Portuguese Journal of Sport Sciences
11 (Suppl. 2), 2011

SPORT INFLUENCE ON FOOTPRINTS OF COLOMBIAN´S POWERLIFTERS, SWIMMERS AND FIELD ATHLETES

Gómez Lessby[1], Franco Juan Manuel[2], Nathy Jhon Jairo[2], Valencia Edwin[2] and Vargas Diana[2]

Universidad Libre de Colombia, Cali, Colombia[1]
Escuela Nacional del Deporte, Cali, Colombia[2]

The aim of this study was to establish the influence of sports on the characteristics of the footprint in sport practitioners of Powerlifting, Swimming and Field Athletics. The research was conducted in a population of 280 athletes, which were classified according to foot type, the type of forefoot and some anthropometric variables such as length and width of the footprint. The results showed a tendency to a cavus foot type, regardless of sport practiced, with a higher prevalence of these in practitioners of field athletics and swimming. It also showed a high percentage of asymmetric (right and left foot) and differences in the forefoot type, length and width of the footprint.

KEY WORDS: Foot, anthropometry, biomechanics, sport.

INTRODUCTION: The human foot is a highly specialized structure, with a complex biomechanics that lets you perform the functions of locomotion, amortization and balance, reflected in a proper distribution of loads on the musculoskeletal system in both static and dynamic conditions. Previous studies on the foot (Faria, Gabriel, Abrantes, Brás, & Moreira, 2010; Mauch, Grau, Krauss, Maiwald, & Horstmann, 2008; Stavlas, Grivas, Michas, Vasiliadis, & Polyzois, 2005), showed variations in the characteristics of the footprint and foot morphology by virtue of age, gender, race and individual occupation. However, there is a controversy in publications about the influence of sport on the foot architecture. Specifically in this study, the research problem was determining the anthropometric characteristics, type of foot and forefoot that predominates in Colombian elite athletes who practice sports with different biomechanical requirements: weightlifting, swimming and athletics. In weightlifting, the foot is constantly subjected to action of heavy weights that sometimes are more than twice the athlete's body weight. Contrary to this, swimming involves the apparent loss of load during practice, but more important, it requires unusual foot positions in order to generate greater propulsion. For its part in field athletics, the foot has several requirements such as running, push to jump, among others.

METHOD: The study was performed on 280 men and women Colombian athletes, practitioners of weightlifting, swimming and field athletics. In sport, all participants in the study were: 50 weightlifters, 135 field athletes, and 95 swimmers, equivalent to 34%, 57.6% and 34.3% of participants respectively. The average age was 22 years for weightlifting, 18 for swimming and 23 for athletics. Total ages ranged between 15 and 46 years. The years of sport practice varied from 1 to 15, with the average in 7 years for weightlifting, 10 years for swimming and 8 for athletics.
The criteria for selection of the sample was voluntary participation in the study, excluding subjects who reported having had any traumatic injury or disease that could possibly altered the morphology of the foot.
The footprint was obtained by using a podoscope and a digital camera. The information obtained was digitized using software Fotoanalysis and took measurements of length and width of the foot. Subsequently the photographs were printed and it was proceeded to determine the foot type, using the method of Hernandez Corvo (De la Fuente 2003), classifying these in flat foot, normal flat foot, normal foot, normal cavus foot, pes cavus, strong pes cavus and extreme pes cavus. The results were systematized and analyzed statistically using SPSS 11.5 software for Windows.

RESULTS AND DISCUSSION In all populations a tendency to pes cavus was more evident in swimmers, where subjects with pes cavus, strong cavus and extreme cavus presented the highest frequency. In weightlifters it's larger the prevalence of subjects with normal foot. The differences between sports are statistically significant for the right foot and the left foot. The values are shown in Table 1 (p=0.001 and p=0.000 respectively).

Table 1
Frequency of foot type, by limb and sports

FOOT TYPE	Weightlifting (n=50)		Swimming (n=95)		Athletics (n=135)	
	Right foot	Left foot	Right foot	Left foot	Right foot	Left foot
Flat	0 (0%)	1(2%)	0(0%)	0(0%)	3(2%)	3(2%)
Normal Flat	1(2%)	1(2%)	0(0%)	1(1%)	0(0%)	0(0%)
Normal	16(32%)	19(38%)	10(11%)	11(12%)	33(24%)	24(18%)
Normal Cavus	10(20%)	13(26%)	20(21%)	29(30%)	27(20%)	28(21%)
Cavus	23(46%)	16(32%)	58(61%)	49(52%)	64(48%)	72(53%)
Strong Cavus	0(0%)	0(0%)	6(6%)	4(4%)	6(4%)	7(5%)
Extreme Cavus	0(0%)	0(0%)	1(1%)	1(1%)	2(2%)	1(1%)

During the study it was evident, in some subjects, a difference between the foot type observed in each side (Chi square=482.9476 p=0.000), reason why we included a variable called symmetry, corresponding to equal or not equal contralateral type of foot. The range of symmetry in the foot type, was between 56% and 59% in different sports, and difference was not statistically significant (Chi square=0.933 p=0.1393).
The type of forefoot was markedly different among weightlifters and other athletes (Chi square=9.86 p=0.007) (See Table 2).

