JOURNAL OF BASHIR INSTITUTE OF HEALTH SCIENCES

RESEARCH ARTICLE

OPEN ACCESS

ARTICLE INFO
Date Received:
June 14, 2024
Date Revised:
December 04, 2024
Date Published Online
December 30, 2024

Prevalence of Pes Planus Among Army Soldiers of Rawalpindi and Islamabad Due to Prolong Standing and Heavy Equipment Utility

[a]Haseeb Muhammad Khan, [b]Muhammad Taimoor ul Hassan Javed, [c]Anam Javed, [d]Aqsa Nadeem, [e]Ayesha Haleem, [f]Syed Ali shah, [g]Ubaid Ur Rheman

[a]*Assistant Professor at Department of Rehabilitation Sciences, Bashir Institute of Health Sciences, Bhara Kahu, Islamabad, Pakistan*
[b]*Senior Lecturer at Department of Rehabilitation Sciences, Bashir Institute of Health Sciences, Bhara Kahu, Islamabad, Pakistan*
[c]*Assistant Professor at Department of Rehabilitation Sciences, Bashir Institute of Health Sciences, Bhara Kahu, Islamabad, Pakistan*
[d]*Physiotherapist at CDA hospital, Islamabad, Pakistan*
[e]*House officer Hazrat Bari Imam Sarkar (HBS) General Hospital, Islamabad, Pakistan*
[f]*Physiotherapist Ali Therapy Center Islamabad, Pakistan*
[g]*Graduate Student of Department of Rehabilitation Sciences, Bashir Institute of Health Sciences, Bhara Kahu, Islamabad, Pakistan*

*CORRESPONDENCE
Haseeb Muhammad Khan
Assistant Professor at the Department of Rehabilitation Sciences, Bashir Institute of Health Sciences, Bhara Kahu, Islamabad, Pakistan
E-mail: haceebdpt@yahoo.com
Phone: +92- 346 9368855

ABSTRACT

Background: Pes planus, commonly known as flat feet, is a condition where the arch of the foot collapses, leading to a flattened sole. This study aimed to determine the prevalence of pes planus among army soldiers and investigate its association with prolonged standing and heavy equipment utility. Understanding these factors is critical for implementing preventive measures to reduce the risk of this condition among soldiers, who often endure extensive physical demands. **Methods:** A cross-sectional study was conducted over six months in various army units in Rawalpindi and Islamabad, involving 230 male soldiers aged 25-35 years. Participants were selected using non-probability convenience sampling and had standing duties lasting 4-8 hours while regularly carrying weights of 3 kg or more. Data collection included physical examinations, footprint assessments, and a structured questionnaire. Necessary permissions were obtained from relevant ethical review boards. Data analysis involved SPSS version 27, with frequency charts, and multiple regression analyses to assess the relationship between pes planus and occupational activities. **Results:** The study population primarily consisted of young soldiers (59% aged 20-30 years). Regarding rank, the largest group was Sepoy (37%), and 53% had served between 6-10 years. Most soldiers (61%) carried heavy equipment weighing 21-25 kg, and 63% had standing duties of 6 hours. The prevalence of pes planus was found to be 15% among soldiers. Symptoms associated with pes planus included pain on use (44.3%), swelling (44.3%), and characteristic calluses (24.3%). Multiple regression analysis revealed that the weight of the equipment carried during standing hours had a significant positive relationship with pes planus development (beta=0.609, R^2=0.371, p<0.001), while daily standing hours showed a weaker, non-significant trend (beta=0.109, R^2=0.010, p=0.057). **Conclusion:** The study identified a significant prevalence of pes planus among army

soldiers, with heavy equipment utility being a critical factor. Prolonged standing also contributed to the risk, albeit to a lesser extent. These findings underscore the need for preventive measures, such as reducing equipment weight and providing ergonomic support, to mitigate the development of pes planus and enhance soldiers' foot health.

