ORIGINAL ARTICLE

Difference in plantar pressure between the preferred and non-preferred feet in four soccer-related movements

Pui-lam Wong, Karim Chamari, Anis Chaouachi, De Wei Mao, Ulrik Wisløff, Youlian Hong

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See end of article for authors' affiliations

Correspondence to:
P Wong, Department of
Sports Science and Physical
Education, The Chinese
University of Hong Kong,
852 Hong Kong; delwong@
alumni.cuhk.net

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Objective and participants: The present study measured the difference in plantar pressure between the preferred and non-preferred foot in four soccer-related movements in 15 male university soccer players (mean (SD) age 20.9 (1.3) years, mean (SD) height 173 (4) cm and mean (SD) weight 61.7 (3.6) kg).

Design: To record plantar pressure distribution, players randomly wore three types of soccer shoes (classical 6-stud and 12-stud, and specially designed 12-stud) embedded with an insole pressure recorder device with 99 sensors, divided into 10 areas for analysis. Plantar pressure was recorded in five successful trials in each of the four soccer-related movements: running (at 3.3 m/s), sideward cutting, 45° cutting and landing from a vertical jump.

Results: Plantar pressures of the preferred and non-preferred foot were different in 115 of 120 comparisons. The overall plantar pressure of the preferred foot was higher than that of the non-preferred foot. Specifically, in each of the four movements, higher pressure was found in the preferred foot during the take-off phase, whereas this was found in the non-preferred foot during the landing phase. This would suggest a tendency of the preferred foot for higher motion force and of the non-preferred foot for a greater role in body stabilisation.

Conclusions: The data indicate that the preferred and non-preferred foot should be treated independently with regard to strength/power training to avoid unnecessary injuries. Different shoes/insoles and different muscular strengthening programmes are thus suggested for each of the soccer player's feet.

Soccer is one of the most popular sports, with >240 million players worldwide.¹ While playing, most soccer players tend to have a preferred leg with which they would receive, control and kick the ball.^{2–3} Previous studies have reported that the preferred leg of soccer players, when compared with the non-preferred leg:

- produces significantly higher ball speed in maximal instep kicking⁴ and three-steps drive kicking⁵;
- has considerably greater angular velocities of the shank and thigh on impact with the ball;^{4,6}
- has significantly greater peak and average torques measured by computerised dynamometer during knee extension at angular velocities of 0°/s, 60°/s, 180°/s and 240°/s;^{2,5}
- has considerably greater knee muscle moment⁶ and strength of knee flexor muscles³;
- has a notably larger muscle size⁷; and
- has considerably higher accuracy at kicking the ball.⁵

As the characteristics of the preferred leg are very different from the non-preferred leg, it would be reasonable to hypothesise that the plantar pressure distribution of the preferred foot is different from that of the non-preferred foot. However, to our knowledge, there is no experimental evidence. Furthermore, it has also been reported that the preferential use of one leg over the other in soccer players leads to muscle imbalance,⁸ and muscle imbalance then increases the potential for injury.^{9–10} To show the degree of asymmetry, absolute difference¹¹ and adjusted ratio¹² have been used. The symmetry index is a ratio that was first introduced by Robinson *et al*¹³ and has been used for evaluation of symmetry in ground reaction force of gait,¹⁴ kinematics of gait¹⁵ and running,¹⁶ and has been found to be the most useful and easily understood method of presenting the results, as it defines perfect symmetry as zero and shifts either towards or away from it.¹⁵

Plantar pressure asymmetry provides useful information for training to avoid body imbalance. It can be used as a guideline in the assessment of progress in a rehabilitation programme and can serve as an objective evaluation tool in the diagnosis of players with risk of incurring injuries in the plantar surface of the foot. It could also provide information for soccer shoe manufacturers to know whether shoes for the preferred and non-preferred foot have to be made similarly, or whether a different shoe should be made for each foot.

