Effects of wearing shoes on the feet:
A comparative study of the feet of middle-aged partially shod and regularly shod Maasai and Korean women

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Jun Young Choi, Jin Soo Suh

My disclosure is in the Final AOFAS Mobile App. I have no potential conflicts with this presentation.
The Maasai tribe

• **Semi-nomadic lifestyle**
  → Either barefoot or wearing a traditional shoes made from recycled car tires.

• **No foot ailments** with a long distance walking (up to 60km daily)

• **Choi et al (J Foot Ankle Res, 2014)**
  Partially shod Maasai women’s feet VS Regularly shod Korean women’s feet
  → Middle aged partially shod Maasai women have a higher prevalence of
    1. Abducted midfeet
    2. Everted hindfeet
    3. Fallen medial longitudinal arches.
  → Genetic and ethnic factors might have not been rule out.
• **A newly designed study**
  that compared radiographs of the feet of

Middle-aged Maasai women dwelling **partially shod in the bush** and those of middle-aged Maasai and Korean women living in the **modernized ready-made shoe-wearing society**.

• **Hypothesis**

  1. Partially shod (**PS**) Maasai women would be more likely to have **pes plano-valgus and claw toe deformities** than regularly shod (**RS**) Maasai and Korean women

  2. RS Maasai and Korean would have **larger hallux valgus deformity**
Materials & Methods

- From Sep, 2012 ~ Mar, 2013 (PS Maasai in Tanzania)
- From Jun, 2014 ~ Dec, 2014 (Korea)
- From May, 2016 ~ Oct, 2016 (RS Maasai in Tanzania)

- **Forty feet from 20 healthy middle aged women for each group (46~55 years old)**

- **Exclusion criteria**
  1) Systemic inflammatory ds. (RA, gout)
  2) Predisposing trauma

- **Measuring surface anatomy**
  1) Foot length, width and the ratio
  2) Toe deformity : mallet, claw with/without corn

- **Measuring step length, cadence, walking velocity**
Materials & Methods

The angle between

a and b (Hallux Valgus Angle)

b and c (the first to second Inter-Metatarsal Angle)

b and d (Talo-1st metatarsal angle)

e and f (Talo-Navicular Coverage Angle)

The angle between

g and h (Mearly angle)
i and j (Calcaneal Pitch Angle)

The ratio of l divided by k (Naviculo-Cuboid Overlap)
The length of m (Medial Cuneiform Height)
## Results

### Participant demographic characteristics

<table>
<thead>
<tr>
<th></th>
<th>PS Maasai</th>
<th>RS Maasai</th>
<th>Korean</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>48.55±3.76</td>
<td>48.90±2.92</td>
<td>49.1±3.28</td>
<td>0.489</td>
</tr>
<tr>
<td><strong>Body weight (kg)</strong></td>
<td>57.3±12.03</td>
<td>54.25±10.92</td>
<td>62.0±8.91</td>
<td>0.096</td>
</tr>
<tr>
<td><strong>Body height (cm)</strong></td>
<td>159.55±5.60</td>
<td>156.15±6.37</td>
<td>160.7±3.91</td>
<td>0.287</td>
</tr>
<tr>
<td><strong>BMI (kg/m(^2))</strong></td>
<td>22.44±4.30</td>
<td>22.27±4.42</td>
<td>24.06±3.72</td>
<td>0.108</td>
</tr>
</tbody>
</table>

### Surface anatomy and gait related parameters

<table>
<thead>
<tr>
<th></th>
<th>PS Maasai</th>
<th>RS Maasai</th>
<th>Korean</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Foot length (cm)</strong></td>
<td>243.5±12.15</td>
<td>238.5±12.72</td>
<td>234.75±6.78</td>
<td>0.014</td>
</tr>
<tr>
<td><strong>Foot width (cm)</strong></td>
<td>99.73±5.02</td>
<td>98.21±5.48</td>
<td>95.59±4.53</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>Foot width/foot length</strong></td>
<td>0.41±0.01</td>
<td>0.41±0.04</td>
<td>0.41±0.02</td>
<td>0.677</td>
</tr>
<tr>
<td><strong>Step length (cm)</strong></td>
<td>43.35±6.94</td>
<td>40.48±7.01</td>
<td>36.83±11.46</td>
<td>0.031</td>
</tr>
<tr>
<td><strong>Cadence</strong></td>
<td>95.1±3.39</td>
<td>95.45±4.00</td>
<td>114.8±12.45</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>Walking velocity (m/min)</strong></td>
<td>41.17±6.48</td>
<td>38.22±6.72</td>
<td>42.81±15.16</td>
<td>0.755</td>
</tr>
</tbody>
</table>

