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Left wind forward in football (soccer). Khinanthropometry and footprint analysis

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Abstract

Introduction: Kinanthropometry is the study of size, shape, proportionality, body composition, biological maturation and body function with the objective of understanding the process of growth, exercise, sport performance and nutrition. It has been accepted measurements in the right side of the subject as equivalent of the overall sportsman. Right and left side variations therefore have not been sufficiently studied, particularly in left handed football players. Materials and Methods: Analysis of 5 professional footballers from the C.D. Leganés, S.A.D. was carried, being left dominant and by their team position considered as left wing forwards. The method selected to study kinanthropometric variables was established by Heath-Carter and followed by the ISAK-GREC (International Society for the Advancement of Kinanthropometry and Grupo Español de Cineantropometría-Spanish Group of Kinanthropometry-). Footprint obtained by the simplified Hernandez-Corvo methodology, being classified as: flat, flat-normal, normal, normal-high arch, high arch, strong high arch and extreme high arch, prior and subsequent to a football match. Informed consent attained as established by local legislation. Statistics analysed by t-Student with a significance of 95% ($p<0.05$) and the results processed by the PC statistical software SPSS 11.5. Results: Football players have a mean height of 174.02 cm. and a mean weight of 75.32 Kg. Right foot mean length is 24.84 cm. and left foot mean length is 24.96 cm., while right foot mean width is 9.73 cm. and left foot mean width is 9.60 cm.; the footprint varies from normal prior to match to normal- high arch after the game, whereas left foot remains normal-high arch all along. Total number of lesions accounted for 9 sprains in the right ankle and 12 sprains in left ankle, 1 anterior cruciate ligament rupture and 1 menisectomy in the right knee with 1 interior lateral ligament rupture and 1 menisectomy in the left knee. Discussion: Data in variation of right and left side related to football is missing in international bibliography, which may be important due to the fact of the general belief in football environment that left dominant footballers are of better technique and therefore will have more chance of success in a world ruled by financial interests. Notice to analysis remarks the fact whereas the mean left foot is longer than the mean right foot, the mean right foot is wider than the mean left foot. Statistical significant differences arise between left and right footprint prior and subsequent to a football match, associated to statistical significant changes in various anthropometric measurements: ileospinal, throcanteric and tibial heights; total superior extremity, arm, forearm, hand, thigh, leg and foot lengths; subescapular, axillary, ileocrestal, supraspinal, thigh, leg and abdominal skinfolds; epicondyle of humerus diameter and ankle perimeter. Conclusion: 1) Footprint modifies with football practice. 2) Footprint differs in a football player in left and right feet prior and subsequent to a football match, associated with statistical discrepancies between various right and left kinanthropometric variables. 3) Broader population must be studied to better value the repercussion of football practice in footprint. 4) Research must be completed in order to analyse modification in right handed football players. 5) Research must be completed in order to analyse modification of footprint because of sport practice. 6) Research must be completed to observe differences with similar population detailing in certain sportive gestures (running, jumping, swimming, etc.).

Key words: Kinanthropometry, football, soccer, football, bilateralism.

Introduction

William Ross is the first author to reference the word Kinanthropometry to classify the "study of size, shape, proportionality, body composition, biological maturation and body function, with the objective to understand the process of growth, exercise, sport performance and nutrition", quoted in an article wrote in 1972 in the scientific journal "Kinanthropologie"[1], edited between the years 1969 to 1974.

Kinanthropometry is defined as the "scientific specialisation dealing with the measurement of people in a variety of morphological perspectives. Its application to movement and those factors which influence movement, including the components of body build, body measurements, proportions, composition, shape and maturation, motor abilities and cardiorespiratory capacities and physical activity including recreational activity as well as highly specialised sports performance". This is the definition mostly accepted, postulated by the I.S.A.K. (International Society for the Advancement of Kinanthropometry), international society dedicated from long ago to the study and development of technical protocols for anthropometric evaluations, particularly in athletes. Defined as such, kinanthropometry is a scientific specialisation closely allied to physical education, sports science, sports medicine, human biology, auxiology, physical anthropologie, gerontology, ergometry, and several medical disciplines. Kinanthropometry is a vehicle for individuals to contribute to basic reseaech and applications in medicine, education and government.

It has been accepted measurements in the right side of the subject as equivalent of the overall sportsman. We have studied bilaterality based in the results of an investigation carried by Jones in a series of radiographies taken during 30 years in professional tennis players that showed disparity in humerus size (related to differences in the arm size) and bone density between the dominant and non dominant upper limb[2]. Right and left side variations therefore have not been sufficiently studied, particularly in left handed football players

Material and Methods

Research of a population of 5 professional football players from the 2nd A Spanish division, belonging to the team C.D. Leganés, S.A.D., left handed and of left lower limb dominance. The athletes are classified as left wing forwards by the team distribution on the football pitch.

