ORIGINAL ARTICLES

The Foot Posture Index in Men Practicing Three Sports Different in Their Biomechanical Gestures

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Background: The technical gestures characteristic of certain sports may lead to one type of foot being more prevalent than the others. The Foot Posture Index (FPI) has been used as a diagnostic tool for support postures in various sports, but the differences in these postures between sports of distinct gestures in their actions are far from completely understood.

Methods: The overall FPI, obtained as the sum of the scores of its six individual criteria, was determined in 90 male athletes (30 runners, 30 basketball players, and 30 handball players) in static bipedal stance and relaxed position. Analysis of variance was used to find significant differences among the three sports in the total FPI and its six criteria.

Results: The mean ± SD FPI was 2.9 ± 2.8 in runners, 3.9 ± 4.1 in basketball players, and −0.4 ± 6.9 in handball players, with significant differences among these groups (P = .008). Significant differences were also found in the talar head position and talonavicular prominence values between handball players and runners (P = .001 and P = .004, respectively) and between handball and basketball players (P = .002 and P = .006, respectively).

Conclusions: Runners and basketball players had neutral feet, whereas handball players had supinated feet. The differences in foot posture seem to be mainly determined by two of the FPI criteria: talar head position and talonavicular prominence. (J Am Podiatr Med Assoc 104(2): 154-158, 2014)

In recent years, research into sports biomechanics has emerged as a useful tool for the prevention of sports injuries.1-3 The technical execution of ball sports such as basketball and handball involves sprints, jumps, accelerations, and decelerations in different planes and torsional loads or moments on the musculoskeletal system. In particular, the magnitudes and directions of the forces of impact are irregular and vary widely.4 Running is an example of a nonball sport. Its execution involves a repetitive technical gesture characterized by a succession of strides driving from support provided by each foot in turn, with one foot in support and the other airborne.5 In the past decade, there has been increased research interest in the static and dynamic behavior of the foot in different sports.6-8 One observation has been that the technical exigencies of certain sports lead to one foot type predominating over the others. For example, there is a greater proportion of pronated feet among runners9 and volleyball players.8 The Foot Posture Index (FPI) evaluates the multisegmental nature of foot posture in all three planes. Its measurement does not require the use of specialized equipment,10,11 and it has demonstrated good reliability and construct validity.12,13 The FPI has been used in studies of different sports.

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populations: runners, futsal players (five-on-a-side indoor soccer), triathletes, volleyball players, and professional dancers. One of the findings that stands out in these studies is the lower FPI of runners versus triathletes or futsal players, with runners having a more pronated foot, which may be associated with a series of overuse injuries.

However, there have as yet been no studies of differences in the FPI and its individual criteria among sports such as running, basketball, and handball, which involve distinct technical movements. One would expect the FPI to differ in these three sports, reflecting a specialization or adaptation of the foot posture to the sport’s technical gestures, thus increasing efficiency and reducing the incidence of injury. The objective of the present study was, therefore, to compare the foot posture, using the overall FPI and its individual criteria, in three sports with different technical gestures (running, handball, and basketball) and to determine whether age influences the static posture.

Materials and Methods

Participants

The sample consisted of 90 male participants (30 runners, 30 basketball players, and 30 handball players). All of the athletes were amateurs, but they were doing at least three training sessions per week and were competing regularly in their disciplines. The mean ± SD age of the sample was 32.2 ± 9.8 years; weight, 78.9 ± 11.8 kg; and height, 178.7 ± 9.2 cm. The anthropometric data by sport are listed in Table 1.

The criteria for inclusion were 1) men who are practicing running, basketball, or handball at least 4 days a week; 2) feet asymptomatic at the time of the study; 3) symmetrical feet, without joint deformities; and 4) age 18 to 65 years. The exclusion criteria were 1) female sex; 2) lower-limb surgery; 3) a serious foot injury that could alter its morphologic features or recent injuries that might modify either the support itself or the examiner’s perceptions during the clinical observation; 4) evident heterometry of the lower limbs; 5) loss of balance; and 6) practicing the sport below the stipulated level.

Informed verbal and written consent were obtained from all of the participants before enrollment, and all of the rights of the participants were protected. The procedures were approved by the Medical Research Ethics Committee of the University of Extremadura (Plasencia, Spain) and were conducted in accordance with the Declaration of Helsinki.

