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Original Article

Investigation on futsal shoes outsole features

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Abstract:
This study presents the typical outsole features of futsal shoes and classifies them into several main categories. A total of 100 futsal shoes from twelve manufacturers are selected for analysis. Each shoe's tread groove pattern, as well as other features, are visually observed. All shoes are categorised into five different groups according to their outsole features at the forefoot, mid foot and rear foot regions. The level of association between specific features and the outsole region (forefoot and rear foot) are further analysed using the chi-square test. Nine typical tread groove patterns are identified among the futsal shoes: 1. honeycomb, 2. herringbone, 3. omni, 4. waffle, 5. straight line, 6. smooth, 7. checker, 8. scribble line and 9. concentric line. Three common outsole features are identified: 1. flexi bar, 2. pivot point and 3. flex line. The results indicate that most futsal shoes (43%) are classified into Group 5 (non-identical tread groove pattern for all outsole regions). Approximately 15% of the analysed futsal shoes possess identical tread groove features (Group 4) at all three outsole regions. The pivot point and flex line are also found to be significantly associated with the forefoot region [$\chi2(1) = 12.05$, $p = .001$, and $\chi2(1) = 4.97$, $p=0.026$, respectively]. The variability within the outsole features of futsal shoes indicates the specific functions assigned to each region of the entire outsole. This includes the pivot point at the forefoot region, which may act as a rotational movement-assist feature, and the flex line at the forefoot region which can help optimise metatarsophalangeal joint range of motion while executing futsal-specific tasks.
Key Words*:* **- Footwear, Tread pattern, Design, Football codes, Classification**

Introduction

Futsal is one of the fastest-growing indoor sports worldwide (Berdejo-del-Fresno, 2014; Moore & Radford, 2014; The Football Association, 2018). The emergence of futsal is apparent. The sport has transformed into a commercial success with its overall progress in terms of the technical and physical improvements by futsal athletes, global tournaments and widespread marketing (Roxburgh, 2008). The importance of futsal has dramatically increased when FIFA (The Fédération Internationale de Football Association) launched the inaugural futsal development program in 2015. In sports, footwear is of utmost importance. Previous studies have proven the significance of footwear and how it can influence performance and injury (Kulessa et al., 2017; Lake, 2000). The recent research on futsal shoes have highlighted the effect of the outsole design on the playing-surface interaction (Ismail et al., 2018; Ismail et al., 2021a). Futsal has been included on the list of the most injury-prone sports where one incident of injury occurs every 181 hours of futsal play (Schmikli et al., 2009). The same study also revealed that almost 33% of injury in futsal are non-contact injuries. This may be due to the demand of high-intensity movements where players execute rapid translational and rotational actions (Ismail & Nunome, 2021). The role of footwear in relation to injury remains unknown. No specific research has examined futsal shoe designs. Only three studies had highlighted futsal footwear (Kulessa et al., 2017). Ismail et al. (2021b) found that there are certain mechanical properties of futsal shoes that can influence futsal-specific movements, such as changing directions. However, in that particular study, only three different types of shoes were compared, and the shoe properties were not systematically controlled. This can be a limiting factor for generalising the findings obtained from that study. Therefore, futsal footwear requires additional assessments.

Studies that focused on non-studded shoes are limited, and their categorisation was based on the visual features of the tread groove (Blanchette & Powers, 2015; Li et al., 2006). In the market, there are currently many types of futsal shoes with several outsole tread groove features. However, these features have not been examined. Therefore, the purpose of this study is to identify the features of futsal outsole designs and categorise the currently available futsal shoes based on the outsole tread features. The second purpose is to investigate the

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potential association between the inclusion and exclusion features on the outsoles of futsal shoes. It is hypothesised that there is an association between the inclusion and exclusion of certain features (flexi bar, pivot point and flex line) on different outsole regions.

Material & methods

Sample

In this study, 100 widely commercial futsal shoes from 12 different manufacturers were selected for analysis. Convenience sampling was adopted as the sampling method in this study. The outsoles (bottom segments of the shoe) of all 100 shoes were photographed for analysis purposes (Figure 1).

Figure 1. Example of photographed shoe for analysis

Identification of Instruments and Categorisation Method

The shoe was identified by dividing the outsole into three parts: forefoot region, mid foot region and rear foot region (Figure 2). Each outsole feature was identified based on the reference work previously accomplished by Valiant (1986). All shoes were then categorised into five groups according to identical or non-identical features of the forefoot, mid foot and rear foot regions (Figure 3). In addition, the outsole features' level of association with the forefoot and rear foot regions were also analysed.