Kinanthropometry technique followed the recommendations of the G.R.E.C. (Grupo Español de Cineantropometría, Spanish Group of Kinanthropometry), which ensue the I.S.A.K[3,4,5,6]. Informed consent was obtained and the results managed to keep confidentiality as established by Spanish health legislation.

49 anthropometric measurements were, those included: weight; height; sitting height; armspan; heights: acromial, radial, ileospinal, throchanteric and tibial; lengths: total upper extremity, arm, forearm, hand, thigh, leg and foot; skinfolds: axilar, subscapular, biceps, triceps, forearm, ileocrestal, supraspinal, anterior thigh, medial leg and abdominal, diameters: biacromial, transverse thorax, antero-posterior thorax, biileocrestal, biepicondyle humerus, bistyloid, transverse hand, bicondyle femur, bimaleolar and transverse foot; perimeters: cephalic, neck, thorax, hip, waist, arm contracted, arm relaxed, forearm, wrist, thigh superior, thigh inferior, leg and ankle.

Table 1 - Anthropometric Data

Morphological Characterisrtics	Height	Weight	Right Foot Lenght	Right Foot Width	Left Foot Lenght	Left Foot Width
Mean	174.02	75.32	24.84	9.73	24.96	9.60
SD	5.46	6.11	0.92	0.37	0.96	0.33

Anatomic surface marks were highlighted in the right and left side prior to obtain the appropriate measurements, which were obtained with standardize anthropometric suitcase, Soehnle scale and a Holtain skinfolder.

The methodology followed is the stablished by Heath-Carter, with fractioning of body composition in four constituents following the strategy proposed by De Rose and Guimaraes, using Faulkner´s formulae to calculate percentage of fat, for bone mass uses Rocha´s formulae, for muscle mass using Matiegka´s formulae and for residual weight using Würch´s formulae[7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23].

The method to obtain footprint was by imprint of feet in veiled X-rays of 40x30 and 43x35 cm, prior and posterior to a football match in turf, with competition footwear.

Analysis of footprint followed the methodology established by the Simplified Henández-Corvo Method, which classifies footprint in: flat, flat-normal, normal, normal-high arch, high arch and extreme high arch[24].

Statistical analysis was performed with the PC compatible software SPSS 11.5, using t Student test for related samples and ANOVA (Analysis of Variance) test for comparison of means, in both cases with a significance level of 95% ($p<0.05$).

Results

The morphological characteristic of football players shows mean height of 174.02 cm. and mean weight of 75.32 Kg., right foot mean length of 24.84 cm., left foot mean length of 24.96 cm., right foot mean width of 9.73cm. and left foot mean width of 9.60 cm. The anthropometric data is exposed in table 1 (*table 1*).

The analysis of data shows that the left foot is longer than the right foot, statement that already has been pointed previously. This study combines the values described with the width of the right and left foot; being this combination not founded in the bibliography searched.

The paradox of this investigation arises when assembling the longitudinal and transversal axis of feet, verifying a left foot longer but narrower than the right foot and vice versa. A valid scientific explanation can not be arisen for this evidence.

Once established the anthropometric main characteristics of this football players, the investigation centres in the biomechanics of normal and pathological gait of the football players, therefore clinical history is revised in order to focus on trauma injuries, mainly those affecting the lower limb, searching relevant information that could led the work to clarify if the respective footballers have modified in any way their postural gesture either as consequence of an injury in the past or is a natural acquired postural attitude effect of the type of the game played or the technical skills developed in early years, seeking for a cue to explain the paradox established. These results will be described following and showed in figures 1 and 2.

The total number of lesions in lower limb accounts for nineteen sprains, one anterior cruciate ligament rupture, one interior collateral ligament rupture and two menisci ruptures.

Outstand in this investigation that injuries occurred in two joints, knee and ankle. As expected, the consequences more severe are suffered by the knee, but greater number appears in the lowest joint.

Clinical history is revaluated to clarify the mechanism of injury.

Right side injuries are shown in figure 1 (*figure 1*).

