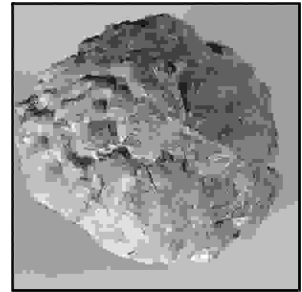


ORIGINAL

PROF-907

WEIGHT OF CALCANEUM AND TALUS FOR DETERMINATION OF SEX



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ABSTRACT... bilal_mustafa20@hotmail.com **Introduction:** Talus & Calcaneum are involved in the transmission of body weight to the ground, considerable variation in the morphological features and weight of these bones have been reported by various authors. **Objectives:** To determine the importance of bone weight as a discriminative factor in identification of sex. **Material and Method:** 198 calcanei and 150 tali from Anatomy department of Quaid-e-Azam Medical College Bahawalpur were selected for the study. Mean weight of male & female bones on right & left side were determined. To increase the efficacy of the results they were statistically reevaluated by applying $\pm 3SD$ and determining a calculated range. From this range, D.P. or demarcating points were established. **Results:** Bones of the right side were found to be heavier than those of the left side; also the mean weights of the male bones were greater than those of the female bones. On applying D.P.s it was possible to identify sex with greater accuracy than with other metrical criteria. **Conclusion:** These findings suggest that weight of tarsal bones is a useful metrical feature for sex determination.

Key Words: Calcaneum, Talus, Identification points (I.P.), Demarcating points(D.P.), Bicondylar width, Metrical criteria.

INTRODUCTION

The importance of sex determination from available skeleton is well recognized in medico legal work. Sex determination from individual bones is a difficult task but several workers have attempted to do so using various morphological features. Even when entire bony pelvis and skull are available no more than 90-95% accuracy can be achieved¹⁶. A number of studies have been

carried out to identify sex through morphological features of bones such as measurement of femoral head^{4,11,12,13,15,24,30}, length & curvature of femoral shaft, bicondylar width, trochanteric length, and mid circumference of the shaft^{28,30}. Morphological features of other bones such as Sacrum^{3,5,31}, Pelvis⁶, Sternum^{2,20,21}, Clavicle^{14,22,29}, Scapula⁹ and Mandible^{7,17} have also been studied to identify sex.

Talus is the link between foot & leg and is involved in the formation of ankle sub talar and talocalcaneonavicular joints³². Calcaneum is the largest and the strongest of the tarsal bones, it transmits body weight from the talus to the ground. It articulates with the talus superiorly and cuboid anteriorly.

Its shelf like projection sustentaculum tali supports the talar head, the articular facets on the sustentaculum tali show regional and racial variation^{18,19}. Bone weight in foot is stable between 19-40 years of age. Time environment & heat has minimal effect on the bones²⁷. Ageing process occurs in the foot bones as well but is more evident in metatarsal & the phalanges as compared to the tarsal bones¹⁶.

Identification of sex based on morphological features is not very reliable because of subjective assessment of the observer and these methods have been replaced by metrical ones^{8,10,21,28}. Identification of sex by weight have been carried out for femur²⁵, Clavicle^{14,22}, Humerus²³ and Tarsal bones²⁶. The present study attempts to establish the value of weight of the calcaneum & talus as a criterion for discriminating sexual dimorphism in Pakistan.

MATERIAL AND METHOD

198 calcanei (126 males & 72 females) and 150 tali (96 males & 54 females) were selected for study from cadavers between 20-40 years of age. Bones with any pathological lesions or showing any signs of crumbling were discarded. The study was carried out on bones from cadavers obtained from Anatomy Department of Quaid-e-Azam Medical College, Bahawalpur from 1995--2004.

The bones were prepared by removing any excess soft tissue, boiling them in water for two hours, cleaning with soap water and a soft brush. The cleaned bones were dried under shade and weighed on electric scale (Sartorius GM 5n GOTTINGEN Made in Germany).

The actual range and mean weight for right and left male and female calcanei were established. Identification

points or I.P. were determined by noting the minimum and maximum limits for corresponding bones in males and females i.e. the I.P for right male calcaneum was the highest weight recorded for the right female calcaneum, while the I.P for right female calcaneum was the lowest weight recorded for right male calcaneum. All bones weighing more than the determined I.P for males were identified as males and all bones weighing less than the determined I.P for females were identified as females²⁶.

In medico legal practice identification of sex with 100% accuracy is required and identification points (I.P) thus established may not be applicable to other data even from the same region. To make the results more accurate a calculated range was determined by adding and subtracting $\pm 3SD$ to and from the mean value of each measurement (which would cover 99.75% of the sample).

The maximum and minimum weights in the calculated range were taken as demarcating points or D.P. for corresponding bones of the opposite sex i.e. the highest weight in the calculated range of the right female calcaneum was taken as the D.P. for right male calcaneum and the lowest weight in the calculated range of right male calcaneum was the demarcating point for right female calcaneum²⁶. Student "t" test was used for comparison of means between the male and female bones.

OBSERVATION

The weight of right male calcaneum varied from 35.30gms--65 gm with a mean of 52.91gms. Where as the weight of left male calcaneum varied from 35gms-68.13 gm. with a mean of 47.72gms. 92% of the right male calcanei were heavier than the left male calcanei (Table I).

