The effect of minimal shoes in combination with textured and supportive insoles on spatiotemporal gait parameters across the lifespan.

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Summary: This study assessed the effect of habitual, barefoot, minimal shoe conditions, and minimal shoes in combination with textured and supportive insoles on gait parameters during a 2-minute walk in healthy adults across the lifespan (18-80 years). Older adults covered significantly less distance in minimal shoes with or without insoles compared to middle-age and young adults suggesting stability is compromised. Although older adults take smaller strides, they maintained speed in their habitual footwear and when barefoot by increasing their cadence. Using insoles in minimal shoes had no advantage over minimal shoes without insoles on the observed parameters.

Introduction: Maintaining stability during daily functional tasks is multifactorial. Footwear and insoles have been explored as an external factor for maintaining or disrupting stability. For example, minimal shoes, textured insoles and supportive insoles increased stride length and walking speed in young adults and improved postural balance in older adults [1–3]. Though several studies shows beneficial effects of minimal shoes and insoles on stability related gait parameters, little attention was given to the combined effects of minimal shoes and insoles on spatiotemporal gait parameters across the lifespan [4]. This study examined the effects of minimal shoes without insoles and in combination with textured and supportive insoles on spatiotemporal gait parameters in healthy adults lifespan compared to barefoot and participants' habitual footwear.

Methods: A total of 142 healthy volunteers (62 young, 40 middle-aged and 40 older adults) performed a 2-minute walk test at a self-selected speed in a random order of five footwear conditions: habitual, barefoot, minimal shoes, and minimal shoes in combination with textured or supportive insoles featuring heel cups and arch support. Kinesis Gait^{TM} sensors recorded distance covered, stride length, cadence, stride length variability and stride time variability. Type III ANOVA was performed on linear mixed-effects models with footwear, age group, and their interaction as fixed effects, and participants as random intercepts. Post-hoc analysis compared estimated marginal means from the models, with p values (p<0.05) adjusted using the false discovery rate.

Results and Discussion: The insole conditions tested in minimal shoes had no different effect on the gait parameters compared to minimal shoes without insoles, as similar interactions were found in all three minimal shoe conditions across age groups (Table 1). Specifically, older adults covered significantly less distance in minimal shoes with or without insoles compared to middle-age and young adults. Across all footwear conditions, older adults had significantly reduced stride length compared to the middle and young age groups. However, cadence significantly increased in older adults compared to young adults in habitual shoes and tended to when barefoot, which enabled them to maintain the similar distance covered by middle age and young adults, despite their smaller stride length. No significant main effect of footwear/age groups or interaction was found in stride length variability. Stride time variability significantly increased in habitual shoes compared to all other footwear conditions across age groups. This suggests minimal shoes in any insole condition or being barefoot compared to participants' habitual footwear is associated with greater stability during gait [5].

Conclusions: Minimal shoes with or without textured or supportive insoles may compromised stability whilst walking in older adults, suggested by slower gait speed. Middle age and young adults gait parameters were not affected by minimal footwear. Future research should assess the effect of a longer habituation period to minimal footwear in older adults.

References

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Table 1: Estimated mean values of gait parameters across footwear conditions and groups

Parameter	Barefoot			Habitual shoes			Minimal shoe conditions									Footwear and group interaction
							No insoles			Supportive insoles			Textured insoles			
	Young	Middle age	Old	Young	Middle age	Old	Young	Middle age	Old	Young	Middle age	Old	Young	Middle age	Old	
Distance (m)	148.3 (2.3)	151.8 (2.7)	144.7 (2.8)	151.3 (2.3)	154.7 (2.7)	146.5 (2.8)	157.8 (2.3)	156.6 (2.7)	147.1 (2.8)	157.8 (2.3)	157.9 (2.7)	148.6 (2.8)	157.4 (2.3)	158.7 (2.7)	147.4 (2.8)	MS & MSI; MA>OA*, YA>OA* MTI; MA>OA**, YA>OA**
Stride length (cm)	128.0 (1.3)	129.8 (1.6)	121.8 (1.6)	137.9 (1.3)	136.7 (1.6)	127.2 (1.6)	137.7 (1.3)	136.8 (1.6)	127.4 (1.6)	139.7 (1.3)	137.8 (1.6)	128.0 (1.6)	138.9 (1.3)	137.3 (1.6)	127.3 (1.6)	BF; MA>OA**, YA>OA** HS, MS, MSI & MTI; MA>OA***, YA>OA***
Cadence (steps/min)	115.9 (1.0)	117.1 (1.3)	119.6 (1.3)	109.9 (1.0)	113.2 (1.3)	115.4 (1.3)	114.0 (1.0)	114.6 (1.25)	115.4 (1.3)	113.1 (1.0)	114.7 (1.3)	116.2 (1.3)	113.5 (1.0)	115.7 (1.3)	115.7 (1.3)	HS; OA>YA**

Note: *** indicates p<0.001, ** indicates 0.001<p<0.01, * indicates 0.01<p<0.05.