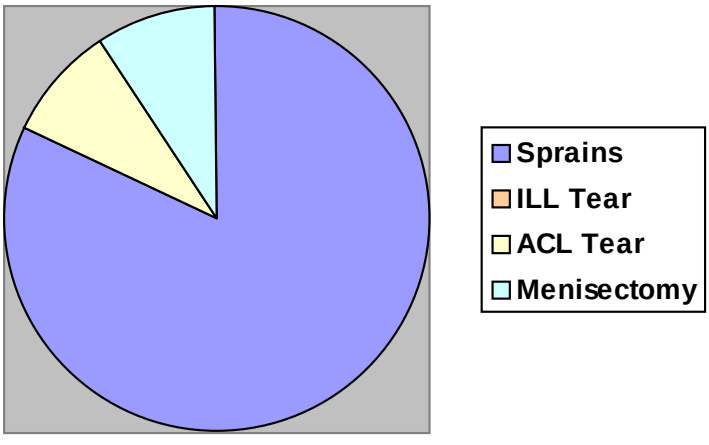

Figure 1. Right Injuries.

In the right side of players total number of injuries are eleven, divided in 9 sprains, 1 anterior cruciate ligament rupture and one meniscus tear. In all cases the mechanism of lesion was confronting another player in a football match, against an opposite team in the most severe, occurring in the knee, and for the more benign some in competition and mostly during training sessions.

When analysing damage in the knee, the system how the harm accounted as commonly described in bibliography{25,26], with a counter movement of the body away from a force wield to the leg being stucked to the turf. The force exerted during this classical mechanism explains why the knee suffered the most severe injuries, needing surgical repair. As expected the most severe harm in a left handed football player happens in the right side, the one of support.

The meniscus injury was directly visualised by one member of this study, while the anterior cruciate ligament tear was recorded from the clinical history with confirmation of the event with the medical service of the team where the athlete was playing for.

Injuries of the ankle analysed showed similar mechanism of production as knee, based in a counter force exerted by an opponent with the joint fixed to the pitch. All were treated conservative, no accounting for ankle ligament tears.

Five of the total sprains were directly visualised by the investigator, the rest obtained from the clinical record as described by the player, without

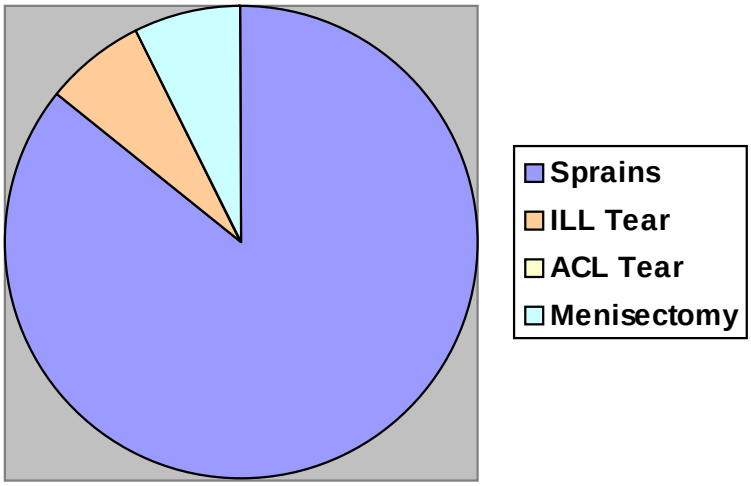

Figure 3. Left injuries.

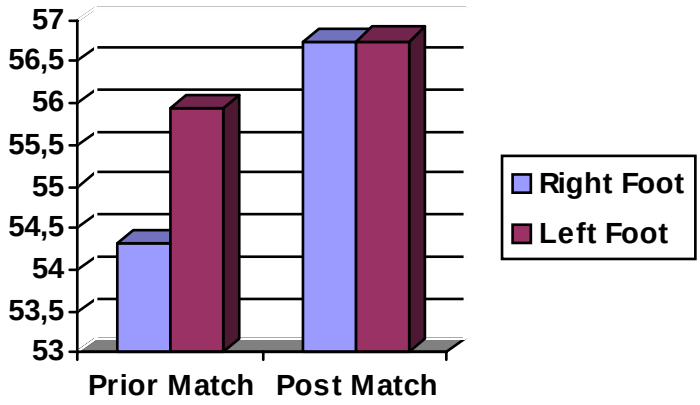

Figure 3. Footprint results.

confirmation of the respective medical staff at the times of injury. Left side injuries are shown in figure 2 (*figure 2*).

The left side accounts eleven injuries, divided in 12 sprains, 1 interior collateral ligament rupture and one meniscus tear. In all cases the mechanism of lesion was confronting another player in a football match, against an opposite team in the most severe, occurring in the knee, and for the more benign some in competition and mostly during training sessions.

