Comparison of Balance Effectiveness Between a Newly Designed Arch-Supporting Slipper and Two Commercially Available Slippers

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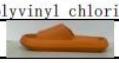
Summary

The study aimed to compare the balance effectiveness of a newly designed arch-supporting slipper with two commercially available slippers and barefoot walking. It involved 11 female participants aged 65, testing four conditions: flat slippers, thick-soled slippers, arch-supporting slippers, and barefoot. Results indicated that barefoot walking provided the most stable gait. While arch-supporting slippers offered structural support, they increased displacement and sway velocity compared to barefoot, suggesting a need for adaptation. The study concluded that sole thickness alone might not significantly influence stability, highlighting the importance of arch support in preventing falls for older adults.

Introduction

Falls were one of the leading causes of injuries and hospitalizations among older adults, with approximately 28 – 35% of individuals aged 65 and older experiencing a fall annually, and this rate increasing to 32 – 42% for those over 70 [1] . The risk factors for falls were categorized as intrinsic (e.g., decreased proprioception, muscle weakness) and extrinsic (e.g., footwear design, surface conditions) [2] . Footwear played a crucial role in influencing gait stability, as appropriate arch support and a stable sole enhanced balance control during walking, potentially reducing the risk of falls [1] [2] . Commonly available slippers included flat slippers and thick-soled slippers, but many of these designs did not incorporate arch support, which might have impacted walking stability. This study aimed to compare four different conditions (A: flat slippers, B: thick-soled slippers, C: newly designed arch-supporting slippers, D: barefoot)(Table 1) to analyze their effects on walking stability and determine whether the new slipper design enhanced gait stability and contributed to fall prevention.

Table 1 slippers type

Code	A	B	C
Name	Flat slippers	Thick-soled slippers	Newly designed arch-supporting slippers
Brand	Jie He Feng Ltd.,	Jie He Feng Ltd.,	FOOTDISC
Material	Ethylene	Polyvinyl chloride	EVA
Picture			

Methods

A total of 11 female participants, aged 65±5 years, with a BMI between 19 and 29, were recruited. Participants had not experienced any falls or undergone surgery in the past two years. Exclusion criteria included individuals with neurological disorders or severe lower limb musculoskeletal conditions that could have affected gait performance. The Gyko system (Microgate, Bolzano, Italy) was used to collect data during the gait. The following sway parameters were measured. Overall sway area: ellipse area; Anteroposterior (AP) and mediolateral (ML) sway parameters: Length, mean distance, RMS (root mean square), velocity, comprehensive sway data, D-dimension parameters. Each participant walked a 20-meter path under each of the four footwear conditions. Each condition was tested twice, and the average value was used for analysis. The test was conducted in a flat, obstacle-free indoor environment to ensure consistency and safety. The order of footwear conditions was randomized to minimize learning effects or fatigue biases. Friedman tests and Wilcoxon signed-rank tests (*post-hoc* analysis) were used for statistical analyses.

Results and Discussion

The results (Table 2) suggested that while arch-supporting slippers (C) provide structural support, they may increase displacement length and sway velocity compared to barefoot (D). This suggests that an adaptation period may be required for optimal stability.Flat slippers(A) also showed increased displacement, further confirming that insufficient foot support may affect balance.Thick-soled slippers(B) were tested but did not show significant effects in pairwise comparisons, indicating that sole thickness alone may not be a key determinant of stability.

Conclusions

Overall, barefoot exhibited the most stable gait performance, while flat slippers and arch-supporting slippers introduced variations in balance parameters. Future studies should explore long-term adaptation to arch support and analyze muscle activation patterns and proprioceptive feedback to better understand how different footwear designs influence postural control.

References

[1] Liu, Y., Yang, S., & Liu, K.Efficacy of different insole designs on fall prevention of the elderly. Gerontechnology, 2012,Vol 11,No2

[2] Menz, H. B., Auhl, M., & Munteanu, S. E. (2016). Effects of indoor footwear on balance and gait patterns in community-dwelling older women . Gerontology, 63(2), 129.

Table 2 Result

GyKo variable	p-value	Mean(Std.Devition)		
Total Length	.008	A 1044.8 (129.5)	D 1012.6 (95.7)	.041 (A>D)
		C 1068.6 (134)	D 1012.6 (95.7)	.01 (C>D)
Total Velocity	.012	B 49.6 (6.2)	D 47 (5.6)	.026 (B>D)
		C 50.7(7.2)	D 47 (5.6)	.013 (C>D)
Length AP	.013	B 766.9(131.3)	D 721.9(112.8)	.013 (B>D)
		C 785.4(130.4)	D 721.9(112.8)	.004 (C>D)
Velocity AP	.011	B 36.2(5)	D 33.4(5)	.004 (B>D)
		C 37.2(5.9)	D 33.4(5)	.006 (C>D)

Data are presented as mean, only present significant statistical differences data. (p-value<.05)
A:flat slippers,B:thick-soled slippers,C:newly designed arch-supporting slippers,D:barefoot