H59 Evaluation of the Relationship Between Fifth Metatarsal Length and Foot Length/ Shoe Size: A Possible Aid in Human Identification

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The goal of this presentation is to demonstrate new methods for assisting in the identification of human remains utilizing bones of the foot, specifically the length of the fifth metatarsal. This particular element is useful because it can be manually palpated and measured in test subjects, thus avoiding invasive procedures or ionizing radiation.

This presentation will impact the forensic community and/or humanity by demonstrating that the metatarsal bones of the foot, specifically the fifth metatarsal, can provide information useful to forensic anthropology research and casework, contributing information potentially useful for personal identification. This seemingly inconsequential bone has an unprecedented body of data to share and this study demonstrates the strong association between the length of the fifth metatarsal and weight-bearing foot length and also in the estimation of potential shoe size worn by an unidentified individual. In general, the findings of this study may prove useful as an additional resource when faced with the difficulty of attributing individual characteristics to unidentified isolated osteological material. The results also warrant consideration by the footwear industry with regard to the standardization of shoe sizes.

Significant data exists with regard to the information gleaned from the metatarsal bones. This has been well documented by a number of researchers, in particular with regard to the estimation of sex, stature, and race. However, there is potentially additional valuable information to be obtained from this unique collection of bones, which are easily identifiable and often survive due to there size and robusticity. This research explores the relationship between the length of the fifth metatarsal and overall length of the human foot. This data is of potential relevance to a multitude of disciplines including forensic podiatry and the footwear industry. In an effort to raise the issue of utilizing feet and footwear evidence to assist with the identification process, the research also considered the relationship between the fifth metatarsal size and an individual's correct (recommended) shoe size, as a possible unique supporting aid in the identification process. This could potentially provide supplemental information to well established techniques when more conventional means of anthropological identification, such as examination of skeletal anomalies or sinus configurations, are not possible.

This research was conducted with the intention of testing two alternative hypotheses: First, that a strong positive relationship exits between the length of the fifth metatarsal of the foot and the overall foot length and second, that a similar relationship also exists between the length of the fifth metatarsal of the foot and shoe size worn by test subjects.

Biological and metric data, including the fifth metatarsal length, foot length, weight, shoe size worn and correct shoe size, were collected from 120 British subjects (50 males and 70 females, of primarily European ancestry) with ages ranging from 18–94 years old. The fifth metatarsal length, defined as 'the measured distance between the most laterally-protruding aspect of the styloid process (approximating the proximal end), and the distal head of the bone', was measured to the nearest millimetre using digital sliding calipers. The individual extremities were located by manually palpating the lateral side of the foot. Foot length and 'correct' (best fit) shoe size were determined using a modified 'Brannock' device, with the subjects standing in a weight-bearing position. Interestingly, slightly more than half the subjects were found to be wearing an incorrect shoe size (i.e. 0.5 to 1 size too large), a result which was greater for women, due to factors such as personal choice and variation in manufacturing practices. Linear regression equations were constructed from the data using least squares formulae to determine the degree of relationship between the pairs of data. A blind test was subsequently undertaken using a small sub-sample of data collected independently, but consistent with the population from which the main sample of individuals were taken, to assess the reliability and accuracy of the calculated regression equations.

The construction of the linear regression equations revealed that the fifth metatarsal length displays a significant correlation with foot length (left foot: $r = 0.764$; right foot: $r = 0.778$, $p < 0.0005$). For the right foot, the calculated regression equation is $Y1 = 149.102 + 1.531 \times MT$ (where: Y1 = right foot length, MT = fifth metatarsal length; $r^2 = 0.605$). In addition, a significant relationship was shown to exist between the fifth metatarsal size and the determined correct shoe size, with strong positive correlations identified between left and right metatarsal lengths and 'correct' shoe size ($r = 0.741$ and 0.782, respectively; $p < 0.0005$). The calculated regression equation for right-foot shoe size is $Y2 = -5.344 + 0.188 \times MT$ (where: Y2 = correct shoe size, MT = fifth metatarsal length; $r^2 = 0.612$). The blind test results indicated that foot length can be predicted to within ± 7.3 mm of the actual values, within a 95% confidence interval, using known fifth metatarsal lengths of either side. The regression models correctly assigned 85% of individuals to within ±0.5 (one-half shoe size) of their correct shoe size and the remaining 15% correct to within ±1 whole shoe size. These small inaccuracies are consistent with the errors calculated in the subjects wearing the incorrect shoe size for their foot.

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The results of this study demonstrate that the metatarsal bones of the foot, specifically the fifth metatarsal, can provide information useful to forensic anthropology research and casework. This seemingly inconsequential bone has an unprecedented body of data to share and has in this instance been shown to have a strong association to foot length and also in

the estimation of potential shoe size worn by an unidentified individual. In general, the findings of this study may prove useful as an additional resource when faced with the difficulty of attributing individual characteristics to unidentified isolated osteological material. The results also warrant consideration by the footwear industry with regard to the standardization of shoe sizes.

Foot Length, Fifth Metatarsal Length, Shoe Size

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