PERCEPTIONS OF SLIPPERY SLIPPERS: HOW DOES THIS PERCEPTION CHANGE THE GAIT PATTERN OF OLDER WOMEN?

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INTRODUCTION

An estimated 90% of slips leading to falls occur during level walking at initial foot-ground contact when there is a loss of traction between an individual's footwear/foot and the surface beneath their feet. To avoid such a fall, individuals typically adjust their gait when a slippery floor surface is perceived to elicit slip-avoidance behavior or a more stable gait pattern (Swensen et al. 1992). As the foot's tactile senses are often inhibited by footwear, and may be impaired in older individuals, people often rely upon visual and auditory cues to assess surface slipperiness (Cohen & Cohen, 1994). If, however, the slippery surface is not detected within an individual's effective visual field, usually four or five paces away, or the surface slipperiness is misinterpreted, there is limited time available to make immediate compensatory gait adjustments to accommodate the slippery surface and the likelihood of a slip is significantly increased (Lin et al., 1995). Therefore, correct subjective perceptions of shoe/surface slipperiness are vital for older individuals with age-related declines in muscle strength, flexibility and proprioception to prevent falls.

Despite a plethora of research investigating surface slipperiness, very little research has examined slipperiness associated with typical household shoe/surface combinations. Therefore, there is a need to determine how older people perceive different household shoe/surface combinations and how these perceptions affect the walking patterns of older people if we are to better understand the complex relationship between gait biomechanics and slip avoidance. This study aims to determine whether subjective perceptions of shoe/surface slipperiness change the gait of older women when they are wearing household footwear and walking on typical household surfaces.

METHODS

Eight older RA women (67.8 ± 7.3 yr) and eight women (65.3 ± 3.1 yr) unaffected by RA but matched to the RA subjects for age, height and mass participated in the study. While wearing a custom-designed safety harness system, the subjects walked along an 8 m walkway, at a self-selected speed under three footwear conditions (barefoot, toe slippers, closed-back slippers) and three surface conditions (carpet, dry linoleum, wet linoleum). During the five trials per condition, ground reaction force data were sampled using a Kistler force platform (1000 Hz) embedded in the walkway. Onset of the resultant ground reaction force data were used to both provide a temporal reference of initial contact and to calculate the coefficient of friction. Following completion of each trial, subjects were asked to subjectively rate shoe/surface slipperiness using a visual analog scale (verbal anchors = "not slippery" to "extremely slippery"). Data were then analysed using a three-way ANOVA with one between factor (subject group) and two within factors (footwear and surface type) to determine whether interactions between the footwear and surface conditions had any significant ($p \leq 0.05$) effect on the shoe/surface slipperiness perceptions or gait modifications used by the subjects to prepare for initial contact.

RESULTS AND DISCUSSION

There were no significant between-group differences for perception of shoe/surface slipperiness or the coefficient of friction, suggesting that both subject groups exhibited similar gait patterns independent of

their RA status. However, when the data were pooled across subject group and surface condition, there was a significant ($p < 0.05$) main effect of footwear on shoe/surface slipperiness and the coefficient of friction whereby subjects perceived the closed back slippers to be significantly less slippery (3.5 ± 1.4) than when walking barefoot (17.2 ± 3.4) or wearing toe slippers (10.7 ± 6.4) and, consequently, displayed a significantly reduced coefficient of friction when they walked barefoot compared to when walking in closed back slippers. Interestingly, both the closed back and toe slippers had the same outsole design, suggesting that both slipper types would interact similarly with any supporting surface. However, subjective comments pertaining to the toe slippers indicated that some subjects found them difficult to keep on their feet when walking, reporting them to be "slippery" because their feet kept slipping/moving within the slippers. If foot slippage inside the shoe alters the gait of older women, then shoe types such as toe slippers and other household shoes that are sloppy and do not fit the foot well may place older women at a greater risk of falls and, in turn, should be discouraged for this population.

As anticipated, when the data were pooled across subject group and footwear condition, there was a significant main effect of surface type on shoe/surface slipperiness and the coefficient of friction. Pairwise comparisons showed that subjects found walking across the wet vinyl tile surface (24.7 ± 5.9) to be significantly more slippery compared to dry vinyl tile (4.0 ± 3.4) or carpet (2.6 ± 2.1) and, consequently, displayed a significantly reduced coefficient of friction when walking across the wet vinyl tile surface compared to the other surface types. However, although not evident for the coefficient of friction, a significant footwear x surface interaction was found for the perception of shoe/surface slipperiness (see Figure 1) whereby subjects found walking barefoot on the wet vinyl tile surface to be significantly more slippery than walking shod on the same surface. Therefore, although subjects perceived the wet surface to be slippery, they did not modify their gait accordingly when wearing either slipper type perhaps due to discrepancies in learned or perceived behavior and the tactile sensation of actually walking on the surface.

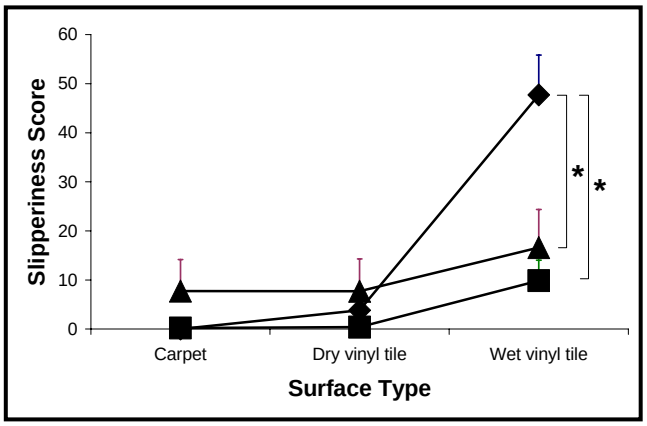

Figure 1: Footwear x surface interaction for the mean (SEM) shoe/surface slipperiness perception when subjects (n = 16) walked barefoot (◆), in closed back slippers (■) and in toe slippers (▲) under different surface conditions (* indicates statistical significance at $p < 0.05$).

SUMMARY

It was concluded that subjects will modify their gait when walking in toe slippers on any surface and when walking barefoot, particularly on the wet vinyl tile surface. However further research is warranted to determine the true effect of subjective perceptions and sensory feedback when older people walk barefoot or shod, particularly in shoes with differing outsole thickness, hardness and roughness, on the variables characterising their gait and slip risk.

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