Keywords: Pes Planus, Flat Feet, Army Soldiers, Heavy Equipment, Prolonged Standing, Foot Health

INTRODUCTION

The foot deformity known as pes planus, or flat feet, is a common one that is characterized by the lack of normal medial longitudinal arch where the foot touches or almost touches the ground [1, 2]. The ligaments, tendons, and fascia that link the forefoot and hindfoot form the strong, flexible arch of the foot. The spring ligament, medial talocalcaneal ligament, tibionavicular component of the deltoid ligament, and talocalcaneal interosseous ligament all help to stabilize the foot's arch [3]. The arch provides the entire body with a flexible and adaptable foundation. During the gait cycle, it disperses the forces of weight bearing and stores mechanical energy in the stretched elastic ligaments [4]. The arch complex, in particular, flexible flat foot dysfunction, can often be asymptomatic, but it can change the lumbar spine and lower limb biomechanics, increasing the risk of pain and injury [5].

Pes planus is a rather prevalent condition. As part of normal foot development, it is present in most infants and gradually declines to 15–20% in adulthood [6]. The pes planus is typically flexible, with the rigid form observed in 1% of cases [7]. Several investigations carried out in diverse age groups show that men are more likely than women to have pes planus [8]. According to relevant studies, the incidence varies from 5 to 21%incertain populations, such as the military population, which is required to engage in demanding physical activity for training or operations [9]. Adults may develop pes planus because of wearing inappropriate footwear, standing on hard surfaces for extended periods while working, or circumstances in which plantar fasciitis is overexerted due to weight bearing [10]. Several risk factors contributing to flat foot have been acknowledged such as tarsal coalition, ligamentous laxity, equines foot deformity, tibial torsional defect congenitally vertical talus, and posterior tibial tendon dysfunction (PTTD) [11, 12].

Furthermore, PAINFUL symptom presentations associated with flexible pes planus include hip discomfort, osteoarthritis, Achilles tendinopathy, patellofemoral issues, and generalized lower limb pain [13]. The adults with flexible flat feet report a lower quality of life and noticeably higher levels of lower limb and back pain [14]. Symptoms such as abnormal rear foot kinematics (e.g., excessive rear foot eversion or increased range of rear foot eversion), abnormal foot and ankle kinetics (e.g., elevated joint moments or abnormal loading forces), and altered physical function (e.g., altered muscle activation and timing or increased energy consumption) are commonly reported [11, 14].

Similarly, the treatments should focus on these anomalies since the functional implications of these signs have been connected to the symptoms of flexible pes planus. Treatment may be necessary for inflexible and symptomatic pes planus. Conservative treatment approaches typically include adjusting activity levels, decreasing weight if needed, changing shoes, immobilization, anti-inflammatory drugs, massage, and, finally, physical therapy techniques [15]. Surgical intervention would be taken into consideration if conservative measures prove ineffective. Physiotherapists can treat patients with flat feet in a variety of ways, including by using various taping techniques strengthening the foot muscles, and stretching the triceps sure muscle. Foot orthosis is also prescribed for pes planus [16]. This study aims to determine the prevalence of pes planus among army soldiers and to investigate the association between prolonged standing, heavy weightlifting, and the development of pes planus. This study is significant due to the limited literature on pes planus in military personnel, despite the high physical demands placed on soldiers. Understanding how these factors impact soldiers' physical performance, injury rates, and overall military effectiveness can lead to better preventive measures and improved medical support, enhancing the overall effectiveness of military operations.

MATERIALS AND METHODS

This cross-sectional study was conducted over six months in various army units in Rawalpindi and Islamabad to determine the prevalence of pes planus among army soldiers and its association with prolonged standing and heavy equipment utility. The study involved 230 male soldiers, aged 25-35, withstanding duties lasting 4-8 hours and who regularly carried weights of 3 kg or

more. Non-probability convenience sampling was used to select the participants. Data collection involved physical examinations and taking footprints, following a structured questionnaire. Soldiers outside of above above-defined inclusion criteria were excluded from the research study including female soldiers, soldiers less than 25 years of age, soldiers posted outside Rawalpindi and Islamabad, or having responsibility for standing less than four hours. Necessary permissions were obtained from the relevant institutional review boards and ethical review committees. The collected data were analysed to identify the prevalence of pes planus and its correlation with the defined occupational activities.