Previous studies analysing professional players in international matches found that passing, jumping/heading, turning, running and dribbling are the most frequent movements.^{17–18} Furthermore, two previous studies have reported that professional players covered the most distance by jogging (running at moderate speed), followed by walking, sprinting and moving backwards.^{19–20} In addition, jump landing, which is one of the most frequent movements in soccer,^{17–18} has not been studied previously. To increase reproducibility, those movements involving a ball (ie, passing and dribbling) were not selected. Therefore, in the present study, moderate speed running (approximately 3.3 m/s), sideward cutting, 45° cutting and jump landing were selected.

The purposes of this study were (1) to examine the differences of in-shoe plantar pressure and (2) to calculate the degree of asymmetry between the preferred and non-preferred foot in four soccer-related movements using different types of studded-soccer shoes.

METHODS

Subjects and shoes

Fifteen male soccer players (mean (SD) age 20.9 (1.3) years; height 173 (4) cm; weight 61.7 (3.6) kg; self-reported experience of playing soccer 10.2 (3) years; self-reported experience of wearing soccer shoes 4.7 (2.2) years) with approximately the same foot size participated in the study. They were asked to

identify their preferred leg according to their experience; as recorded, three of them shoot dominantly with their left leg. The players were, at the time, members of the university soccer team and were free, from injuries during the time of the study. All players were properly informed of the nature of the study without being informed of its detailed aims, and each signed a written consent before participation. The protocol was approved by the Clinical Research Ethics Committee.

Three experimental shoes were used (fig 1): 6 (circular) studs, 12 (circular) studs and 12 studs designed by Diadora (Giavera del Montello, Veneto, Italy), hereafter named 12 D-stud. These shoes were of the same size (EUR 43) and were used by all players to minimise any possible effect of shoe size on performance and subsequent measures. The three shoe types were provided to the players in random order. Players were required to finish the four movements in one shoe type before changing into another shoe type. Players wore the same type of thin soccer socks without being taped at the ankles. The shoes were then examined manually by palpation to ensure that they fitted the players. The players' feet did not present any visible valgus or varus, and none of the players reported any foot problem during the test procedures.

Equipment

Insole plantar pressure distribution was recorded using the Pedar Mobile System (Novel GmbH, Munich, Germany) containing 99 sensors in a matrix design. The device has been proved as an accurate, highly repeatable and valid instrument

to measure human movements.^{21 22} During data collection, the device was placed between the shoe and the plantar surface of the foot. The data logger for data storage was secured by a belt on the players' waist, which received the data by telemetry. Plantar pressures were recorded at 50 Hz simultaneously from the players' feet.

Experimental design and procedure

Before the experimental testing, the players warmed up on a FIFA-approved 20 m × 8 m third generation synthetic turf area (FieldTurf, New York, USA). During the self-paced warm-up period, players were required to perform 210 m of running, five sideward cuttings on each of the left and right sides, five 45° cuttings on each of the left and right sides, five landings from countermovement vertical jump (maximum height) and another 5 min of passive muscle stretching.

The test was performed on the same turf. The four soccer-related movements performed were:

- running at 3.3 m/s;
- sideward cutting at maximum speed;
- 45° cutting at maximum speed; and
- landings from countermovement vertical jump after an effort to reach maximal jump height each time.

The same movement sequence was arranged for all players, and five successful trials were collected for each movement. The average of the five trials was used in data handling. Players

Figure 1 The experimental shoes and their stud positions. The black lines in each footprint represent the 10 recorded areas (from top to bottom, and from left to right): hallux, second toe, lateral toes, medial forefoot, central forefoot, lateral forefoot, medial arch, lateral arch, medial heel and lateral heel.

