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Foot Arch in Indonesia: A Narrative Review

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Abstract: Research on the plantar segment has been conducted worldwide. Individuals who do not experience foot pain or problems often do not examine their feet and are unaware of their foot arch type. Various methods exist for obtaining footprints and determining foot arch types. However, studies and records related to foot arch research in Indonesia remain limited. The aim of this study is to collect data on foot arch types in the Indonesian population and to provide recommendations based on the identified foot arch types. This narrative literature review involved a comprehensive search of five databases: Medline, PubMed, SciELO, PEDro, and Google Scholar. The review included all articles published up to September 15, 2021. The selected studies were evaluated based on the following criteria: focus on human foot arches, relevance to the Indonesian population, clearly defined subject criteria, detailed methods for obtaining footprints, and thorough techniques for determining foot arch types. The review identified 11 studies that met all eligibility criteria. A normal foot arch was the most common, observed in 72.73% of cases. A low foot arch is associated with reduced physical fitness and physiological performance. This review may serve as valuable epidemiological evidence and provide a foundation for future research and therapeutic approaches related to foot arch abnormalities. The use of customized insoles may offer an effective solution for individuals with abnormal foot arches. A normal foot arch is the most prevalent type among



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the Indonesian population. Customized insoles may be beneficial for individuals with foot arch abnormalities.

Keywords: Foot Arch, Plantar, Recommendation, Physiology, Insole.

印度尼西亚的足弓：叙述性回顾

摘要：全球范围内已开展了针对足底的研究。没有足部疼痛或其他问题的人通常不会检查自己的足部，也不了解自己的足弓类型。目前有多种方法可以获取足印并确定足弓类型。然而，在印度尼西亚，与足弓研究相关的研究和记录仍然有限。本研究旨在收集印度尼西亚人群的足弓类型数据，并根据已确定的足弓类型提供建议。这篇叙述性文献综述全面检索了五个数据库：Medline、PubMed、SciELO、PEDro 和 Google Scholar。综述涵盖了截至 2021 年 9 月 15 日发表的所有文章。所选研究的评估标准如下：关注人类足弓、与印度尼西亚人群的相关性、明确的研究对象标准、详细的足印获取方法以及完善的足弓类型确定技术。综述共纳入 11 篇符合所有纳入标准的研究。其中，正常足弓最为常见，占 72.73%。低足弓与体能素质和生理机能下降相关。本综述可作为宝贵的流行病学证据，并为未来与足弓异常相关的研究和治疗方法奠定基础。定制鞋垫的使用可能为足弓异常患者提供有效的解决方案。正常足弓是印度尼西亚人群中最常见的足弓类型。定制鞋垫可能对足弓异常患者有益。

关键词：足弓、足底、建议、生理学、鞋垫。

1. Introduction

The foot consists of 26 bones, 30 joints, 30 muscles, and more than 100 ligaments, all working together to enable efficient movement. The foot plays a crucial role in the function of the lower extremity. It supports the body's weight during standing and movement. Additionally, the foot adapts when contacting uneven surfaces and acts as a shock absorber to mitigate pressure from surface contact [1], [2], [3].

The foot has several key characteristics, including foot length, width, height, and the foot arch. It features three distinct arches: the medial longitudinal arch, the lateral longitudinal arch, and the transverse arch [1]. The medial longitudinal arch is the longest and highest of these three arches, playing a critical role in adapting to surface variations, absorbing pressure, supporting weight, and acting as a lever mechanism for propulsion [2]. The lever function for propulsion relies on the bony structure of the three arches, ligaments, fascia, and dynamic muscle contractions [1].

Normal foot arches provide optimal support for physical activities. Low foot arches tend to over-

pronate, causing excessive movement, where much of the plantar surface contacts the ground and weakens the medial side. High foot arches are characterized by limited contact with the surface in the central area, and they exhibit little to no inversion or eversion movement when standing, which leads to poor pressure absorption [1]. Individuals can be classified based on the height of the medial longitudinal arch into three categories: normal foot arch, high foot arch (pes cavus), and low foot arch (pes planus). Foot arches can also be classified as either rigid or flexible [1], [2].

The medial longitudinal arch of the foot, commonly known as the foot arch, is important because it helps protect the foot from injury [4], [5]. A study conducted on 166 runners found that 71.4% of high foot arches were associated with a greater tendency for injury [6]. The foot arch continues to develop in children but stabilizes in adults, so it is essential to clearly define the appropriate age group for study [7], [8], [9]. Research on foot arches has evolved from studying foot characteristics to the development of footwear for various populations and specific sports [10], [11], [12].