DATA COLLECTION PROCEDURE

Permission for the study was obtained from the Head of Department of Bashir Institute of Health Sciences, Bhara Kahu, Islamabad, as well as from the Institutional Review Committee (IRC) and Ethical Review Board (ERB) of the same institution. The permission was also taken from the responsible authorities and institution boards of involved armed institutions. Data collection involved conducting demographic and physical examinations of the participants, guided by a structured questionnaire. Footprints were taken to assess the prevalence of pes planus among the soldiers, ensuring that all assessments adhered to the inclusion criteria.

STATISTICAL ANALYSIS

The data analysis was conducted using SPSS version 27. Frequency charts and graphs were created to represent the qualitative variables, such as age, standing hours, equipment weight, and footprints. These visual tools helped in interpreting the distribution and prevalence of pes planus among the study participants, providing a clear understanding of the data trends and relationships. Correlation and multiple regression analysis were conducted to assess the association of long-standing and heavy equipment utility with pes planus.

RESULTS

The demographic characteristics of the population reveal that the majority, 59%, are aged between 20 and 30 years, with 136 individuals in this age group. The remaining 41% are aged between 31 and 35 years, accounting for 94 individuals. Regarding rank distribution, 15% (35 individuals) are Naib-Subedar, 23% (53 individuals) are Havildars, 25% (58 individuals) are Naik, and the largest group, 37% (84 individuals), are Sepoy. In terms of service period, 18% (41 individuals) have served for less than 5 years, 53% (122 individuals) have served between 6 and 10 years, and 29% (67 individuals) have a service period of 11 to 15 years. This analysis indicates a predominantly young population with a substantial portion having mid-range service experience, and the largest rank group being Sepoy.

Table 1: Assessment of Demographic Characteristics of Population

		F	%
Age	20 to 30 Years	136	59%
	31 to 35 Years	94	41%
Rank	Naib-Subedar	35	15%
	Havildar	53	23%
	Naik	58	25%
	Sepoy	84	37%
Service Period	Less than 5 Years	41	18%
	6 to 10 Years	122	53%
	11 to 15 Years	67	29%

N=230

The analysis of the frequency distribution of heavy equipment utility and the prolongation of standing periods during duty hours provides insightful details on the physical demands faced by the soldiers. A significant 61% of soldiers carry heavy equipment weighing between 21 to 25 kilograms during their duty hours. This is the most common weight range, highlighting the substantial load most soldiers must manage regularly. Meanwhile, 21% of the soldiers bear weights between 15 to 20 kilograms, and 18% carry even heavier equipment, ranging from 26 to 30 kilograms. Regarding the prolongation of duty periods, the data reveals that a vast majority, 63%, of the soldiers are required to endure standing periods of 6 hours. Additionally, 35% of the soldiers stand for 5 hours, while a small fraction, 2%, stands for 4 hours. These findings indicate that most soldiers are subject to extended periods of physical exertion while carrying heavy loads. From this analysis, most soldiers carry substantial weight for prolonged periods. Specifically, 61% carry between 21 to 25 kilograms, and 63% stand for 6 hours. This combination of heavy equipment and extended standing periods suggests that soldiers are under considerable physical strain during their duty hours. The implications of these findings are critical for understanding the physical demands placed on soldiers and the potential need for measures to mitigate the risk of fatigue and injury. Effective strategies might include optimizing load distribution, providing more frequent breaks, or employing ergonomic equipment to reduce strain.

Table 2: Frequency Distribuend of Prolongation of Standing Period and Heavy Equipment Utility

		F	%
Heavy Equipment Utility During Duty Hours	15 to 20 Kg	53	21%
	21 to 25 Kg	153	61%
	26 to 30 Kg	45	18%
Prolongation of Duty Period	4 Hours	5	2%
	5 Hours	88	35%
	6 Hours	158	63%

N=230

The analysis depicted in Figure 1 examines the prevalence of pes planus, or flat footedness, among soldiers because of prolonged standing while carrying heavy equipment. Out of a total of 230 soldiers, 38 have been diagnosed with a pes planus. This accounts for 15% of the entire soldier population under study. This data indicates that a noteworthy portion of the soldiers, specifically 15%, are affected by flat-footedness due to the demanding nature of their duties. The prolonged periods of standing combined with the burden of heavy equipment are likely contributing factors to the development of this condition.