6 (circular) studs

12 (circular) studs

12 Diadora studs

Figure 2 The experimental set-up and running paths for the following movements: (A) running, (B) sideward cutting and (C) 45° cutting to the right. For running (A), the subjects ran from the starting point to the end point in each trial. Two pairs of infrared timing sensors (R) were located in the middle of the run. For sideward cutting (B), the subjects started from the left cutting area (SL), performed three or four side steps to reach the right cutting area (SR), and then cut back to the left cutting area (SL); the movement was started from a standing still position. For 45° cutting (C), the subjects started from the starting point, ran to the right cutting area (CR) and then, after cutting in the area, the subjects performed sidesteps to the left cutting area (CL).

were allowed to recover for 1 min between each of the movement repetitions.

Figure 2 illustrates the running paths. Two pairs of infrared timing sensors ("R" in fig 2A; Speedtrap II Wireless Timing System, Brower Timing System, Australia) were located in the middle of the run (10 m) to determine whether the running speed was within 5% of 3.3 m/s. Only the trials that fell within the desired range of speed were accepted and subsequently analysed.

The players performed sideward cutting and 45° cutting movements with their preferred and non-preferred legs, in a random order of legs. Figure 2B,C shows the paths of sideward

cutting and 45° cutting for players cutting to the right side; the paths for players cutting to the left side were in the opposite direction.

For the countermovement vertical jump, the players performed the jump on the turf area near the starting point. They were required to land on both feet after trying to reach their maximum jump height.

Plantar pressure data

Each footprint was divided into 10 recorded areas (fig 1) using the Novel Multimask software: hallux, second toe, lateral toes, medial forefoot, central forefoot, lateral forefoot, medial arch,

Figure 3 Typical plantar pressure during running. The preferred foot is the right foot.

Table 1 Peak plantar pressure (kPa) in preferred and non-preferred foot in 10 recorded areas