PS, partially shod; RS, regularly shod; BMI, body mass index
### Results

#### Radiographic parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PS Maasai (°)</th>
<th>RS Maasai (°)</th>
<th>Korean (°)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight-bearing ankle AP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TAS</strong></td>
<td>91.67±1.65</td>
<td>90.56±2.59</td>
<td>88.85±2.21</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>TLS</strong></td>
<td>83.97±1.96</td>
<td>83.31±2.93</td>
<td>79.7±2.27</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>Talar tilt</strong></td>
<td>1.58±0.63</td>
<td>1.48±0.78</td>
<td>1.47±1.06</td>
<td>0.201</td>
</tr>
<tr>
<td><strong>Weight-bearing foot AP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TNCA</strong></td>
<td>31.95±10.23</td>
<td>21.95±10.04</td>
<td>15.60±7.06</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>T1MTA</strong></td>
<td>26.53±5.42</td>
<td>19.82±10.55</td>
<td>11.70±6.25</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>HVA</strong></td>
<td>7.57±4.43</td>
<td>10.15±5.62</td>
<td>13.99±4.88</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>IMA</strong></td>
<td>7.59±2.17</td>
<td>9.29±2.69</td>
<td>10.86±2.19</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>Weight-bearing foot lateral</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mearry angle</strong></td>
<td>-15.55±6.46</td>
<td>-11.65±7.65</td>
<td>-9.08±7.08</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>CPA</strong></td>
<td>15.98±3.81</td>
<td>16.84±4.37</td>
<td>17.19±5.31</td>
<td>0.388</td>
</tr>
<tr>
<td><strong>MCH (mm)</strong></td>
<td>15.55±2.31</td>
<td>17.78±2.95</td>
<td>17.75±3.03</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>NCO (ratio)</strong></td>
<td>0.54±0.12</td>
<td>0.47±0.15</td>
<td>0.44±0.14</td>
<td>0.001</td>
</tr>
</tbody>
</table>

PS, partially shod; RS, regularly shod; TAS, tibial anterior surface angle; TLS, talar lateral surface angle; TNCA, talo-navicular coverage angle; T1MTA, talo-1st metatarsal angle; HVA, hallux valgus angle; IMA, 1st to 2nd intermetatarsal angle; CPA, calcaneal pitch angle; MCH, medial cuneiform height; NCO, naviculo-cuboid overlap.
**Discussion**

• **Regarding ankle alignment**
  - TAS and TLS in both PS and RS Maasai were significantly higher than Korean
    → not affected by wearing shoes, but by the characteristics of ethnic group.
  - Talar tilt: maintained constantly regardless of ethnic group, shoe-wearing habit

• **Regarding midfoot & hindfoot alignment**
  - **PS Maasai** showed more abducted midfoot and greater degree of pes plano-valgus deformity than RS Maasai and Koreans.
    1. Significantly greatest NCO, TNCA and T1MTA
    2. Significantly lower Meary angle and MCH

• **NCO, TNCA and T1MTA** were reliable and valid measures for the evaluation of hindfoot valgus and varus deformity

*Lee KM et al. JBJS Am. 2010*
Discussion

• Regarding forefoot deformity
  - Significantly increased HVA and IMA in **RS Maasai** and **Korean**
  - Significantly lower HVA and IMA in **RS Maasai** comparing to Korean
  - Claw toe deformity was very common in the Maasai tribe regardless of shoe wearing habits (PS Maasai 95%, RS Maasai 80%, Korean 0%)

• Claw toe deformity occurred in 98.79% of 1,096 Maasai people. (especially in 5th, 62.34%)

• Limitations of our study
  1. Small sample number
  2. Need for comparison with other ethnic groups (i.e., Caucasians)

*Choi et al. Clin in Ortho Surg. 2014*
Summary

- Regularly wearing shoes would protect the feet from pes plano-valgus deformity, despite increasing the risk of hallux valgus deformity.

- Claw toe deformity was found frequently in the Maasai tribe, regardless of shoe-wearing habits.