Damage in the knee happened as commonly described in literature, with a counter movement of the body away from a force exerted to the leg being stuck to the turf. The force applied during this classical mechanism explains why the knee suffered the most severe injuries, needing surgical repair for the meniscus, but the interior collateral ligament treated with non bearing conservative treatment. As expected the injuries in a left handed football player that happens by accident in the left side are not as serious as in right side.

The meniscus and ligament injuries were directly visualised by one member of this study.

Injuries of the ankle analysed showed similar mechanism of production as knee, based in a counter force exerted by an opponent with the joint fixed to the pitch. All were treated conservative, even though one of them caused with rupture of deltoid ligament.

Ten of the total sprains were directly visualised by the investigator, the rest obtained from the clinical record as described by the player, without confirmation of the respective medical staff at the times of injury.

Footprint is studied by simplified Hernández-Corvo method to establish a classification. By this methodology the right foot varies from normal prior to the football match to normal-high arch posterior to the game, whereas left foot remains constant as normal-high arch all trough. The result of the variation of footprint is shown in table 2 (*table 2*).

Analysing closely we can observe how footprint varies in right foot, changing from normal, but very close in percentage to normal-high arch, to normal-high arch. This agrees with our previous results in a more general study where we observed that the foot of a football player arches due to the practice of football.

This does not occur in left foot, where the left foot remains normal high arch before and after the game, but as we can observe in figure 3, remaining in the same classification, there exists a variation towards arching of the foot, not as significant as the right foot, but still the foot arches as well (*figure 3*).

Statistical significant differences arise between left and right footprint prior and subsequent to a football match, associated to statistical significant changes in various anthropometric measurements: ileospinal, throcanteric and tibial heights; total superior extremity, arm, forearm, hand, thigh, leg and foot lengths; subescapular, axillary, ileocrestal, supraspinal, thigh, leg and abdominal skinfolds; epicondyle of humerus diameter and ankle perimeter.

Discussion

Data in variation of right and left side related to injuries and kinanthropometric measurements in football is missing in international bibliography, which may be important due to the fact of the general belief in football environment that left dominant footballers are of better technique and therefore will have more chance of sportive and

Table 2 - Footprint Data

Footprint	**Right Foot**		**Left Foot**	
Incidences	Prior Match	Posterior Match	Prior Match	Posterior Match
Classification	53.32%	56.72%	55.93%	56.75%
SD	10.79	6.26	9.40	8.19

economical success in a world ruled by financial interests.

The paradox arise in this study where the mean left foot is longer than the mean right foot being statistically significant these differences), whereas the mean right foot is wider than the mean left foot (not being statistically significant these dissimilarities). These results go accompanied with statistical significant differences between right and left side of the body.

Surprisingly there exists not only statistically significant differences between the right and left side in the lower limb, such could be expected, but also in upper limb and trunk.

These football players have a longer but narrower left foot, suffered more severe injuries in the right knee than in the left knee, while for the first statement there is not a valid scientific reasoning, the second fact is explained by the biomechanical principles applied to football, because in left handed footballers the right lower limb is mainly used for support for tricking the opponent with technical skills of the dominant leg, and so bearing on one limb the whole of the weight, if the counter forces appear as described above, when the player accidents, this usually is more severe than the left leg, which stands still less often and has more defence reacting to unexpected lesional mechanisms. Ankle injuries are more often in the left side than in right due to the dominance of the lower limb as well; the football player will dribble more repeatedly and more successfully with his dominant side as is in this dodging where the ankle an be trapped by the opponent, obviously with lesser force that supported by the knee, and so more frequent but less serious injuries appears in ankle versus knee, but this same biomechanical reason explains why by contrary, harm is bigger in left ankle than in right. In addition we founded significant differences between right and left side of the football player in the heights associated to both joints involved in the injuries described, this is tibial height, but also are other statures associated, either in lower limb as occurs with trochanteric height as well as affecting trunk, ilespinal height. Outstands other values different significately from one side to another to notice as explanation of injury biomechanics, affecting lower limb (thigh, leg and foot lengths; thigh and leg skinfolds and ankle perimeter) besides trunk (subescapular, axillary, ileocrestal, supraspinal and abdominal skinfolds) and upper limb (total upper extremitie, arm, forearm and hand length, and epicondyle of humerus diameter).

Conclusion

From this we can conclude that footprint modifies with football practice, related to the injuries suffered by the football player during his sportive life and his anthropometric profile. Footprint differs in a football player in left and right feet prior and subsequent to a football match, associated with statistical discrepancies between various right and left kinanthropometric variables. Broader population must be studied to better value the repercussion of football practice in footprint. Research must be completed in order to analyse modification in right handed football players. Research must be completed in order to analyse modification of footprint because of sport practice. Research must be completed to observe differences with similar population detailing in certain sportive gestures (running, jumping, swimming, etc.)