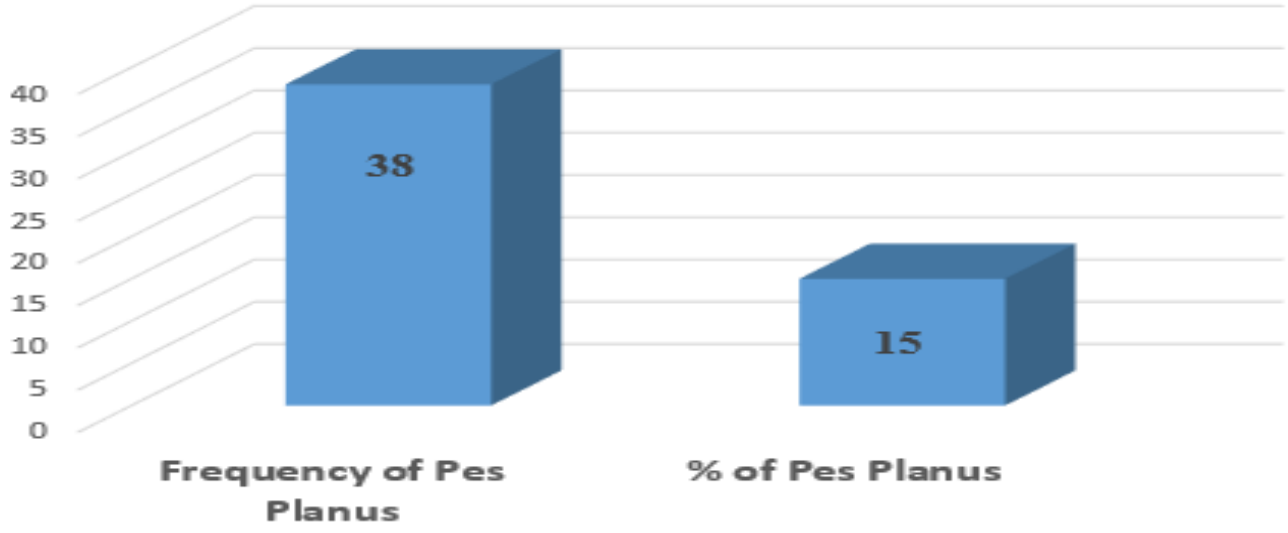

Figure 1: Prevalence of Pes Planus (Flat Footed) among Soldiers Due to Prolong Standing with Heavy Equipment

The data in Table 3 provides an analysis of symptoms associated with pes planus among soldiers subjected to prolonged standing with heavy equipment. Nearly half of the soldiers, 44.3%, reported experiencing pain when using their feet, suggesting the development of pes planus or other foot issues. A smaller percentage, 23.9%, experienced pain upon manipulation of the feet. The same 44.3% also reported swelling upon use, indicating a correlation between pain and swelling. Characteristic calluses were present in 24.3% of soldiers, and extreme plantar tenderness was reported by 44.3%. A decreased arch height was found in 19.6% of soldiers, with both unilateral and bilateral presentations. Marked deformity and pronation were observed in approximately one-fifth of the soldiers. However, none exhibited the weight-bearing line falling over or medial to the great toe, a key diagnostic feature of severe pes planus. Other lower extremity deformities, inward bowing of the Achilles tendon, and severe Achilles tendon spasms were each noted in 19.6% of soldiers. A substantial number of soldiers develop symptoms of pes planus, impacting their feet and overall lower extremity function. This highlights the need for preventive measures and interventions to mitigate the condition's development and progression among soldiers.

