Ratios de longitud del pie en una muestra no patológica

Selected foot length ratios in a non-pathological sample

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RESUMEN
Este estudio presenta los ratios de longitud del pie en una muestra midiendo las impresiones del pie obtenidas con una plataforma de presiones plantares disponible en el mercado. Estimamos un cociente medio de 1.3 (SD = 0.04) entre la longitud del pie y la distancia entre el talón y la cabeza del primer metatarsiano, 5.5 (SD = 0.49) entre la longitud del pie y el ancho del talón y 3.3 (SD = 0.3) entre la longitud del pie y la anchura del mismo en la zona metatarsal. Estos cocientes fueron similares, en comparación a otros estudios publicados previamente. No solo estos resultados pueden proporcionar información útil a la hora de la clasificación de los diferentes tipos de pie, si no también pueden servir de ayuda a la industria del calzado para diseñar con rigor calzados terapéuticos.

PALABRAS CLAVE: Ratios de longitud del pie. Sistema de plataforma de presiones comparadas con el sistema de Harris y Beath.

ABSTRACT
This study reports on selected foot length ratios using foot prints obtained from a commercially available pressure platform system. An average ratio of 1.3 (SD = 0.04) between the foot length and the distance between heel and the head of the first metatarsal, 5.5 (SD = 0.49) between the foot length and heel width and 3.3 (SD = 0.3) between the foot length and ball width, were estimated. These ratios were consistent across the subjects and are comparable to previously published studies. While the results may provide useful information in the classification of foot types, it will also help the footwear industry in the modelling of lasts for therapeutic footwear.

KEY WORDS: Foot length ratios. Pressure platform system compared to Harris and Beath system.

INTRODUCTION

Although there are various studies involving foot measures in children,[1, 2] there is a paucity of information on the mathematical relationship within various foot measures.

The authors declare not to have any economic or commercial interest.

A previous investigation documented a significant relationship between foot length, toe lengths and other ankle and calf measurements.[3] This study suggested that in order to develop correct foot standards more detailed measurements had to be carried out separately for different age groups of both sexes than the reported measurements.[3] Another investigation examined the relationship between the foot length, breadth, ball girth, height and weight of Turkish university students aged between 17 and 25 and noted that in both males and females, the correlation between foot length and height was more significant than the correlation between foot length and weight.[4] Furthermore, when the percentage ratio of foot breadth and ball girth to foot length was calculated in both sexes, the percentage ratio in students with longer feet turned out to be smaller. However it was found that foot breadth and ball girth of males in the same foot length category were greater than in female students. It was also reported that while the ball girth of the individuals are different, the comparison of right foot length and ball girth in the same foot length category in study sample of Turkish, French and Japanese students, indicated that there was a similarity between Turkish and French with regard to foot breadth. The average foot lengths of Turkish students were larger than French and Japanese. This study suggests that all three elements have to be considered separately and racial differences may have to be considered for shoe last manufacture.[4]

More recently another study by Chockalingam and Ashford;[5] suggested that selected foot length ratios in a non-clinical male sample, are remarkably consistent. This work reported ratios of 1.45 (SD 0.01) between the foot length and the distance between the heel and the head of the first metatarsal and 4.5 (SD 0.11) between the length and heel width. The methodology adopted by this study utilised a low technology, relatively less expensive Harris and Beath print method of recording the foot print data.

Although previous studies have highlighted the usefulness of Harris footprints for quantifying clinical foot conditions and evaluated the diagnostic value of these prints,[6] recent investigation by Urry and Wearing[7] compared footprint indexes calculated from ink and electronic footprints. This study, while indicating that the contact area was consistently underestimated by the electronic prints and the long plantar angle was poorly correlated between the techniques, concluded that the electronic footprints derived from a pressure platform are not representative of the equivalent ink footprints and consequently should not be interpreted with reference to literature on conventional footprints.

In contrary, another previous study indicated that intra-rater reliability of the geometric analysis of electronic footprints was excellent when the same print was evaluated on two separate occasions. Moreover when different prints of the same foot were evaluated, the majority of the parameters, with the exception of the footprint angle, were acceptably consistent.[8] Given the diversity of opinion of reliability in electronic footprint data, it is suggested this area warranted further investigation.

Although Chu et al[9] raised the issue of accuracy of electronic footprints and speculated that the boundary of an electronic footprint may be poorly delineated and irregular and that this might be a source of error, electronic foot prints have been used in foot surveys for last and foot size standardisation in various countries. This study is almost a decade old and the speculation of error may be somewhat tentative when related to the degree of accuracy various pressure platform systems can offer today.