	Running			Sideward cutting			45° cutting			Jump landing		
	6-stud	12-stud	12 D-stud	6-stud	12-stud	12 D-stud	6-stud	12-stud	12 D-stud	6-stud	12-stud	12 D-stud
Hallux												
Preferred	371 (66)	383 (124)	382 (75)	381 (86)	436 (83)	372 (87)	418 (88)	492 (75)	463 (78)	329 (58)	375 (70)	330 (66)
Non-preferred	337 (94)	310 (116)	337 (99)	346 (76)	410 (104)	364 (84)	387 (88)	492 (81)	433 (82)	307 (91)	336 (87)	298 (84)
p Value	0.06	0.01*	0.01*	0.01*	0.17	0.61	0.14	0.99	0.08	0.11	0.04†	0.01*
Second toe												
Preferred	149 (25)	141 (33)	142 (29)	286 (70)	221 (85)	241 (89)	383 (67)	296 (109)	331 (90)	145 (33)	126 (43)	135 (33)
Non-preferred	142 (36)	126 (21)	140 (47)	276 (99)	234 (95)	257 (100)	332 (91)	286 (98)	314 (122)	139 (48)	111 (33)	143 (56)
p Value	0.49	0.05†	0.85	0.7	0.61	0.53	0.03†	0.68	0.57	0.55	0.16	0.59
Lateral toes												
Preferred	157 (42)	133 (42)	157 (48)	175 (65)	145 (59)	148 (51)	220 (63)	183 (47)	198 (49)	126 (46)	129 (65)	140 (59)
Non-preferred	157 (41)	126 (44)	148 (36)	183 (61)	157 (44)	170 (51)	206 (58)	191 (44)	195 (46)	124 (44)	111 (42)	126 (38)
p Value	0.96	0.32	0.31	0.59	0.28	0.07	0.42	0.51	0.72	0.90	0.11	0.15
Medial forefoot												
Preferred	313 (90)	367 (129)	322 (95)	457 (85)	518 (78)	420 (93)	472 (60)	550 (72)	474 (91)	251 (74)	325 (108)	241 (68)
Non-preferred	307 (76)	347 (110)	297 (82)	479 (96)	531 (84)	422 (96)	463 (78)	529 (63)	462 (84)	246 (76)	285 (84)	220 (65)
p Value	0.68	0.22	0.14	0.19	0.47	0.90	0.60	0.28	0.45	0.62	0.02†	0.07
Central forefoot												
Preferred	243 (40)	326 (51)	252 (47)	348 (105)	330 (150)	321 (112)	358 (103)	347 (134)	356 (127)	184 (39)	198 (35)	172 (334)
Non-preferred	246 (45)	310 (51)	242 (39)	323 (88)	343 (122)	326 (80)	335 (87)	373 (113)	338 (77)	169 (38)	192 (54)	171 (34)
p Value	0.73	0.30	0.34	0.28	0.66	0.82	0.38	0.23	0.40	0.04†	0.46	0.79
Lateral forefoot												
Preferred	205 (49)	178 (45)	194 (51)	93 (26)	82 (27)	115 (27)	101 (27)	79 (30)	116 (22)	148 (21)	132 (28)	153 (28)
Non-preferred	221 (49)	186 (42)	198 (36)	112 (19)	84 (19)	120 (24)	105 (33)	80 (34)	113 (38)	157 (32)	141 (40)	160 (30)
p Value	0.18	0.41	0.71	0.01*	0.85	0.59	0.77	0.90	0.83	0.27	0.26	0.38
Medial arch												
Preferred	88 (19)	106 (25)	103 (22)	183 (63)	181 (70)	219 (98)	171 (75)	144 (84)	167 (80)	92 (26)	111 (40)	122 (54)
Non-preferred	85 (15)	109 (21)	97 (19)	164 (69)	167 (73)	202 (79)	144 (47)	123 (59)	143 (54)	86 (17)	107 (22)	103 (30)
p Value	0.51	0.35	0.13	0.25	0.51	0.37	0.15	0.33	0.13	0.27	0.56	0.06
Lateral arch												
Preferred	106 (21)	121 (24)	108 (18)	77 (20)	86 (26)	86 (25)	72 (22)	69 (18)	79 (23)	91 (32)	113 (38)	109 (44)
Non-preferred	106 (23)	127 (29)	111 (20)	70 (20)	88 (35)	85 (29)	67 (24)	69 (22)	83 (20)	93 (24)	116 (28)	116 (33)
p Value	0.99	0.09	0.45	0.14	0.83	0.95	0.39	0.91	0.52	0.83	0.65	0.49
Medial heel												
Preferred	197 (46)	238 (49)	218 (59)	289 (95)	351 (82)	276 (97)	388 (95)	441 (78)	387 (83)	148 (54)	217 (116)	181 (82)
Non-preferred	213 (44)	254 (48)	219 (51)	286 (114)	334 (105)	277 (116)	370 (91)	438 (74)	368 (95)	158 (55)	200 (61)	166 (63)
p Value	0.08	0.03†	0.93	0.88	0.49	0.96	0.41	0.84	0.27	0.45	0.44	0.20
Lateral heel												
Preferred	194 (47)	247 (59)	183 (47)	250 (79)	295 (90)	227 (72)	316 (101)	401 (104)	299 (86)	156 (58)	208 (115)	155 (77)
Non-preferred	208 (37)	262 (53)	206 (54)	253 (91)	297 (101)	257 (91)	304 (97)	407 (81)	301 (71)	163 (66)	196 (54)	160 (66)
p Value	0.03†	0.04†	0.05	0.86	0.91	0.15	0.60	0.76	0.94	0.52	0.58	0.63

Values are shown as mean (SD).

*Indicates significant difference between the preferred and non-preferred foot at $p < 0.01$.†Indicates significant difference between the preferred and non-preferred foot at $p < 0.05$.

Table 2 Comparison between the preferred and non-preferred foot in three shoes

	6-stud		12-stud		12 D-stud	
	Mean 12 studs	Mean difference	Mean 12 studs	Mean difference	Mean 12 studs	Mean difference p
Preferred	228.32		245.50		227.35	
Non-preferred	221.67	6.65	239.62	5.88	222.20	5.15

Mean represents the estimated marginal mean (kPa) of the four soccer-related movements. Mean difference was calculated using estimated marginal means (kPa; the mean of preferred foot minus the mean of the non-preferred foot).

lateral arch, medial heel and lateral heel. For each footprint, peak pressure (kPa) was extracted. Peak pressure represented the highest pressure measured by each recorded area at any time during the data collection period.

