Methods of inducing trip incidents during gait affect the recovery strategies.

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Summary

We compared the impact of two trip-inducing methods on recovery strategies during treadmill walking. One method used a side-placed obstacle that positioned off the treadmill (method 1), while the other employed a treadmill-based setup with the insertion of obstacles upon the treadmill surface (method 2). Both methods used obstacles of identical height with controlled timing to simulate real-world perturbations while wearing safety shoes. The results showed different recovery strategies between the two trip-inducing methods, emphasizing the importance of laboratory setups that closely mimic real-life conditions.

Introduction

Research has largely focused on slip resistance, overlooking trip-related dynamics, which lacks a standardized method for testing trip-related biomechanics. Trip-related biomechanics have been evaluated using various test setups [1, 2, 3]. It is not known whether the method of inducing a trip in a laboratory setting influences the recovery strategy. This study aimed to investigate the impact of two distinct trip-inducing methods on recovery strategies during treadmill walking, focusing on evaluating setups designed to replicate real-world scenarios.

Methods

Two methods of inducing trips were analyzed (method 1 & 2). In total, 43 participants (method 1 n = 23 & method 2 n = 20) walked on treadmills with fixed walking speeds (method 1 = 5.4 km/h & method 2 = 4.5 km/h). Both tests timed the trip to occur late mid-swing in 50-60% of the swing phase and had an obstacle 3.1cm height. In both tests, the kinematics were recorded with Xsens Link system (Movella Technologies, B.V., Enschede, the Netherlands).

Method 1: Inserted the obstacle from the lateral side of the participant. This obstacle was positioned off the treadmill and fixed to the ground and could not move anterior during the trip resulting in a stationary perturbation relative to the subject (figure 1 left) [4].

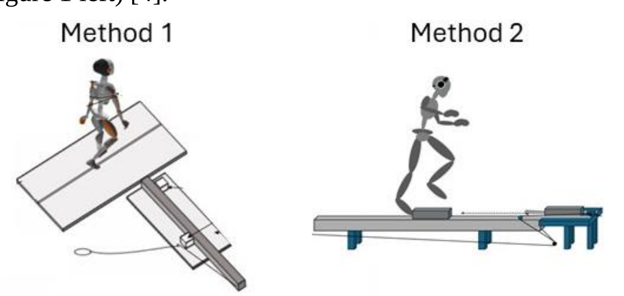

Figure 1: Test setup for method 1 & 2.

Method 2: Inserted the obstacle upon the treadmill anterior to the participant. With this approach the perturbation device was not fixed to the treadmill and could move anterior during the trip. (figure 1 right).

Results and Discussion

The results showed that method 1 provoked the highest use of an elevating strategy, while method 2 resulted in the use of a lowering strategy. A delayed strategy was also more often chosen for method 2 compared with method 1.

Table 1: Distribution of recovery strategies after unexpected trips during treadmill walking.

	Elevating [%]	*Lowering [%]*	*Delayed [%]*	*Undefined [%]*
Method1	56.5	26.1	13.1	4.3
Method2	2.4	58.6	36.6	2.4

Even if the timing and height of the perturbation were standardized, there were large differences in the adopted recovery strategy. These differences can most likely be explained by differences in foot relative to the obstacle velocity, as the obstacle in method 1 was stationary. The velocity of the foot in late mid-swing is three times faster than the walking speed [5]. Thus, difference in foot-obstacle velocity (method 1: 10.8 km/h and method 2: 13.5 km/h) most likely explained the reduced use of elevating strategy in method 2. Method 2 mimicked a real-life scenario where unexpected objects lay on the ground.

Conclusions

The way of inducing unexpected trips influenced how participants recover. Trip-simulating studies should therefore mimic a specific real-life condition to better understand the biomechanics of tripping incidents and the adopted recovery strategy.

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