FPI Measurement

The participants stood in their relaxed stance position with double-limb support, their arms relaxed at their sides, and looking straight ahead; they were required to stand still in that position for approximately 2 min. Because the FPI has good intraobserver reliability but only moderate interobserver reliability, all of the measurements were made by the same examiner (E.G.B., with 5 years of experience as a podiatric physician and 3 years working with the FPI), with previously established intrarater reliability (intraclass correlation coefficient = 0.90–0.97) similar to that of other studies.

The six criteria used to evaluate the FPI were talar head palpation, supramalleolar and inframalleolar curvature, calcaneal frontal plane position, prominence in the region of the talonavicular joint, congruence of the medial longitudinal arch, and abduction/adduction of the forefoot on the rearfoot, scoring each criterion on a scale of −2, −1, 0, +1, or +2. Because there are no significant differences in the FPI between the right and left feet in asymptomatic individuals, for the statistical study and to maintain the independence of the data, the FPI values used refer only to the left foot measurements.

Statistical Methods

The values of the individual criteria and the total FPI used for the comparative analyses are given as mean ± SD. Differences between sports were examined using an analysis of variance (the Tukey test).
post hoc test). To determine the influence of age and foot size on the FPIs, a Pearson correlation \((r)\) analysis was performed for these variables. The statistical calculations were performed using the SPSS software package, version 15.0 (SPSS Inc, Chicago, Illinois). The significance level was taken to be \(P \leq .05\).

**Results**

The mean \(\pm\) SD value of the FPI for the overall sample was 2.5 \(\pm\) 4.8. Separately, the mean \(\pm\) SD values were 2.9 \(\pm\) 2.8 for runners, 3.9 \(\pm\) 4.1 for basketball players, and –0.4 \(\pm\) 6.9 for handball players. The analysis of variance showed significant differences in FPI values among the three sports \((P = .008)\).

The Tukey post hoc test showed that the differences in the FPI were significant between basketball players and handball players \((P = .006)\) and between runners and handball players \((P = .011)\) (Table 2).

The comparison between sports of each separate FPI criterion showed significant differences for talar head scores between runners and handball players \((P = .001)\) and between basketball and handball players \((P = .002)\) (Table 3). For the talonavicular prominence, there were significant differences between runners and handball players \((P = .004)\) and between basketball and handball players \((P = .006)\). Finally, there were significant differences between basketball and handball players \((P = .017)\) for the congruence of the medial longitudinal arch. There were no significant correlations of the age of the participants with their FPI or its individual criteria (Table 4).

**Discussion**

The mean FPI of the overall sample, 2.5, is closer to a position of neutrality than that of the general population, for which the FPI values tend to be approximately 4.10 The runners in this sample had a more pronated foot posture, which was even more accentuated in the basketball players. Both postures, however, were classifiable as neutral. The findings are similar to those reported in volleyball players and dancers, with a mean FPI of 4 in volleyball players8 and a tendency toward pronation in classical dancers.16

In contrast, handball players had a mean FPI in the range corresponding to supination. This may be because, in their sport, athletes are continually

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### Table 2. The Tukey Post Hoc Test for Comparison of the Overall FPI Between Sports

<table>
<thead>
<tr>
<th>Sport 1</th>
<th>Sport 2</th>
<th>(P) Value</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runners</td>
<td>Basketball</td>
<td>0.656</td>
<td>–4.01 to 1.86</td>
</tr>
<tr>
<td>Handball</td>
<td>Runners</td>
<td>0.011(^a)</td>
<td>–6.62 to 0.06</td>
</tr>
<tr>
<td>Basketball</td>
<td>Handball</td>
<td>0.006(^a)</td>
<td>1.06 to 7.65</td>
</tr>
</tbody>
</table>

\(^a\)Statistically significant.

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### Table 3. Multiple Comparisons of the Separate FPI Criteria Between Sports