Figure 2. Segmentation of outsole region

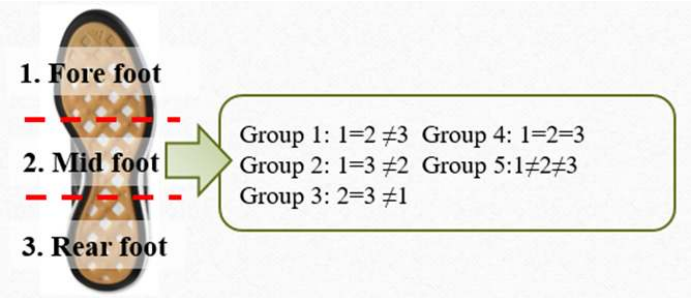

Figure 3. Categorisation of futsal shoe based on five outsole groups

Statistical Analysis

Two experienced amateur futsal players (males, age: 30 ± 5 years) volunteered as independent observers when categorising all shoes into different groups. For the grouping, an interrater reliability (Cohen Kappa (K) statistic) was performed at 95% CI. The level of association between the inclusion and exclusion of outsole features (for the forefoot and rear foot regions) was measured using the chi-square test. The statistical significance level was set at $p<0.05$ throughout all evaluations.

Results

It was found that there is strong agreement between the research categorisation and the two observers [Cohen's K = 0.85 (95% CI, 0.772 to 0.928), p < 0.05]. Nine typical tread groove patterns were identified from the 100 shoes analysed: 1. honeycomb, 2. herringbone, 3. omni, 4. waffle, 5. straight line, 6. smooth (no groove), 7. checker, 8. scribble line and 9. concentric line (Figure 4).

Figure 4. Typical tread groove patterns for futsal shoes

Three common features of futsal shoes were also identified: 1. flexi bar, 2. pivot point and 3. flex line (Figure 5).

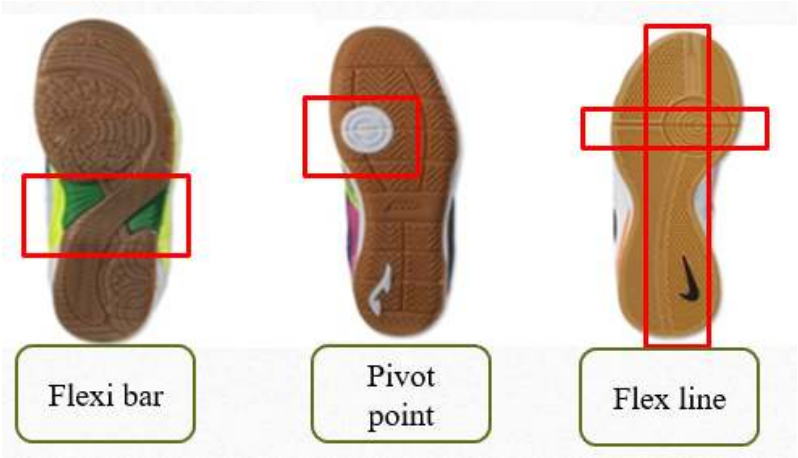

Figure 5. Common features for futsal shoes

Figure 6 presents the proportions of futsal shoes based on the group. It was found that Group 5 has the highest proportion at 43%, followed by Group 2 (21%), Group 3 (16%), Group 4 (15%) and Group 1 (5%). In terms of associations between the inclusion and exclusion outsole features (flexi bar, pivot point and flex line), a statistically significant association was found between the inclusion of the pivot point [$\chi 2(1) = 12.05$, $p = .001$] and the flex line [$\chi 2(1) = 4.97$, $p = .026$] in the forefoot region of the outsole design.

No statistically significant association was found in the inclusion of the flexi bar at the forefoot region of the outsole design (p=0.273). In contrast, no statistically significant association was found between the inclusion or exclusion of the flexi bar (p=0.13), the flex line (p=0.728) and the pivot point (p=0.688) in the rear foot region of the outsole design.

