiojo pirštuotas kojines. Verta paminėti, kad autoriai sutelkė dėmesį tik į konservatyvias intervencijas, o visi keturi tyrimai tyrė pirštuotų kojinių dėvėjimo ilgiau nei vieną savaitę poveikį.

*Išvados.* Tai pirmoji literatūros apžvalga, kurioje pateikiama išsami temos apžvalga. Rezultatai rodo aiškias pirminių tyrimų spragas, patvirtinančias, kad dabartinis tyrimo pritaikymas pagrįstas žiniomis apie pirštuotas kojines. Ši apžvalga gali būti naudinga bendrajam tyrimo pritaikymui ir gali būti atspirties tašku būsimiems tyrimams.

**Raktažodžiai:** pėdų priežiūra, pėdų problemos, pirštuotos kojinės, pirštai.

*Gauta 2023 01 27*

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