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Biomechanics for inclusive urban design: Effects of tactile paving on older adults' gait when crossing the street

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ABSTRACT

In light of our ageing population it is important that the urban environment is easily accessible and hence supports older adults' independence. Tactile 'blister' paving was originally designed to provide guidance for visually impaired people at pedestrian crossings. However, as research links irregular surfaces to falls in older adults, such paving may have an adverse effect on older people. We investigated the effects of tactile paving on older adults' gait in a scenario closely resembling crossing the street. Gait analysis of 32 healthy older adults showed that tactile, as compared to smooth, paving increases the variability in timing of foot placement by 20%, thereby indicating a disturbance of the rhythmic gait pattern. Moreover, toe clearance during the swing phase increased by 7% on tactile paving, and the ability to stop upon cue from the traffic light was compromised. These results need to be viewed under the consideration of limitations associated with laboratory studies and real world analysis is needed to fully understand their implications for urban design.

1. Introduction

In light of our ageing population and rapid expansion of the oldest-old group (age >85; (Christensen et al., 2009), it is important that the urban environment is easily accessible. As part of 'inclusive design' policies, tactile 'blister' paving was designed to provide guidance for visually impaired and blind people at sites such as pedestrian crossings. However, a report by the UK Health and Safety Laboratory (HSL2005/07) questioned whether tactile blister paving may lead to trips in older adults due to the height of the blisters. Tactile paving may be considered as manmade uneven ground and we know that walking on uneven ground is associated with falls (Berg et al., 1997). Only one study has investigated gait on tactile paving (Kobayashi et al., 2005): increased toe height during swing and increased hip flexion moment were the major gait changes attributed to tactile paving. While useful, the conclusions were limited by the healthy young test population.

To date, no study has investigated the gait of older adults on tactile paving or the effect of tactile paving on measures of gait that are associated with stability and falls risk in older adults. Our objective was to develop a laboratory platform closely resembling a pedestrian crossing, and to investigate suitable gait parameters in older adults on smooth and tactile paving.

A number of studies have identified the relationship between biomechanical variables, measured during walking on smooth or irregular surfaces, and fear of falling, gait stability, and falls risk. For example, reduced gait speed has been associated with fear of falling in older adults, while walking with a wider stride appeared to be linked to falling and fear of falling (Maki, 1997). Similarly, investigations of surface effects in healthy young and older adults showed that for walking on uneven, as compared to even, ground, step width and toe clearance increased and speed decreased (Menant et al., 2008, 2009). These gait adaptations in response to uneven ground were interpreted as a more cautious gait allowing stabilization of torso and visual field and avoidance of tripping hazards. Hence we tested the primary hypothesis that older adults exhibit a more conservative gait on tactile blister paving compared to smooth paving, i.e. when negotiating the 5 mm-high protruding blister domes they would decrease their speed, increase their step width, and increase their toe clearance in mid-swing.

Walking stability requires continuous control of the whole-body centre of mass in response to the changing boundaries of the base of support. This can be achieved via adjustments of foot placement and also via changes in timing of foot placement.

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