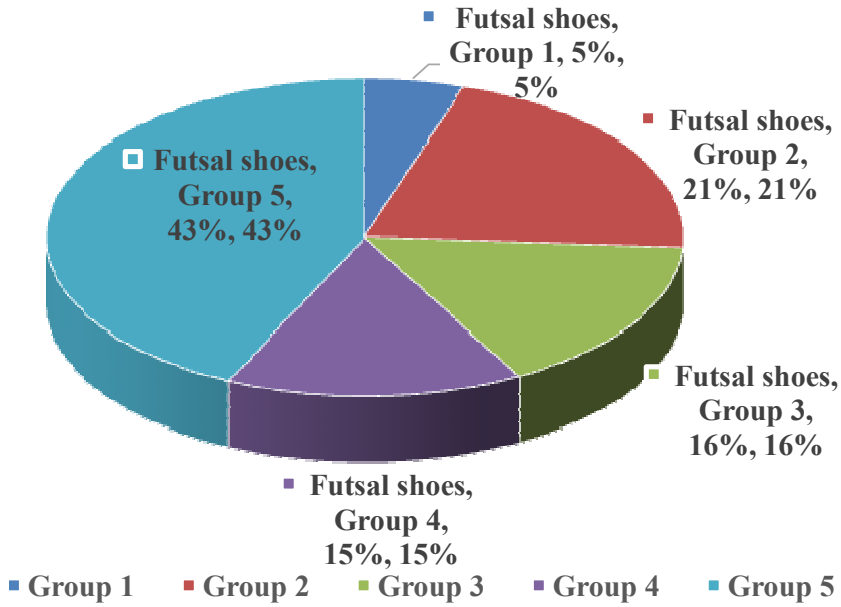

Figure 6. Group proportions of futsal shoes

Discussion

In this study, 100 futsal shoes from various models were visually observed. Nine different tread groove patterns were found with three common features (pivot point, flex line and flexi bar). An association was present between the pivot point and flex line for the forefoot region of the outsole. No association was present between the three features and the mid foot and rear foot regions. The study found that there is variability in outsole tread designs of futsal shoes, which is in line with the diverse nature of the sport's movement and tactical behaviour (Bueno et al., 2020). Almost half (43%) of the analysed shoes have a non-identical tread design for each region of the outsole. It is possible that manufacturers are producing efficient shoes with numerous functionalities (such as running, sprinting, braking and ball control) since futsal is a sport that involves a high occurrence of accelerated-decelerated running motion during ball control. The different features at the forefoot, mid foot and rear foot regions can potentially help improve the functional aspects of futsal shoes.

The inclusion of the pivot point and flex line in the forefoot region indicates the importance of these features. The pivot point feature is crucial for changing directions during futsal. The circular-shaped design of the pivot point can functionally reduce any potentially high rotational traction force generated while turning or changing directions during the game. A previous research has shown that high rotational traction between the playing surface and shoe outsoles can potentially increase the risk of injury in sports due to higher ankle and knee joint loading (Wannop & Stefanyshyn, 2015). Therefore, the exclusion of the pivot point feature at the forefoot region of the outsoles may potentially reduce any foot fixations on the playing surface. This may cause injury while turning or changing directions. The flex line can supposedly increase the flexibility of shoes, particularly surrounding the metatarsophalangeal joint (MTPJ). A previous study has shown that futsal players perform various rapid movements and sprints during matches (Castagna et al., 2009). These movements would typically require players to flex the forefoot region. Increased forefoot flexibility will optimise the range of motion at the MTPJ and potentially assist players in performing highly demanding and rapid movements, such as sprints. This has been previously supported by a study which found that altering MTPJ range of motion can increase the peak joint moment, thus increasing the total energy generated during the push-off phase of sprinting (Smith et al., 2014).

However, the outcomes of this study revealed that the mid foot and rear foot regions have no association with any features, indicating that there are no specific features that currently define the mid and rear foot regions of the outsole. Th rear foot region of footwear is typically used to reduce any high-impact attenuation during movement which may increase the risk of injury (Morales-Orcajo et al., 2018). Therefore, the functionality of the rear foot region of the outsole may not be obvious from a visual perspective since its material properties can be the factor of impact reduction rather that its visual appearance. As for the mid foot region, it is unclear why no specific feature is associated with this region. Further research is warranted since the mid foot region includes the foot arch, which has shown to be one of the possible aspects that influence injury occurrence and sports performance (Han et al., 2015; Huang et al., 2022). Currently no study has clearly proven the effectiveness of the outsole features of shoes in providing any advantage to athletes, particularly in futsal. Therefore, these features and their effect on motion while playing sports should be extensively examined.

Conclusions

This study successfully illustrated the outsole features of futsal shoes, such as the tread groove pattern, and other characteristics like the pivot point, flex line and flexi bar. Most futsal outsoles were represented by Group 5 (43%), indicating that the forefoot, mid foot and rear foot possess non-identical tread designs. Futsal shoes that have identical tread patterns (15%) are much less for all three regions of the outsole (forefoot, mid foot and rear foot). The results further indicate the importance of features, such as the pivot point and flex line, based on the association with the forefoot region of the outsole. It is likely that these features will help futsal players successfully execute specific movements. The differences found within the outsole design represent their specific function assigned to each region of the shoe. However, these functions must be confirmed. Future research should focus on identifying and validating the actual functions of the mentioned features. This will determine whether these features help futsal players perform better and reduce any potential risk of injury during matches, or if such features are purely for aesthetic purpose.

Conflicts of interest: The authors have no conflicts of interest to declare.

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