Table 3: Symptoms as Indicators of Pes Planus Appeared in Soldiers after Prolong Standings with Heavy Equipment

Symptoms of Pes planus as Indicator	Indicator Present	Indicator Not Present
Pain on Use	102 (44.3%)	128 (55.7%)
Pain on Manipulation	55 (23.9%)	175 (76.1%)
Swelling on Use	102 (44.3%)	128 (55.7%)
Characteristic Calluses	56(24.3%)	174(75.7%)
Extreme Plantar Tenderness	102(44.3%)	128(55.7%)
Decreased Arch Height (One Foot)	Unilateral 12(5.2%)	Bilateral 33(14.3%)
Decreased Arch Height (Both Feet)	45(19.6%)	185(80.4%)
Marked Deformity	45(19.6%)	185(80.4%)
Marked Pronation	48(20.9%)	182(79.1%)
Weight-Bearing Line (Great Toe)	0(0%)	230(100.0%)
Other Lower Extremity Deformity	45(19.6%)	185(80.4%)
Inward Bowing of Achilles (Hind foot Valgus)	45(19.6%)	185(80.4%)
Achilles Displacement and Spasm	Pes planus 45(19.6%)	Normal 185 (80.4%)

Table 4 shows pes planus development in soldiers based on multiple regression analysis with emphasis on the number of standing hours and weight of load carried. Daily standing hours are significantly correlated with pes planus risk but have low predictive ability, with beta = 0.109, R^2 = 0.010, and p = 0.057. On the other hand, the carried equipment weight is positively correlated with pes planus and is statistically significant (beta = 0.609, R^2 = 0.371, p = 0.000) and accounts for 37.1% of the variability in pes planus. These results imply that although standing for a long time has a small effect, the weight of the equipment is important in reducing the risk of pes planus among soldiers, thus the need for ergonomic measures.

Table 4: Multiple Regression Analysis to Assess the Factors Affecting Pes Planus of Soldiers During Services

	Pes Planus			
	Beta	R^2	t-value	Sig.
Daily Standing Hours	0.109	0.010	1.912	0.057
Equipment Weight During Standing Hours	0.609	0.371	10.719	0.000

DISCUSSION

The outcomes of the current study on soldiers' physical demands and health issues present both similarities and differences when compared to previous research findings. In the current study, 61% of soldiers carry equipment weighing 21 to 25 kg, which is consistent with previous studies indicating that military personnel often bear heavy loads that can exceed 20 kg. This is comparable to Troiano et al. (2017) who highlighted the physical strain from such weights on foot morphology [17]. Furthermore, the current study's findings that 63% of soldiers stand for six hours during duty align with Choudhary and Chitkara's (2019) research indicating prolonged standing significantly impacts foot structure, leading to issues like foot pronation and reduced medial arch height [18]. The prevalence of pes planus (flatfoot) among soldiers in the current study was 15%, which is slightly lower than the 15.6% prevalence reported in Salinas-Torres et al.'s systematic review (2023) and considerably lower than the 52.5% prevalence found among Thai Army privates [19, 20]. The symptoms such as pain on use and manipulation, swelling, and decreased arch height were consistent across studies, confirming the significant discomfort and functional impairment associated with pes planus. This study also identified daily standing hours and equipment weight as factors affecting pes planus, with equipment weight showing a strong correlation (Beta: 0.609, Sig.: 0.000), mirroring the findings of Resubun et al. (2022) on the impact of body mass index and weight-bearing activities [21].

Similarly, in terms of mitigation strategies, previous studies have recommended ergonomic improvements and load redistribution techniques to alleviate the physical burden on soldiers. Chaiphrom et al. (2015) emphasized the need for proper screening techniques and supportive footwear to manage symptoms and prevent flatfoot progression [20]. This is echoed by Troiano et al. (2017), who suggested that addressing foot deformities is crucial for maintaining workforce productivity and quality of life [17, 20]. Comparing statistical analyses, the current study's beta coefficients and R^2 values for equipment weight align with findings in similar studies, indicating a significant relationship between physical load and health outcomes. However, the relatively lower beta coefficient for daily standing hours suggests other variables may also contribute to the development of pes planus, as supported by Choudhary and Chitkara (2019), who observed changes in foot structure due to prolonged standing [18]. Future research should consider additional factors such as age, BMI, and the specific types of physical activities performed by soldiers, as indicated by Ryu et al. (2022), who found significant correlations between these variables and flatfoot prevalence [22].

