



# Heel–Ball index: An analysis of footprint dimensions for determination of sex



Tanuj Kanchan <sup>a,\*</sup>, Kewal Krishan <sup>b</sup>, Disha Prusty <sup>c</sup>, Meghna Machado <sup>c</sup>

<sup>a</sup> Department of Forensic Medicine, Kasturba Medical College, Mangalore (A Constituent College of Manipal University), India

<sup>b</sup> Department of Anthropology, Punjab University, Chandigarh, India

<sup>c</sup> Kasturba Medical College (A Constituent College of Manipal University), Mangalore, India

Received 7 December 2013; revised 14 January 2014; accepted 11 February 2014

Available online 24 March 2014

## KEYWORDS

Forensic anthropology;  
Identification;  
Sex determination;  
Footprints;  
Heel–Ball index

**Abstract** Determination of sex from the footprints recovered at crime scenes can help the investigation by narrowing down the pool of possible suspects. The present research studies the dimensions of the heel and the ball in footprints, and derives the Heel–Ball (HB) index from these foot dimensions with the aim to find out if the foot dimensions and the HB index exhibit sexual dimorphisms. The study was carried out on 100 individuals (50 males, 50 females) of Indian origin. Footprints were obtained from both feet of the study participants using standard techniques. Thus, a total of 200 footprints were obtained. The breadth of the footprint at ball (BBAL) and the breadth of the footprint at heel (BHEL) were measured on the footprints. The HB index was derived as  $(BHEL \div BBAL) \times 100$ . The footprint measurements at the ball and heel were significantly larger in males on both the sides. Likewise, the derived HB index was larger in males in both feet, but the sex differences were not statistically significant. The study concludes that though footprint dimensions can be used in the determination of sex, the HB index may not be utilized in sex determination from footprints.

© 2014 Production and hosting by Elsevier B.V. on behalf of Forensic Medicine Authority.

## 1. Introduction

Sex, age, stature, and ancestry are the primary characteristics determined to establish the biological profile of an individual. Similarly, various prints such as fingerprints, footprints, palm prints, lip prints, and ear prints, etc., are used in forensic identification mostly by comparative analysis. While fingerprints are the most frequently studied prints for comparative analysis in forensic identification, the footprints are mostly studied for estimating the primary characteristics in forensic examinations.

Footprints are usually recovered at the crime scenes and the evaluation of footprints can provide valuable information about the crime and the criminal. Individualistic characteristics

\* Corresponding author. Address: Department of Forensic Medicine, Kasturba Medical College (A Constituent College of Manipal University), Mangalore 575001, India. Mobile: +91 9448252394; fax: +91 824 2428183.

E-mail addresses: [tanujkanchan@yahoo.co.in](mailto:tanujkanchan@yahoo.co.in), [tanuj.kanchan@manipal.edu](mailto:tanuj.kanchan@manipal.edu) (T. Kanchan).

Peer review under responsibility of Forensic Medicine Authority.



Production and hosting by Elsevier

of the footprint can help the investigators in this regard.<sup>1-3</sup> Footprints and their parts are largely studied for the determination of stature,<sup>4-9</sup> while a few studies have studied its utility in sex determination.<sup>10,11</sup> Footprints have also been studied for the determination of sex from footprint ridge density.<sup>12</sup> Determination of sex from the morphometry of the footprints obtained at the crime scenes can help the investigation by narrowing down the pool of possible suspects. Literature on the determination of sex from the footprints is limited.<sup>10,11</sup> Krishan et al.<sup>13</sup> in a recent study proposed the Heel-Ball (HB) index from the foot measurements, and studied its utility in sex determination. HB index derived on foot measurements, however, may not apply on footprint measurements.

The present research is conducted to study the dimensions of the heel and the ball in footprints, and to derive the heel ball (HB) index from these foot dimensions with an aim to find out if the footprint dimensions and the HB index exhibit sexual dimorphisms in the Indian population. The ability of the HB index to determine the sex of the individual from footprints has not yet been explored. The present study is thus a preliminary investigation on HB index from footprints.

## 2. Material and methods

The present research was carried out on 100 individuals (50 males, 50 females) of Indian origin. Healthy individuals without any deformity of the foot were included in the study. Determining the ethnicity of the footprint may not be possible and hence, study samples in the present study were comprised of a mixed population. Footprints were obtained from both the feet of the study participants using standard techniques. Thus, a total of 200 footprints were obtained. The breadth of footprint at ball (BBAL) and the breadth of footprint at heel (BHEL) were measured on the footprints. Foot breadth at the ball (BBAL) was measured as the widest part of the foot at the ball while the foot breadth at heel (BHEL) was measured as the widest part of the heel (Fig. 1).

The data obtained were computed and analyzed using SPSS (Statistical Package for Social Sciences) version 11.0 computer software. The HB Index of a footprint was derived as  $(BHEL \div BBAL) \times 100$ . The significance of the sex differences among male and female footprints was tested using student's *t*-test. A paired *t*-test was done to compare the footprint dimensions on the right and left side; '*p*' value of less than 0.05 was considered as significant.

## 3. Results

The measurements at the ball region of the footprints were observed to be larger than the heel region. Both of the footprint breadth measurements were significantly larger in males than females ( $p < 0.001$ ). Descriptive statistics for the breadth of footprints at the ball and heel are shown in Table 1.

The HB index was 54.5 and 53.9 on the right and left sides respectively in males, whereas in females, the HB index was 53.4 on the right and 53.1 on the left side. Although the HB index was observed to be higher in males, the sex differences were not found to be statistically significant (Table 2).

Bilateral differences in footprint breadth are observed only for the ball region in females ( $t = 2.845$ ,  $p = 0.006$ ). Bilateral differences were not observed for other measurements and HB



**Figure 1** Footprint showing the landmarks and measurements.

index among males and females. Side (right-left) differences in foot dimensions (cm) and HB index among males and females are shown in Table 3.

## 4. Discussion

Importance of sex determination in the identification of human remains (dismembered or putrefied) and various prints in crime/death scene investigations is well established. Despite being an important parameter contributing to the biological profile of a person, studies on sex estimation from footprints are scanty in the literature.<sup>10-12</sup> Stature and build of humans are well correlated with the body measurements that are frequently utilized in metric studies on sex determination. Stature and build are essential components of personal identification in forensic casework<sup>14</sup> and hence, most of the studies have utilized morphometric measurements of different body parts in the determination of stature. Researchers in the past have conducted studies on the foot with regard to their utility in forensic identification<sup>15</sup> by estimating stature<sup>16-24</sup> and sex from foot

Download English Version:

<https://daneshyari.com/en/article/1097550>

Download Persian Version:

<https://daneshyari.com/article/1097550>

[Daneshyari.com](https://daneshyari.com)