Statistical analysis

The software package SPSS V.12 was used in the data analysis. The level of significance was set at an α level of 0.05. An independent samples t test was used to examine the differences in the plantar pressure of each recorded area between the preferred foot and the non-preferred foot in each of the three shoes studied. Repeated measures multivariate analysis of variance was used to examine the overall plantar pressure differences in preferred foot and non-preferred foot across the

shoes. In addition, two-way repeated measures analysis of variance (ANOVA) was performed to further dissect the above plantar pressure differences in four soccer-related movements. The degree of asymmetry between the preferred foot and the non-preferred foot was then assessed using the symmetry index,¹³ which was defined as:

$$\text{Symmetry index} = \frac{2(P_d - P_n)}{(P_d + P_n)} \times 100\%$$

where P_d is the peak plantar pressure of the preferred foot and P_n is the peak plantar pressure of the non-preferred foot. The averaged symmetry index among all the players was analysed, and the data were presented as mean (SD).

Figure 4 Typical plantar pressure during sideward cutting. The preferred foot is the right foot.

Figure 5 Typical plantar pressure during 45° cutting. The preferred foot is the right foot.

RESULTS

The approximate time durations of each footprint in the four movements were: running (0.20–0.26 s), sideward cutting (0.28–0.34 s), 45° cutting (0.24–0.28 s) and jump landing (0.12–0.16 s).

We observed significantly different results in plantar pressure in the preferred and non-preferred foot depending on shoe studied. The recorded data for running were $F_{2,13} = 12.12$, $p = 0.001$ and $F_{2,13} = 9.53$, $p = 0.003$ and for jumping $F_{2,13} = 5.84$, $p = 0.016$ and $F_{2,13} = 5.74$, $p = 0.016$ for the preferred and non-preferred foot, respectively; for sideward cutting in preferred foot, $F_{2,13} = 5.77$, $p = 0.016$ and for 45° cutting in non-preferred foot, $F_{2,13} = 5.95$, $p = 0.015$. Hence, the results for the three shoes are presented separately (table 1).

Plantar areas

No identical peak plantar pressures were observed between the preferred and non-preferred foot (table 1), and significant differences in peak pressure were observed between the preferred non-preferred foot during running (peak pressure measured under the hallux for the 12-stud and 12 D-stud shoes, under the second toe for the 12-stud shoe; under the medial heel for the 12-stud shoe; and under the lateral heel for the 6-stud and 12-stud shoes), sideward cutting (peak pressure measured under the hallux and lateral forefoot for the 6-stud shoe), 45° cutting (peak

pressure under the second toe for the 6-stud shoe) and jump landing (peak pressure recorded under the hallux for the 12-stud and 12 D-stud shoes, medial forefoot for under the 12-stud shoe, under the central forefoot for the 6-stud shoe).

Effects of different shoes

Three within-player independent variables (foot preference, type of movement and recorded area) were included to calculate the peak pressure differences of the preferred and non-preferred foot in each recorded area during each soccer-related movement (table 2). Univariate results suggest that the three-way interaction (foot preference $\times$ type of movement $\times$ recorded area) and the two-way interactions (foot preference $\times$ type of movement and foot preference $\times$ recorded area) were not significant ($p > 0.05$). The main effects of foot preference were marginally significant for the 6-stud shoe, $F_{1,14} = 4.10$, $p = 0.06$, followed by the 12-stud shoe, $F_{1,14} = 3.37$, $p = 0.09$, and the 12 D-stud shoe, $F_{1,14} = 3.09$, $p = 0.1$. There were marginally significant plantar pressure differences between the preferred and non-preferred foot in the 6-stud shoe. Bonferroni adjustment was adopted for multiple comparisons to reduce the possibility of a type I error.²³ Results indicate that the mean differences in plantar pressure between the preferred and non-preferred foot were always positive, suggesting that the peak pressure is always greater in the preferred foot.