Furthermore, the management of pes planus symptoms has been addressed in previous studies through interventions like orthotics and targeted physical therapy. Cowley (2019) highlighted the potential for such devices to reduce pain and improve function. Advancements in ergonomic equipment, as suggested by Troiano et al. (2017), could further alleviate the physical strain experienced by soldiers [17, 23]. Policy implications derived from these findings suggest that military organizations should implement regular screening for foot deformities and provide ergonomic gear to mitigate the risks associated with carrying heavy equipment and prolonged standing. Adjusting training and duty protocols to include breaks and reduce continuous standing hours could also help prevent musculoskeletal conditions, supporting the health and operational readiness of military personnel, as advocated by Patel et al. (2019) in their study on traffic police [24]. The current study's findings corroborate previous research while also highlighting areas for future investigation to develop comprehensive strategies for preventing and managing pes planus and related conditions among soldiers. The study's findings highlight significant physical demands on soldiers due to carrying heavy equipment and prolonged standing periods. Most soldiers (61%) carry weights between 21 to 25 kg, and 63% stand for 6 hours, indicating substantial physical strain. To address this, it's crucial to redistribute and potentially reduce the weight of equipment, develop ergonomic gear, and provide supportive footwear. Implementing frequent breaks, rotating duties, and enhancing physical fitness through strength training and flexibility exercises can help manage these demands. Regular health screenings and education on proper techniques are essential for preventing injuries like pes planus, which affects 15% of the soldiers studied. Adjusting duty requirements, offering support programs, and continuous research into effective interventions are also vital.

LIMITATIONS AND RECOMMENDATIONS

The study has limitations, including a sample size of 230 soldiers, which may not be representative of the entire military population, and its cross-sectional design, which limits the ability to establish causality. Self-reported data on symptoms and pain could be subject to bias, and the lack of longitudinal data prevents assessment of long-term effects. Additionally, the study may

not account for all variables influencing soldiers' physical health, such as pre-existing conditions and individual fitness levels. Future research should include longitudinal studies to track long-term effects, involve larger and more diverse samples, and investigate the effectiveness of interventions like ergonomic equipment and load management strategies. Technological solutions such as wearable devices to monitor real-time physical strain, comprehensive health assessments, and policy impact analyses are also recommended to better understand and mitigate the physical demands on soldiers, ultimately improving their health and operational readiness.

CONCLUSION

The study provides a comprehensive analysis of the physical demands faced by soldiers, particularly focusing on the weight of heavy equipment carried and the duration of standing periods during duty hours. The outcomes reveal that most soldiers carry substantial weights, while a majority endure standing periods for extended hours. These conditions highlight the significant physical strain imposed on soldiers, which is further corroborated by the prevalence of pes planus, with a noteworthy portion of soldiers diagnosed with this condition. The development of pes planus and associated symptoms, such as foot pain, swelling, and extreme plantar tenderness, underscores the impact of prolonged standing and heavy load bearing on soldiers' foot health. The study identifies equipment weight as a critical factor in the development of pes planus, indicating that a substantial proportion of the variance in pes planus can be explained by the weight of the equipment. In contrast, daily standing hours show a weaker relationship with pes planus development.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

AUTHOR CONTRIBUTION

All authors equally contributed to this study.

ACKNOWLEDGEMENT

We acknowledge the research and academic environment provided by BIHS, which remained a key factor for the completion of this research study.