Table 2
Frequency of forefoot type by sport

Forefoot type	Weightlifting (n=50)	Swimming (n=95)	Field athletics (n=135)
Egyptian	40	51	83
Greek	10	44	46
Square	0	0	4

In the length and the width of the foot, there were differences between right and left side statistically significant (p=0.01) between subjects and between sports (Table 3). There was a linear association between the length of the right foot with left foot over the whole population, as well as the width of foot (r=0.93, r=0.79).

Table 3
Values of length and width (in mm) of the foot by sports.

	Weightlifting		Swimming		Athletics	
Measure	Mean	S.D.	Mean	S.D.	Mean	S.D.
Length right foot	24.91	1.44	23.97	2.01	24.91	1.89
Length left foot	25.13	1.59	24.06	1.99	24.72	3.27
Width right foot	8.60	0.76	8.06	0.62	8.26	1.96
Width left foot	8.57	0.79	8.16	0.68	8.37	2.06

The previous results show a tendency to pes cavus in all sports, different to those values reported for sedentary subjects (Goméz, Franco et al. 2009). A higher prevalence of pes cavus in athletes who practice swimming and field athletics may be related to the mechanical requirements of the foot toward the plantar flexion as in the case of the kick in swimming, or

the impulse to run or jump in athletics. However, in weightlifting, due to the constant overhead to the foot, it was expected a tendency to flat feet, because this factor is considered by some authors as determinant in the flattening of the longitudinal arch (Günther 2004). The presence of cavus feet may be explained for the endemic presence of pes cavus in the Colombian population or biomechanical adjustment of foot to enable the impulse of bar.
The presence pes cavus and flat foot may be considered a risk factor in the occurrence of sports injuries (Abián Vicén, Alegre Durán, et al. 2005; Wegener, Burns, et al. 2008), as their presence causes inadequate shock absorption. Authors report that "…among other injuries, stress fractures incidence values would range from 5.8% in subjects with normal feet, up 9.9% in subjects with pes cavus", values somewhat higher than that associated with the same authors to. Achilles tendinitis, ranging from 3.6% in normal subjects to 5.7% in subjects with pes cavus (Queen, Mall, et al. 2009).
Another aspect highlighted in the study, is the presence of non-symmetry in much of the population, although not statistically significant is of great importance from the standpoint of ergonomics and shoes industry (Kouchi, Mochimaru, et al. 2005). The differences found in size and foot type between feet, may be of great importance in the comfort of footwear, injury prevention and the execution of sports movements.
It was found no explanation for the difference among the types of forefoot between weightlifters and other athletes, so it is raised as a question to be solved by further research. However, a greater cross-sectional geometric properties of the first ray corresponds to the high pressures recorded for the first ray during most activities (Griffin and Richmond, 2005).

CONCLUSIONS: It was found as a statistical difference in podal structure and anthropometrical values in sport practitioners with a tendency to pes cavus among them and more prevalence in swimmers and field athletes. The differences between left and right foot, show the importance to evaluate both legs when we want to determine the biomechanical implications on the foot. However, more comparative studies are needed with sedentary population and from other countries to complete these results.

REFERENCES

Abián Vicén, J., Alegre Durán, L., Lara Sánchez, A., Jiménez Linares, L., & Aguado Jódar, X. (2005). Fuerzas de reacción del suelo en pies cavos y planos. *Archivos de medicina del deporte*(108), 285.

De la Fuente, J. (2003). *Podología general y biomecánica*: Elsevier España.

Faria, A., Gabriel, R., Abrantes, J., Brás, R., & Moreira, H. (2010). The relationship of body mass index, age and triceps-surae musculotendinous stiffness with the foot arch structure of postmenopausal women. *Clinical Biomechanics, 25*(6), 588-593.

Goméz ., Franco J, Nathy J, Valencia E, Vargas D, & Jiménez L. (2009). Influencia del deporte en las características antropométricas de la huella plantar femenina. *Educación física y deporte, 28*(2), 25.

Griffin, N., & Richmond, B. (2005). Cross-sectional geometry of the human forefoot. *Bone, 37*(2), 253.

Günther, K. (2004). Musculoskeletal consequences of obesity in youth. *Obesity in childhood and adolescence*, 137.

Kouchi, M., Mochimaru, M., Nogawa, H., & Ujihashi, S. (2005). *Morphological fit of running shoes, Perception and Physical Measurements*.

Mauch, M., Grau, S., Krauss, I., Maiwald, C., & Horstmann, T. (2008). Foot morphology of normal, underweight and overweight children. *International Journal of Obesity, 32*(7), 1068-1075.

Queen, R., Mall, N., Nunley, J., & Chuckpaiwong, B. (2009). Differences in plantar loading between flat and normal feet during different athletic tasks. *Gait & posture, 29*(4), 582-586.

Stavlas, P., Grivas, T., Michas, C., Vasiliadis, E., & Polyzois, V. (2005). The evolution of foot morphology in children between 6 and 17 years of age: a cross-sectional study based on footprints in a Mediterranean population. *The Journal of foot and ankle surgery, 44*(6), 424-428.

Wegener, C., Burns, J., & Penkala, S. (2008). Effect of Neutral-Cushioned Running Shoes on Plantar Pressure Loading and Comfort in Athletes With Cavus Feet. *The American Journal of Sports Medicine, 36*(11), 2139.