Figure 6 Typical plantar pressure during jump landing. The preferred foot is the right foot.

Effects of different movements

Figures 3–6 illustrate typical plantar pressure distributions during the four soccer-specific movements. Foot preference (2 levels) and recorded areas (10 levels) were entered as within-player independent variables in each ANOVA performed (table 3), and results show that the interaction (foot preference $\times$ recorded area) was not significant ($p > 0.05$) in the 12 ANOVAs conducted. Significant difference in peak plantar pressure was only identified during running in the 12-stud shoe ($p < 0.05$). Marginal significant differences were identified in running in the 12 D-stud shoe ($p = 0.06$) and 45° cutting in the 6-stud shoe ($p = 0.05$). Bonferroni adjustment was adopted for multiple comparisons of foot preference over the recorded areas. As shown in table 3, the mean differences in peak plantar pressure were all positive except for sideward cutting in the 12 D-stud shoe. This result indicates that the peak pressure in the preferred foot is always higher than that in the non-preferred foot.

Symmetry index

No perfect symmetry of peak pressure between the preferred and non-preferred foot was observed (table 4). In the 120 symmetry indices (10 areas $\times$ 3 shoes $\times$ 4 movements), only five zero values for symmetry indices were reported (ie, the same peak pressure at the area during that specific movement): running (lateral toes for 6-stud shoe), sideward cutting (medial forefoot for 12 D-stud shoe), 45° cutting (hallux for 12-stud shoe), and jump landing (lateral toes for 6-stud shoe and medial arch for 12-stud shoe). Plantar pressures in the preferred foot and the non-preferred foot were not symmetrical in most cases (approximately 96%).

DISCUSSION

The present study shows that, overall, in the studied soccer players, plantar pressure in the preferred foot was higher than

that in the non-preferred foot. Specifically, in each of the four movements, higher pressure was found in the preferred foot during the take-off phase, whereas it was found in the non-preferred foot during the landing phase. However, during landing from a maximal jump, higher pressure was found in the preferred foot under the hallux.

During running, the normal sequence in the ankle joint is supination at foot strike, after which the foot pronates to a position of maximum pronation, and then supinates again during take-off.²⁴ The plantar pressure in the present study is in agreement with the ankle joint movements described above (fig 3). In addition, our results suggest that the preferred foot plays a more important part than the non-preferred foot in forward motions whereas the non-preferred foot ensures strong impact with the ground for stability.

In support of this, we found similar plantar pressure distribution in sideward cutting (fig 4) and 45° cutting (fig 5), during which higher pressure was found in the preferred foot during the take-off phase, and in the non-preferred foot during the landing phase. The major difference between these two movements was that, in sideward cutting, the foot landed first with the hallux and medial forefoot, and, in 45° cutting, the foot landed first with the heel.

Interestingly, the players relied more on the preferred foot during jump landing (fig 6), when, in contrast with the other three movements studied, the feet come into contact with the ground almost simultaneously. Based on the results from previous studies,^{3,6,7} it is reasonable to assume that the preferred leg was stronger than the non-preferred leg, and that the high force involved in a landing from a maximal vertical jump led the players naturally to put more pressure on the stronger leg.

One important observation was that the difference in pressure between the preferred and non-preferred foot was larger when using the 6-stud shoe compared with the other

Table 3 Comparison between the preferred and non-preferred foot in four movements

	6-stud			12-stud			12 D-stud		
	Mean difference 12 studs	F	p Value	Mean difference 12 studs	F	p Value	Mean difference 12 studs	F	p Value
Running	0.03	0	0.99	8.32	5.6	0.03*	6.5	4.27	0.06
Sideward cutting	4.75	0.53	0.48	0.01	0	0.99	-5.52	0.94	0.35
45° cutting	18.93	4.49	0.05	1.233	0.06	0.81	12.04	3.52	0.08
Jump landing	2.9	0.54	0.47	13.96	3.09	0.1	7.6	3.19	0.1

*p<0.05.

