Effect of modular sports flooring on static and dynamic friction of common sport shoes

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Introduction

Friction at the shoe-surface interface is an important property when considering sports performance and injury risk [1,2]. For example, whilst higher shoe-surface friction has been associated with improved change of direction movement, this can also increase the risk of anterior cruciate ligament (ACL) injury [3]. Understanding shoe–surface friction, and how it influences static and dynamic friction (ratio of friction force between interacting surfaces before [static] and during [dynamic] movement) is crucial for safe performance in multidirectional sports. In recent years, modular flooring tiles have been used commercially and in research [1] as an alternative flooring surface, as they are convenient and cost-effective. However, the effect of modular tiles on static and dynamic friction during lateral movements (e.g., sliding) is unknown. This study aimed to compare static and dynamic friction at the shoe-surface interface for a lateral sliding movement, using common sport shoes and modular sports flooring tiles.

Method

Two surfaces and four shoes were assessed. Surfaces included a tennis-specific modular flooring and a multi-sport tile (MSF Sports, Melbourne, Australia). The assessed shoes were the Decathlon Artengo TS1000 Multicourt (Tennis), Nike Zoom Hyperdunk X (Basketball), Nike Mercurial Vapor XIV Club IC (Futsal), and Asics Netburner Ballistic FF (Netball). Shoes were attached to a prosthetic foot (1D10 Dynamic Foot, Otto Bock, United States), which was affixed to the Traction Device [4]. Four interlocked tiles were firmly attached to the base of the testing device during assessments. All shoes completed seven lateral (left-to-right) slides with an applied vertical force of 326 N. The internal friction of the device was calibrated, which resulted in a 71 N offset which was therefore subtracted from the recorded outputs of the sports shoes [4]. From this process, the coefficients of static (μ_s) and dynamic (μ_k) friction were recorded. Paired sample *t*-tests and Cohen's d_z effect sizes comparing tile types were calculated (small d_z = 0.2-0.49, medium d_z = 0.5-0.79, large d_z = > 0.8) [5].

Results

In the multi-sport tile, static friction was greater in the tennis ($p < .001$, d_z= 2.6) and futsal shoes ($p < .001$, d_z= 6.1), while dynamic friction was greater in the

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tennis (p = .002, d_z= 1.9), futsal (p < .001, d_z= 8.5) and netball (p = .029, d_z= 1.1) shoes (Table 1).

Table 1. Coefficients of static and dynamic friction (Mean ± SD) for involved shoes. * indicates a significant difference (p < .05) between flooring tiles.

		Friction type	
Shoes	**Tiles**	**Static**	**Dynamic**
Tennis*	**Tennis**	0.40 ± 0.04	0.39 ± 0.03
	Multi	0.52 ± 0.01	0.46 ± 0.01
Basketball	**Tennis**	1.16 ± 0.07	1.10 ± 0.06
	Multi	1.22 ± 0.05	1.17 ± 0.06
Futsal*	**Tennis**	0.76 ± 0.08	0.66 ± 0.09
	Multi	0.99 ± 0.07	0.92 ± 0.08
Netball*	**Tennis**	1.70 ± 0.31	1.54 ± 0.27
	Multi	1.98 ± 0.07	1.84 ± 0.04

Discussion

Coefficients of static and dynamic friction were greater in the multi-sport tile for the tennis, futsal, and netball shoes (ranging 3.5-14%) when compared with the tennis tile. This indicates that the tennis tile provides lower static and dynamic friction between the sport shoes and tile surface, possibly providing a greater resistance for the shoes to slide laterally. The tennis tile surface is designed with uniformly shaped diamonds (with complete openings within the perimeter), whereas the multi-sport tile is designed with a symmetrical pattern at a consistent level which might increase surface roughness and friction during the lateral shoe slides. In multidirectional sports, lower-limb injuries include ACL ruptures and lateral ankle sprains [1-3], which may have an increased risk of manifestation if shoe-surface friction is high. Further research exploring anterior movements, surface tribology, and representative sports motion with humans is warranted.

References

1. Nigg, B.M., Stefanyshyn, D.J., Rozitis, A.I., & Mündermann, A. (2009). Resultant knee joint moments for lateral movement tasks on sliding and non-sliding sport surfaces. *Journal of Sports Sciences*. 27, 427–435.
2. Frias Bocanegra, J. M., & Fong, D. T. (2021). Playing surface traction influences movement strategies during a sidestep cutting task in futsal: implications for ankle performance and sprain injury risk. *Sports Biomechanics*, 1-11.
3. Dowling, A. V., Corazza, S., Chaudhari, A. M., & Andriacchi, T. P. (2010). Shoe-surface friction influences movement strategies during a sidestep cutting task: implications for anterior cruciate ligament injury risk. *The American Journal of Sports Medicine*, 38(3), 478-485.
4. Ura, D., & Carré, M. (2016). Development of a novel portable test device to measure the tribological behaviour of shoe interactions with tennis courts. *Procedia Engineering*, 147, 550-555.
5. Robertson, D. G. E. (2013). Signal Processing. In *Research Methods in Biomechanics*. (2nd ed., pp. 279-290). Human Kinetics.

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