FINDING SOURCE

No funding was received for this work

REFERENCES

1. 1. Erol, K., et al., *An important cause of pes planus: the posterior tibial tendon dysfunction.* Clinics and practice, 2015. **5**(1): p. 699.
2. Michaudet, C., et al., *Foot and Ankle Conditions: Pes Planus.* FP essentials, 2018. **465**: p. 18-23.
3. Kelly, L.A., A.G. Cresswell, and D.J. Farris, *The energetic behaviour of the human foot across a range of running speeds.* Scientific reports, 2018. **8**(1): p. 10576.
4. Aenumulapalli, A., M.M. Kulkarni, and A.R. Gandotra, *Prevalence of flexible flat foot in adults: a cross-sectional study.* Journal of clinical and diagnostic research: JCDR, 2017. **11**(6): p. AC17.
5. Kitaoka, H.B., et al., *Stability of the arch of the foot.* Foot & ankle international, 2019. **18**(10): p. 644-648.
6. Turner, C., et al., *A guide to the management of paediatric pes planus.* Australian journal of general practice, 2020. **49**(5): p. 245-249.
7. Dars, S., et al., *The effectiveness of non-surgical intervention (Foot Orthoses) for paediatric flexible pes planus: A systematic review: Update.* PloS one, 2018. **13**(2): p. e0193060.

8. Levy, J.C., et al., *Incidence of foot and ankle injuries in West Point cadets with pes planus compared to the general cadet population.* Foot & ankle international, 2021. **27**(12): p. 1060-1064.
9. Nindl, B.C., et al., *Operational physical performance and fitness in military women: physiological, musculoskeletal injury, and optimized physical training considerations for successfully integrating women into combat-centric military occupations.* Military medicine, 2018. **181**(suppl_1): p. 50-62.
10. Açak, M., *The effects of individually designed insoles on pes planus treatment.* Scientific Reports, 2020. **10**(1): p. 19715.
11. Ross, M.H., et al., *Self-reported social and activity restrictions accompany local impairments in posterior tibial tendon dysfunction: a systematic review.* Journal of Foot and Ankle Research, 2018. **11**(1): p. 49.
12. Banwell, G., et al., *Assessments Associated with the Diagnostics and Non-Surgical Treatment of Posterior Tibialis Tendon Dysfunction: A Systematic Review.* Applied Sciences, 2024. **14**(6): p. 2362.
13. Dars, S., et al., *When, why and how foot orthoses (FOs) should be prescribed for children with flexible pes planus: a Delphi survey of podiatrists.* PeerJ, 2018. **6**: p. e4667.
14. Scherer, P.R., et al., *Recent advances in orthotic therapy: improving clinical outcomes with a pathology-specific approach*. 2021: Lower Extremity Review LLC.
15. Cameron, M.H., *Physical agents in rehabilitation: An evidence-based approach to practice*. 2021: Elsevier Health Sciences.
16. Banwell, H.A., S. Mackintosh, and D. Thewlis, *Foot orthoses for adults with flexible pes planus: a systematic review.* Journal of foot and ankle research, 2019. **7**: p. 1-18.
17. Troiano, G., N. Nante, and G. Citarelli, *Epidemiology of foot deformities in southern italy: focus on Pes planus and Pes cavus: Gianmarco Troiano.* The European Journal of Public Health, 2017. **27**(suppl_3): p. ckx186. 017.
18. Choudhary, D. and E. Chitkara, *Determining the impact of prolonged standing on foot morphology-correlative study.* Indian Journal of Basic & Applied Medical Research, 2020. **9**(4).
19. Salinas-Torres, V.M., et al., *Prevalence and clinical factors associated with pes planus among children and adults: A population-based synthesis and systematic review.* The Journal of Foot and Ankle Surgery, 2023.
20. Chaiphrom, N., C. Rungprai, and N. Chuvetsereporn, *Prevalence and effect of flatfoot among army privates.* Journal of Southeast Asian Medical Research, 2017. **1**(2): p. 70-73.
21. Resubun, D., et al., *Relationship between body mass index, type of weight bearing activity and beighton and horan joint mobility index with pes planus in adult athletes.* International Journal of Research Publications, 2022. **94**: p. 120-30.
22. Kyung, M.G., et al., *The effect of backpack load on intersegmental motions of the foot and plantar pressure in individuals with mild flatfoot.* Journal of Foot and Ankle Research, 2022. **15**(1): p. 76.
23. Cowley, E., *The effects of prolonged running on the biomechanics and function of the foot and ankle*. 2019, University of Plymouth.
24. Patel, A.S., et al., *Prevalence and incidence of flat foot due to prolonged standing among traffic police in Navsari: A cross-sectional study.* 2021.