References

1. **Ross WD, Hebbelinck M, Van Gheluwe B,**
2. **Lemmens ML.** Kinanthropométrie et l´apretiation de l´erreur de mesure. Kinanthropologie 1972; 4; 23-24.
3. **Jones HH, Priest JD, Hayes WC, Tichenor CC, Nagel DA.** Humeral hypertrophy in response to exercise. J Bone Joint Surg Am 1977; 59; 2; 204-208.
4. **Ross WD, Brown SR, Hebbelinch M, Faulkner RA**, Kinanthropometry. Terminology and landmarks In: Shepard RJ, Lavallé H, editors. Physical fitness assessment. Springfield. 1978. p. 44-50
5. **Ross WD, Marfell-Jones MJ**, Kinanthropometry. In: MacDougall JD, Wender HA, Green HJ, editors. Physiological testing of elite athlete. Ottawa. 1982. p. 75-115.
6. **Grupo Español de Cineantropometría**, Valoración del deportista. In: Huarte Gráfica editors. Aspectos biomédicos y funcionales. Pamplona 1999.
7. **Grupo Español de Cineantropometria**, Manual de Cineantropometría. In: Huarte Gráfica editors. Pamplona. 1993.
8. **Apon P.** Successful formulae for fitness training. In: Reilly T editors. Science and football : proceedings of the first world congress of science and football. London. 1988. p. 95-107.
9. **Bangsbo J.** The physiology of soccer with special reference to intense intermittent exercise. Acta Physiologica Scandinavica 1994; 619; 100-155
10. **Bangsbo J, Norregaard L, Thorso F.** Activity profile of competition soccer. Can J Sport Sci. 1991; 2; 110-116
11. **Casajús JA, Aragonés MT.** Valoración

antropométrica del futbolista por categoría deportiva y posición en el terreno de juego. Rev Port Med Desp. 1993; 11; 101-116.
12. **Ekblom B.** Applied physiology of soccer. Sports Medecine 1986; 3; 50-60.
13. **Faina M, Gallozzi C, Lupo S, Colli R, Sassi R, Marini C.** Definition of the physiological profile of the soccer player. In: Reilly T editors. Science and football. London. 1988. p. 158-163
14. **Gomes D, Pinheiro F, Silva J.** Estudo das variables antropométricas e somatótipos dos futebolistas portugueses. Med Desportiva 1989; 7; 151-154.
15. **Hanot JL.** Maximal anaerobic power of indian soccer players according to playing position. In: Reilly T editors. Science and football. London. 1988. p. 172-174.
16. **Ramos JJ, Segovia JC, Silvarrey J, Montoya JJ, Legido JC.** Estudio de diversos aspectos del futbolista. Selección 1994; 3; 25-36.
17. **Shepard RJ.** The energy needs of soccer players. Clin J Sport Med. 1992; 2; 62-70.
18. **Togari H, Ohashi J, Ohgushi T.** Isokinetic muscle strength of soccer players. In: Reilly T editors. Science and football. London. 1988.
19. **White JE, Emery TM, Kane JE, Groves R y Risman AB.** Pre-season fitness profiles of professional soccer players. In: Reilly T editors. Science and football. London. 1988. p. 164-171.
20. **Boennec PM, Ginet J.** Le somatotype du footballeur de haut niveau déterminé par le method de Heath et Carter. Comparisons. Cinésiologie 1980; 75; 53-56.
21. **Casajús JA, Aragonés MT.** Estudio morfológico del futbolista de alto nivel. Composición corporal y somatotipo. Arch Med Dep 1991; 30; 147-151.
22. **Casajús JA, Aragonés MT.** Estudio morfológico del futbolista de alto nivel. Proporcionalidad. Arch Med Dep 1991; 31; 237-242.
23. **De Rose EH, Maldonado P, Oliveira JL, Pigato E.** Avaliçao cineantropométrica do futebolista. Análise dos integrantes da selecçao brasileira participante da copa do mundo de 1982. Medicine Desportiva 1983; 2; 8-12.
24. **De Rose EH, Turra JR, Guimaraes AC, Gaya AD.** Composiçao corporal do jogador de futebol. Med. Esporte 1974; 2; 77-79.
25. **Hernández-Corvo, R.** Morfología funcional deportiva. In: Paidotribo editors. Sistema locomotor. Barcelona. 1989.
26. **Hutson MA.** Sports injuries. In: Oxford University Press editors. New York. 1996.
27. **Wilmore J, Costill D.** Physiology of sport and exercise. In: Human Kinetics editors. Champaign. 1994.