Footwear insoles have typically been designed for individuals with a normal foot arch. The insole is tailored for people with a normal foot arch because this arch type is considered ideal for performing foot physiological tasks, ensuring comfort, and supporting performance [1], [2]. The aim of this study is to collect foot arch data from the Indonesian population and provide recommendations based on the identified foot arch types.

2. Method

Search Strategy

The search was conducted across five databases: Medline, PubMed, SciELO, PEDro, and Google Scholar, including all articles published up to September 15, 2021. Keywords, including Medical Subject Headings (MeSH) terms, were used. The MeSH terms applied were “foot arch” and “Indonesia.”

All keywords were searched within titles and abstracts and were written in English.

Eligibility Criteria

To be included in this review, studies had to meet the following eligibility criteria: focus on human foot arches, involve the Indonesian population, specify clear subject criteria, provide detailed methods for obtaining footprints, and describe methods for determining foot arch type. Studies could be written in either English or Indonesian.

Data Extraction and Analysis

Data extraction was performed by three researchers who independently reviewed the titles and abstracts, followed by full-text reviews based on the eligibility criteria. Any disagreements were resolved through discussion.

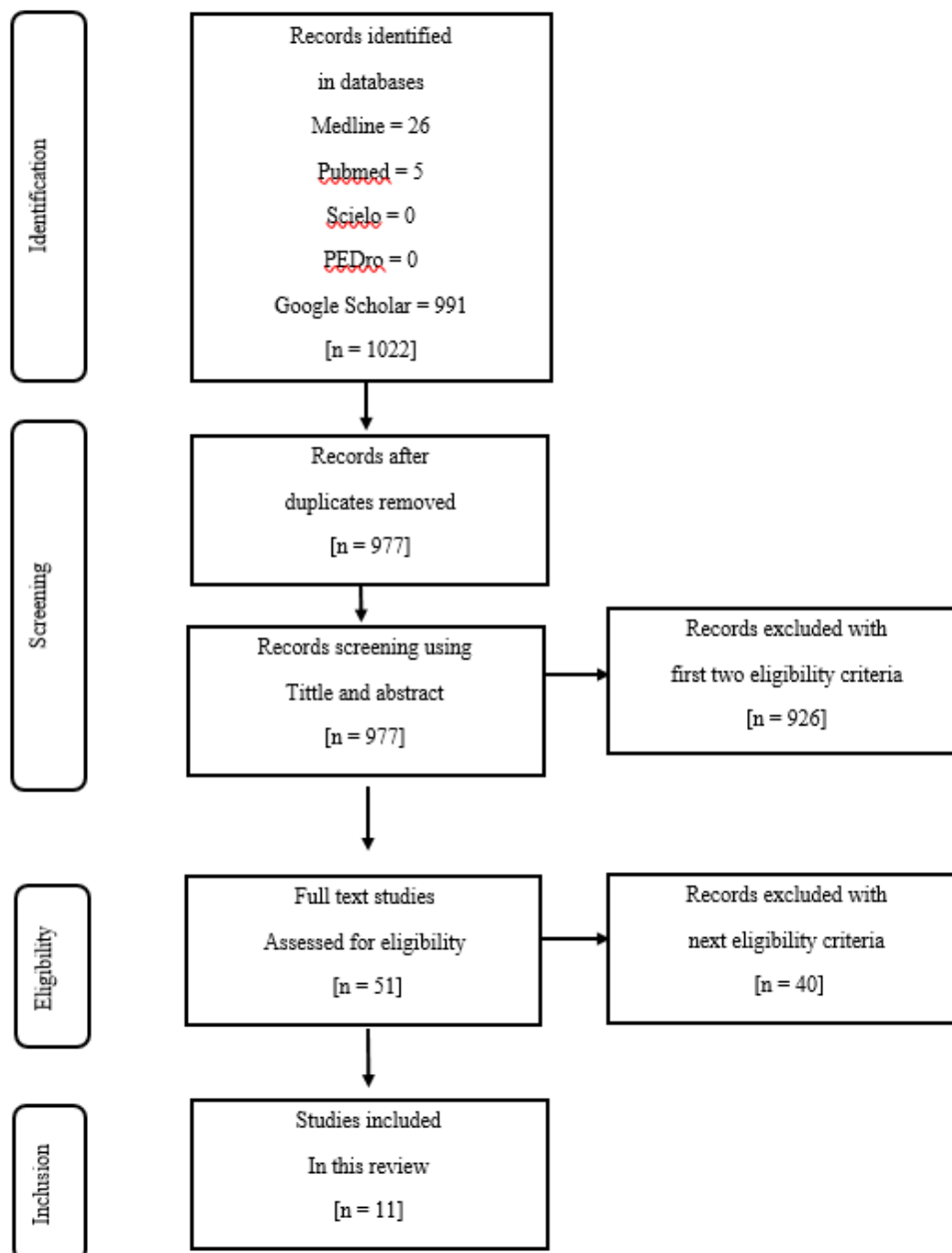


Figure 1. Flowchart detailing systematic search, screening, eligibility and inclusion procedure.

3. Results and Discussion

Initially, a total of 1,022 studies were identified across the different databases. After eliminating 45 duplicates, 977 studies remained for screening based on titles and abstracts. Following this screening, 51 studies were reviewed in full text, while 926 studies were excluded according to the eligibility criteria, which focused on studies of the human foot arch and studies involving the Indonesian population. Ultimately, 11 studies were included in this review.

Discussion

Foot arch research in Indonesia was recorded from 2007 to 2021. The sample sizes varied from 31 to 1,920 subjects. The youngest subject was 5 years old, and the oldest was 86 years old. More specifically, 7 studies (63.64%) focused on children, while 4 studies (36.36%) focused on adults. Research involving children primarily investigated the incidence of flatfoot and the development of the foot arch during growth. Studies involving adults provide valuable data that can contribute to the country's foot arch database.