While the use of ratios have been demonstrated in previous studies,[10] investigations also demonstrate that female feet and legs are not simply scaled down versions of male feet but rather differ in a number of shape characteristics, particularly at the arch, the lateral side of the foot, the first toe and the ball of the foot.[11] Another study investigated the maternal height and foot length as predictors of pelvic adequacy and indicated that these are of limited value to predictors of pelvic in-adequacy.[12] Other methods used to calculate ratios include photography, direct facial measurement and soft tissue radiography.[13]

It has been suggested that the use of the Harris and Beath mats can offer simple measurements, which are relatively easy to record by a clinician, and may be useful in a variety of ways, for example: more quantifiable

available data for the clinician and coincidently 'hard' data for the patients clinical records; could be useful in future research, particularly when classification of foot types are being considered; the design and construction stage of last production and foot orthosis prescription may benefit from this data. However with the advancement of technology, new but relatively more expensive equipment is available to the clinician to record these data.

The present study reports estimated ratios using a commercially available pressure platform system. While reporting on an additional foot ratio not previously published in the academic press, this paper also compares the results between the systems used for recording foot ratios and offers an economic and usability appraisal of these systems.

METHODS

A conveyance sample of 78 university students comprising of 48 males and 30 females with an average age of 21.03 years, height of 173 cm and mass of 71.39 kg were recruited for the study. Ethical approval was sought and granted by the University's Research Ethics Committee. All subjects took part in the study reported no known foot pathologies and were not wearing any foot support devices or orthoses. Furthermore the subjects were recruited from an active sporting population drawn from a variety of sports. . A Footscan (RS Scan Intl, Belgium) pressure platform system was used to measure the pressure distribution and in turn foot prints. Various measurements as shown in figure 1 were carried out.

The following measurements of the foot were examined (Figure 1):

- Length of foot (L) - Distance between the heel (most posterior point recorded on the mat) and the tip of the big toe, or the tip of the second toe, in cases where this was longer
- Length of the tread-point of the ball of the foot (X) - Distance between the heel and the mid point of the head of first metatarsal joint (estimated on the mat).
- Width of heel (Y) - Distance between the inner and outermost point of the heel outline.

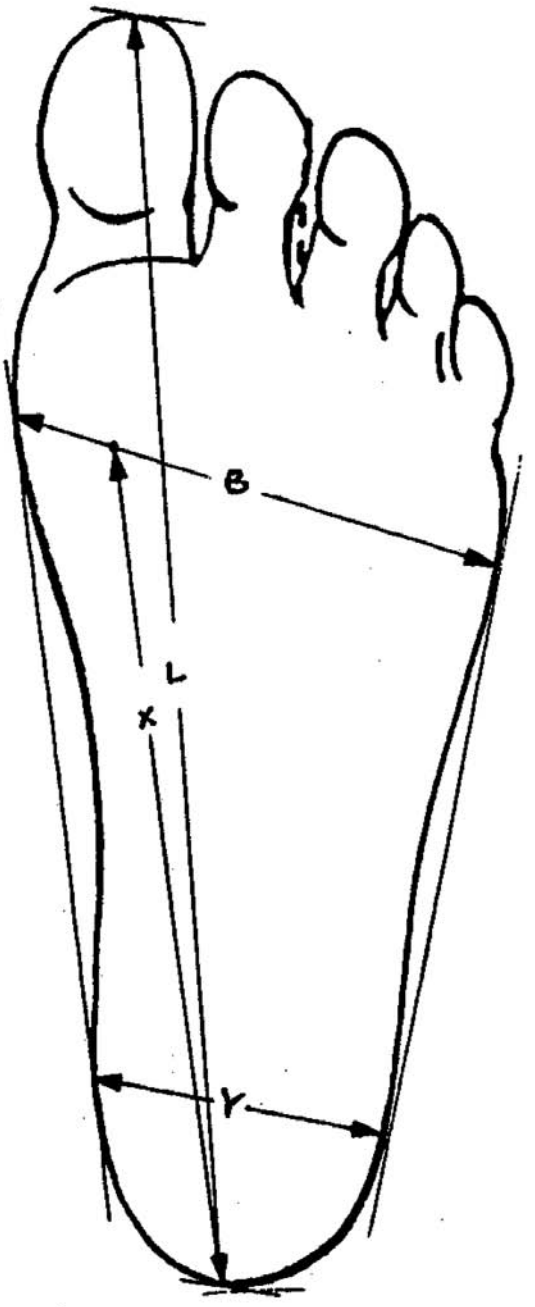

Figure 1: Various foot measurements.

- Width of the Forefoot (B) – Distance between the inner and outermost point of the forefoot outline.
- Ratio calculations – The L-X calculation was found by dividing L by X and similarly the L-Y and L-B, calculation was found by dividing L by Y and L by B respectively.