<table>
<thead>
<tr>
<th>FPI Criterion</th>
<th>Sport 1</th>
<th>Sport 2</th>
<th>(P) Value</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talar head</td>
<td>Runners</td>
<td>Basketball</td>
<td>.971</td>
<td>–0.55 to 0.66</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Runners</td>
<td>.001(^a)</td>
<td>0.39 to 1.76</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>.002(^a)</td>
<td>0.34 to 1.69</td>
</tr>
<tr>
<td>Inf-Sup Curv</td>
<td>Runners</td>
<td>Basketball</td>
<td>.987</td>
<td>–0.54 to 0.48</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Runners</td>
<td>.142</td>
<td>–1.04 to 0.12</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>.101</td>
<td>–0.07 to 1.07</td>
</tr>
<tr>
<td>Calc Pl Fr</td>
<td>Runners</td>
<td>Basketball</td>
<td>.609</td>
<td>–0.73 to 0.32</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Runners</td>
<td>.419</td>
<td>–0.91 to 0.28</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>.091</td>
<td>–0.06 to 1.11</td>
</tr>
<tr>
<td>Tal-Nav Prom</td>
<td>Runners</td>
<td>Basketball</td>
<td>.988</td>
<td>–0.54 to 0.62</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Runners</td>
<td>.004(^a)</td>
<td>–1.57 to –0.25</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>.006(^a)</td>
<td>0.22 to 1.52</td>
</tr>
<tr>
<td>Congr Med Arch</td>
<td>Runners</td>
<td>Basketball</td>
<td>.385</td>
<td>–0.90 to 0.26</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Runners</td>
<td>.248</td>
<td>–1.10 to 0.22</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>.017(^a)</td>
<td>0.12 to 1.42</td>
</tr>
<tr>
<td>For Abd/Add</td>
<td>Runners</td>
<td>Basketball</td>
<td>.482</td>
<td>–0.95 to 0.33</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Runners</td>
<td>.377</td>
<td>–1.13 to 0.32</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>.050</td>
<td>0.00 to 1.43</td>
</tr>
</tbody>
</table>

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Three tables follow with additional information about the comparisons made:

1. Comparison of the FPI between sports using the Tukey post hoc test.
2. Multiple comparisons of the separate FPI criteria between sports using the Tukey post hoc test.
3. Correlations between age and FPI criteria using a Pearson correlation analysis.
making lateral displacements and pivots on the floor, causing moments of inversion in the knee and hip,
which may cause the tendency toward supinated support.

The present sample of runners presented a mean FPI of 2.9, reflecting a degree of pronation. In distance running, the foot would adapt to the ground in a greater degree to reduce the cyclical impact forces. In runners, therefore, a pronated foot may be beneficial and, indeed, is the most common in this sport. Other studies of triathletes and futsal and volleyball players report slightly higher FPI values, ranging from 4 to 5.3 (Table 5).

The FPI values of the samples of runners and basketball players are similar to those corresponding to a neutral position with a slight tendency toward pronation reported by Teyhen et al for runners and de Groot et al for volleyball players. However, in triathletes and futsal players, the FPI was close to the range published by Redmond et al corresponding to pronated feet (Table 5).

With respect to the relationship between the mean FPIs of the basketball and handball players, the difference was very large (FPIs of 3.9 and -0.4, respectively) despite these being the sports with the most technical gestures in common. This may be because the jumps made in handball are more horizontal, with tendencies toward lateralizations, thus causing increased external arch support. In basketball, the jumps are more vertical so that there will be more traction in takeoff and landing, with the medial plantar musculature under tension, the result being that the bone structure of the foot tends toward pronation. In the present sample, the significant difference in FPI between the basketball and handball players seems to be determined by the individual criteria of the position of the talar head, the talonavicular prominence, and the congruence of the medial longitudinal arch.

**Conclusions**

Runners and basketball players present a neutral position of the foot, with a tendency toward pronation. Handball players tend toward a position within the range of supination. The differences in FPI among the three sports are determined by some of its individual criteria, mainly, the position of the talar head and the talonavicular prominence, with the age of the athlete having no influence.

**Financial Disclosure:** None reported.

**Conflict of Interest:** None reported.

**References**


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**Table 5. FPI Values in Sports Reported in Various Studies**

<table>
<thead>
<tr>
<th>Source, Year</th>
<th>Sample</th>
<th>FPI (Mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The present study</td>
<td>Runners (n = 30)</td>
<td>2.9 ± 2.8</td>
</tr>
<tr>
<td>The present study</td>
<td>Basketball players (n = 30)</td>
<td>3.9 ± 4.1</td>
</tr>
<tr>
<td>The present study</td>
<td>Handball players (n = 30)</td>
<td>-0.4 ± 6.9</td>
</tr>
<tr>
<td>Teyhen et al, 2011</td>
<td>Runners (n = 1,000)</td>
<td>3.4 ± 2.9</td>
</tr>
<tr>
<td>Burns et al, 2005</td>
<td>Triathletes (n = 131)</td>
<td>5.1 ± 3.9</td>
</tr>
<tr>
<td>Cain et al, 2007</td>
<td>Indoor football (n = 76)</td>
<td>5.3 ± 2.9</td>
</tr>
<tr>
<td>de Groot et al, 2012</td>
<td>Volleyball players (n = 78)</td>
<td>4 ± 3.5</td>
</tr>
</tbody>
</table>

Abbreviation: FPI, Foot Posture Index.