Table 1. Characteristics of foot arch research in Indonesia

No.	Title, Author, Year	Subject Age, Number	Foot Print	Foot Arch Determination	Result	Additional Data
1	The Relationship between Low Arch with the Level of Endurance Ability in Prospective Pilgrims, Lutfie SH, 2007	28-86 years, 1920 subjects	Wet footprint	Visual foot axis	Normal 89.5% Low 10.2% High 0.3%	Endurance
2	Foot Arch and Plantar Pressure in the Age of 17-21 Years, Wicaksono et al, 2013	17-21 years, 100 subjects	Plantar Scanner	Visual foot axis	Normal 89% Low 4% High 7%	Plantar pressure
3	The Relationship between Body Mass Index and Foot Arch in Medical Study Program Students, Faculty of Medicine Universitas Tanjungpura Class of 2012, Willim et al, 2015	20-23 years, 51 subjects	Wet footprint	Visual foot axis	Right Normal 53% Low 39.2% High 7.8% Left Normal 49% Low 47% High 4%	Body Mass Index
4	Footwear Usage in Children with Flatfoot Disorder in Sukajadi Sub-district, Bandung, Mayasari et al, 2015	6-10 years, 73 subjects	Wet footprint	Arch Index	Normal 45.2% Low 54.8%	footwear usage
5	Relationship between Nutritional Status and Flat Foot in Children, Fung et al, 2015	9-12 years, 259 subjects	Wet footprint	Chippaux-smirak index	Normal 60.2% Low 39.8%	Nutritional status
6	The Relationship between the Arch of the Foot and Agility, Sahri et al, 2017	Under 10 years, 42 subjects	Wet footprint	Clarke's angle	Normal 47.6% Low 52.4%	Agility
7	Correlation Between Body Mass Index and Medial Longitudinal Arch of The Foot in Children Aged 5-6 Years,	5-6 years, 31 subjects	Wet footprint	Clarke's angle	Normal 64.5% Low 35.5%	Body Mass Index

	Rejeki et al, 2017					
8	Correlation of Loaded and Unloaded Foot Area with Arch Index in Younger Flatfoot, Wibowo et al, 2018	17-26 years, 102 subjects	3D Scanner Mini	Arch Index	Normal 30% Low 62% High 8%	Loaded foot area
9	Flat foot at 5 to 6 years old and History of Delayed Walking, Octavius et al, 2018	5-6 years, 120 subjects	Wet footprint	Visual foot axis	Normal 65.8% Low 34.2%	History of delayed walking
10	The Relationship between Flat Foot Posture and Static Balance in Children Aged 12 years, latifah et al, 2019	12 years, 51 subjects	Wet footprint	Clarke's angle	Normal 54.9% Low 45.1%	static balance
11	Flat Foot and Lower Limb Muscle Activation among 12 Years Old Children, Naufal et al, 2021	12 years, 40 subjects	Wet footprint	Clarke's angle	Normal 45% Low 37.5% High 17.5%	Lower limb muscle activation