Mean difference was calculated using estimated marginal means (kPa; with the mean of preferred foot minus the mean of the non-preferred foot).

shoe types. This clearly shows the need for new studies to investigate the relationship between the studs' properties (surface area, length and material) and plantar pressure. Moreover, comparison of peak pressure between the feet in four movements also showed that the overall peak plantar pressure of the preferred foot is always higher than that of the non-preferred foot (table 3). Furthermore, the symmetric index showed no perfect symmetry between the preferred and non-preferred foot, which ranged from -15 to 23. On the basis of these results, it would be reasonable to treat the preferred and non-preferred foot independently.

The data obtained in the present study generally agree with the findings reported by Eils *et al.*²⁵ in which higher peak pressures were measured in the medial side rather than in the lateral side of the plantar surface during running and cutting movements in soccer. In addition, in both studies, the cutting movement produced a higher peak pressure than running under the hallux, second toe, medial forefoot, medial arch, medial heel and lateral heel, but a lower peak pressure than running under the lateral forefoot and lateral arch. However, in the present study, the players' mean body weight was approximately 62 kg, and the shoe size was 43 (Eur), whereas in the study conducted by Eils *et al.*²⁵ the players' mean body weight was approximately 79 kg. This suggests that, compared with players of other stature with body masses of around 75 up to 87 kg,²⁶ the plantar pressures may be much greater than reported in the present study.

Suggestions

Different shoes/insoles for each foot

It has been reported that a thin hard sole increases the stability of the human body.²⁷ Therefore, we suggest that players use an insole that provides higher stability in their non-preferred foot, as this foot is usually used to support the whole body—that is, during passing and kicking. The present study also shows that this foot seems to stabilise the body during moderate-speed

running, sideward cutting and 45° cutting. We also suggest that players use insoles that provide better cushioning in their preferred foot to absorb/reduce the plantar pressure, as this foot has been shown to present higher plantar pressures. In this context, Adidas has recently launched a series of soccer shoes (+F50.6 TUNIT) with detachable insoles. Two sets of different insoles are included in the Premium Set; one is more comfortable and the other is lighter. This concept of different insoles for different playing situations would facilitate the use of different insoles according to the needs of the preferred and non-preferred foot.

Muscle-strengthening programme to prevent injury

While waiting for the manufacturers to act, which could take a long time, soccer and fitness coaches are recommended to implement separate strengthening and conditioning programmes for different legs of soccer players for the purpose of injury prevention. It has been reported that approximately 70% of the soccer players had significant musculoskeletal abnormality (bilateral imbalance >10%) in one or more specific muscle groups.³ In addition, a 20% bilateral leg strength imbalance is relative to the preinjury level of collegiate soccer players,² and the 10% greater bilateral strength imbalance may be a contributing factor to knee-joint injury.²⁸ Moreover, a 15% bilateral leg strength difference would lead to 2.6 times more likelihood of players having an injury to the weaker leg.²⁹

It has been reported that the knee flexors (hamstrings) of the preferred leg are weaker than those of the non-preferred leg, especially in concentric and eccentric modes at an angular velocity of 120°/s.³ The reason for the difference in muscle strength is that, during kicking, the knee of the non-preferred leg is bent so that its flexor muscles help to stabilise the joints, support the body weight and resist the reaction of the torque developed by the preferred leg. In contrast, the knee flexor activity of the preferred leg needs to be minimised so as to allow the knee to extend rapidly as it comes in contact with the ball.