RESULTS

Average ratios between the foot length (L) and various other measurements are given in Table 1.

The data presented in tables 2 & 3 were recorded using the method suggested by Harris and Beath,[14] and originally published in a paper by Chockalingam and Ashford; 2002.[5]

DISCUSION AND CONCLUSION

The consistency of the data in this mixed gender sample demonstrates a similar pattern to previous work. However, given the method of data collection and analysis in this study, it is suggested that the reliability of the data is more sensitive and thus a more accurate reflection of

L X Ratio				L Y Ratio				L B Ratio			
Left		Right		Left		Right		Left		Right	
Mean	1.301	Mean	1.307	Mean	5.560	Mean	5.494	Mean	3.304	Mean	3.297
St. Dev	0.039	St. Dev	0.040	St. Dev	0.474	St. Dev	0.513	St. Dev	0.304	St. Dev	0.309
Range	0.186	Range	0.220	Range	2.282	Range	2.494	Range	1.432	Range	1.279
Min	1.196	Min	1.206	Min	4.497	Min	4.218	Min	2.635	Min	2.641
Max	1.382	Max	1.426	Max	6.779	Max	6.712	Max	4.068	Max	3.920

Tabla 1. Descriptive statistics for various foot length ratios

L X Ratio				L Y Ratio			
Left		Right		Left		Right	
Mean	1.45	Mean	1.45	Mean	4.51	Mean	4.51
St. Dev	0.01	St. Dev	0.01	St. Dev	0.12	St. Dev	0.11
Range	0.05	Range	0.04	Range	0.4	Range	0.4
Minimum	1.42	Minimum	1.43	Minimum	4.3	Minimum	4.3
Maximum	1.47	Maximum	1.47	Maximum	4.7	Maximum	4.7
Conf (95%)	0.00	Conf (95%)	0.00	Conf (95%)	0.03	Conf (95%)	0.03

Table 2: Descriptive Statistics for foot length ratio data (Preliminary trials)

L X Ratio				L Y Ratio			
Left		Right		Left		Right	
Mean	1.45	Mean	1.45	Mean	4.49	Mean	4.50
St. Dev	0.01	St. Dev	0.01	St. Dev	0.13	St. Dev	0.13
Range	0.06	Range	0.05	Range	0.6	Range	0.7
Minimum	1.42	Minimum	1.43	Minimum	4.2	Minimum	4.2
Maximum	1.48	Maximum	1.48	Maximum	4.8	Maximum	4.9
Conf (95%)	0.00	Conf (95%)	0.00	Conf (95%)	0.04	Conf (95%)	0.04064

Table 3: Descriptive Statistics for foot length ratio data (Secondary trials)

the selected foot ratios than the pervious published data. This assertion is primarily based on the premise that whilst using simple footprint data, this methodology does not allow for the margins of the lateral and medial borders of the foot (soft tissue expansion) to be recorded accurately. Furthermore, the third foot ratio (L/B Ratio) not previously published, also shows remarkable consistency across the sample. While the investigation by Urry and Wearing[7] compared footprint indexes calculated from ink and electronic footprints and indicated that the electronic prints consistently underestimated the contact area, this study has not attempted to quantify this parameter. However the reported ratios are higher for LY and lower for LX. This observation as mentioned earlier could be due to the adopted methodology.

In relation to cost and clinical applicability, clinicians may not require the level of accuracy the pressure platform equipment can offer but might be satisfied with results which are easy to acquire in most clinical setting. Moreover the cost of the hardware may also exclude general clinical use. Therefore cost of a system and its clinical applicability are important factors to consider if ratio measurements are to be utilised in the clinical setting.

Further studies are required to chart and map all the foot ratios in different ethnic, gender and pathological foot types, which could be helpful in the clinical, the research dimension and the shoe manufacturing industry.

Although one of the previous studies suggests that the length, ball and heel girths have to be considered separately for shoe last manufacture,[5] non dimensional ratios suggested in the current study will prove useful in the design and development of lasts. Foot length ratios would be also very helpful in normalising foot dimensions and thus aid the construction of sports footwear which is gender specific as indicated by Wunderlich and Cavanagh.[11] In relation to pathological foot types and fundamental foot research data, pes planus possess a real clinical challenge to clinicians. Many of the treatment regimes are based on limited clinical evidence with a plethora of interventions being reported in the literature. These range from, advice only, to foot orthoses, stretching and footwear modifications. Very little 'hard' outcome measures have been developed. Charting foot ratios in this condition might give, in addition to other measures, an indication of the ratios associated with this condition but more importantly an outcome measure following an intervention.

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