Most of the research was conducted on the island of Java [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], with only one study conducted on the island of Kalimantan [23]. In obtaining footprints, 9 studies (81.82%) used the wet footprint method [13], [15], [16], [17], [18], [23], while 2 studies (18.18%) used a scanning tool [14], [19]. The wet footprint method is a simple technique where subjects stand on a wet, solid surface and then step onto a prepared sheet of paper to leave an imprint. Advances in technology now allow for the use of scanners, which are connected to a computer, to capture detailed images of specific body regions, including the feet.

Foot arch type can be determined using several different methods. In this review:

- 4 studies (36.36%) used the visual foot axis method [13], [14], [23],
- 4 studies (36.36%) used Clarke's Angle method [15], [17], [21], [22],
- 2 studies used the Arch Index method [15], [19], and
- 1 study used the Chippaux-Smirak Index method [16].

The visual foot axis method focuses on the midfoot area in relation to the foot axis. Clarke's Angle method measures specific angles, the Arch Index method assesses foot area ratios, and the Chippaux-Smirak Index method compares two lines on the footprint. All methods are considered valid for determining foot arch type. The visual foot axis method is the simplest and

most practical, and researchers may choose to use one or more methods simultaneously.

Normal foot arches were the most commonly reported type in this review. Eight studies [13], [14], [16], [18], [20], [21], [22], [23] found that normal arches were the most prevalent, ranging from 49% to 89.5%. In contrast, three studies [15], [17], [19] reported low arches as the dominant type, with proportions ranging from 52.4% to 62%, while normal arches accounted for 30% to 47.6% in those studies.

Among the studies showing a dominance of normal arches, three involved adult populations [13], [14], [23] and five involved children (17, 19, 21–23). Research in adults revealed interesting findings, such as:

- Low arches may decrease endurance ability in prospective pilgrims [13],
- No significant difference was found between right and left foot plantar pressure [14], and
- Higher body mass index (BMI) was associated with an increased incidence of low foot arches [23].

Meanwhile, findings from studies of children with dominant normal arches included:

- Children with overnutrition were more prone to developing low arches [16],
- No correlation was found between BMI and foot arch type [18],
- Low arches were associated with delayed walking [20],
- Low arches were linked to decreased static balance

ability [21], and

- e. No correlation was found between foot arch type and lower limb muscle activation [22].

The three studies reporting dominance of low arches included two studies on children [15], [17] and one on adults [19]. Findings from the children's studies noted:

- a. Footwear usage affected foot arch development [15], and
b. Low arches were associated with decreased agility [17].

The adult study found that low foot arches could be effectively determined using a foot area ratio method [19].

Normal foot arches, which were predominantly found in this review, provide optimal support for various physical activities. Individuals with a normal foot arch tend to experience greater comfort and better performance in both daily and athletic activities [1], [2]. In contrast, low foot arches tend to exhibit excessive motion, with most of the plantar surface contacting the ground, leading to weakening of the medial side of the foot [1]. In this review, individuals with low foot arches were associated with decreased endurance [13], reduced static balance [21], diminished agility [17], and an increased incidence of delayed walking [20].

It appears that having a low foot arch can result in reduced comfort and impaired physiological function. Low arches can be managed with the use of pads or insoles in footwear. Standard insoles are typically designed for individuals with normal foot arches, as the normal arch is considered ideal for performing foot physiological tasks, providing comfort, and supporting optimal performance [1], [2].

However, insoles can be customized based on an individual's specific foot arch type to enhance comfort and improve performance. Properly fitted insoles help support abnormal foot arches by optimizing the function of surrounding anatomical structures, thereby improving the biomechanics of locomotion. This can lower the pressure on the feet and reduce the amount of energy required for movement [1], [24].

The use of insoles for individuals with low foot arches should ideally be guided by a medical evaluation to correctly diagnose the arch type. A proper diagnosis ensures the prescription of the most appropriate insole to address the individual's specific needs [25].

4. Conclusion

Normal foot arches were the dominant type found in this review. However, individuals with low foot arches are more prone to decreased fitness levels and impaired physiological abilities. This review provides valuable epidemiological support and can serve as a foundation for further research and the development of therapies for foot arch abnormalities. The use of

customized insoles may offer an effective solution for individuals with foot arch abnormalities.

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