Table 4 Averaged symmetry index (%) of peak plantar pressure

	Running			Sideward cutting			45° cutting			Jump landing		
	6-stud	12-stud	12 D-stud	6-stud	12-stud	12 D-stud	6-stud	12-stud	12 D-stud	6-stud	12-stud	12 D-stud
Hallux	12 (21)	23 (24)	15 (19)	9 (11)	8 (19)	2 (17)	8 (22)	1 (16)	7 (14)	10 (21)	12 (23)	12 (17)
Second toe	6 (23)	10 (18)	4 (24)	4 (31)	-6 (46)	-6 (39)	16 (22)	1 (37)	8 (35)	7 (26)	9 (31)	-2 (30)
Lateral toes	1 (15)	6 (19)	5 (22)	-6 (31)	-12 (26)	-15 (29)	6 (32)	-5 (24)	2 (20)	1 (27)	9 (33)	6 (26)
Medial forefoot	1 (20)	5 (20)	8 (20)	-4 (14)	-2 (13)	-1 (13)	3 (15)	4 (15)	2 (15)	3 (18)	13 (22)	9 (17)
Central forefoot	-1 (13)	5 (17)	4 (14)	7 (25)	-8 (34)	-5 (26)	6 (29)	-10 (23)	2 (23)	8 (14)	5 (16)	1 (15)
Lateral forefoot	-8 (20)	-5 (20)	-4 (23)	-21 (28)	-4 (35)	-5 (29)	-1 (44)	-1 (63)	6 (42)	-5 (21)	-5 (18)	-5 (23)
Medial arch	3 (19)	-4 (12)	6 (15)	14 (32)	10 (49)	6 (32)	14 (34)	12 (44)	12 (33)	5 (22)	1 (30)	13 (30)
Lateral arch	1 (17)	-5 (11)	-2 (12)	11 (28)	2 (37)	2 (31)	8 (33)	1 (27)	-5 (21)	-5 (32)	-5 (29)	-11 (44)
Medial heel	-9 (16)	-7 (11)	-2 (23)	3 (26)	6 (27)	2 (37)	4 (22)	1 (13)	5 (19)	-9 (36)	-5 (45)	4 (26)
Lateral heel	-8 (13)	-7 (10)	-12 (20)	-1 (27)	-1 (31)	-11 (32)	4 (26)	-3 (23)	-2 (23)	-3 (26)	-6 (45)	-5 (26)

Values represent mean (SD). Zero represents perfect symmetry, a positive value represents higher peak pressure in the preferred foot, and a negative value represents higher peak pressure in the non-preferred foot.

What is already known on this topic

The preferred leg of soccer players, when compared with the non-preferred leg

- produces higher ball speed;
- has greater angular velocities of the shank and thigh on impact with the ball;
- has greater peak and average torques during knee extension; and
- has higher accuracy at kicking the ball.

What this study adds

During the four soccer-related movements, higher pressure was found in the preferred foot during the take-off phase, whereas higher pressure was found in the non-preferred foot during the landing phase.

CONCLUSION

The present study indicates that the plantar pressure in the preferred and non-preferred foot is not symmetrical. In general, higher plantar pressure is found in the preferred foot, in the three types of shoes and four movements investigated. Therefore, the preferred and non-preferred foot should be considered separately in future studies, as well as for exercise programmes that aim at injury prevention. In addition, owing to the asymmetry between the preferred and non-preferred foot, we suggest that a harder insert be used for the non-preferred foot to improve stability, and a softer insert for the preferred foot to absorb/reduce the plantar pressure, and that different fitness training programmes be used for each foot to reduce the bilateral difference in leg strength.

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Authors' affiliations

Pui-lam Wong, Youlian Hong, Department of Sports Science and Physical Education, The Chinese University of Hong Kong, Hong Kong
Karim Chamari, Anis Chaouachi, Unité de Recherche - Evaluation, Sport, Santé, National Centre of Medicine and Science in Sports (CNMSS), El Menzah, Tunisia

De Wei Mao, Shandong Institute of Physical Education and Sports, Jinan, Shandong, China

Ulrik Wisløff, Department of Circulation and Medical Imaging, Norwegian University of Science and Technology, Trondheim, Norway

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