The right female calcaneum weighed from 31.46-37.90 gm (mean weight of 35.18 gm) while the weight of left female calcaneum varied from 28.60-37.05gms (mean 34.7gms). In 87% of the cases right female calcaneum was heavier than its counterpart on the left side (Table I).

Details of Measurement	Male		Female	
	Right	Left	Right	Left
Number	63	63	37	35
Mean	52.91	47.72	35.18	34.70
Actual range	35.30-65.00	35.00-68.13	31.46-37.90	28.60-37.05
I.P.	> 37.90	> 37.05	> 35.30	> 37.00
% of bones weighing beyond I.P.	96.08%	92%	47.02%	44.04%

Details of Measurement	Male		Female	
	Right	Left	Right	Left
Number	63	63	37	35
Mean	52.91	47.72	35.18	34.70
Standard Deviation	8.32	7.75	1.39	1.89
Calculated range	27.95-77.87	24.52-70.92	31.00-39.36	29.01-40.39
D.P.	> 39.36	> 63.64	< 27.95	< 19.94
% of bones weighing beyond I.P.	96.8%	90%	0%	0%
<i>P<.01 between male & female bones of both right and left side</i>				

96.8% of the right & 92% of the left male calcanei were heavier than the heaviest of the female calcaneum of the corresponding side with an IP of > 37.90 gm for right side and an IP of >37.05 gm for the left side(the max. weight for right and left female calcanei). The IP for female calcanei were <35.30 gm for right & <35.00 gm for left side (min values for right & left male calcanei). Sexual determination using these I.P could only be made in 47.2% of the cases on right and 44.4% cases on the left side, i.e. 47.2% of the right & 44.4% of the left female calcanei were lighter than the lightest of the male bones

(Table I) .

Details of Measurement	Male		Female	
	Right	Left	Right	Left
Number	52	44	24	30
Mean	29.23	28.76	22.25	22.15
Actual range	22.40-34.20	22.20-36.98	20.99-23.50	20.49-23.11
I.P.	> 23.50	> 23.11	< 22.40	< 22.20
% of bones weighing beyond I.P.	85.7%	85.7%	61%	50%

After applying D.P.: sex could still be established in 96.8% of the right and 90% of the left male calcanei, whereas for female calcanei, the percentage of identifiable bones fell to 0% on both right and left sides (Table II).

Details of Measurement	Male		Female	
	Right	Left	Right	Left
Number	52	44	24	30
Mean	29.23	28.76	22.55	22.15
Standard Deviation	3.68	4.45	0.68	0.71
Calculated range	18.18-40.28	15.41-42.11	20.49-24.61	20.02-24.28
D.P.	> 24.61	> 24.28	< 18.18	< 15.41
% of bones weighing beyond I.P.	85.7%	71.4%	0%	0%
<i>P< .01 between male & female tali of both sides</i>				

The weight & mean range for right & left male tali (96) were 22.40--34.20 gm (mean 29.23 gm) & 22.20 -36.98 gm. (mean 28.76 gm) respectively. 78.6% of the right male tali were heavier than the corresponding bones on

the left side. In females the weight & range of right and left sided tali (54) were 20.99-23.50 gm (mean 22.55 gm) & 20.49--23.11gm. (mean 22.15 gm) respectively. 97% of the right female tali were heavier than the left female tali (Table III).

Details of Measurement	Present Study		Singh & Singh	
	Right	Left	Right	Left
Mean	52.91	47.72	36.86	36.41
I.P.	> 37.90	> 37.05	> 33	> 33
% of bones weighing > I.P	96.8%	92%	63%	57%
D.P.	> 39.36	>40.93	> 42.1	>41.29
% of bones weighing > D.P.	96.8%	90%	24%	28%

The I.P. for right & left male tali was >23.50gms. & >23.11 gm respectively. For female tali the I.P were <22.40 gm. on the right & <22.20 gm. on the left sides. By using these I.P, it was possible to identify sex in 85.7% of the right and left male tali. While for female tali the percentage of identifiable bones using the I.P was 61.% on right and 50% on the left side (Table III).

Details of Measurement	Present Study		Singh & Singh	
	Right	Left	Right	Left
Mean	35.18	34.70	25.01	24.25
I.P.	<35.30	<35	<23.3	<23.7
% of bones weighing < I.P	47.2%	44.4%	40%	28%
D.P.	<27.95	<24.52	<11.57	<10.19
% of bones weighing < D.P.	0%	0%	0%	0%

For male and female tali D.P. were calculated in the

same manner as for the calcanei Whereas in male tali the percentages of the identifiable bones remained 85.7% on the right and was slightly reduced to 71.4% on the left side even after applying D.P, it fell to 0% in females on both right & left sides (Table IV).

Details of Measurement	Present Study		Singh & Singh	
	Right	Left	Right	Left
Mean	29.23	28.76	24.06	23.09
I.P.	>23.50	>23.11	>20.5	>20.0
% of bones weighing > I.P	85.7%	85.7%	77%	42%
D.P.	>24.61	>24.28	>26.7	>25.50
% of bones weighing > D.P.	85.7%	71.4%	28%	32%

Details of Measurement	Present Study		Singh & Singh	
	Right	Left	Right	Left
Mean	22.55	22.15	15.66	15.03
I.P.	<22.40	<22.20	<15.1	<15.2
% of bones weighing < I.P	61%	50%	46%	42%
D.P.	<18.18	<15.41	<9.36	<8.27
% of bones weighing < D.P.	0%	0%	28%	8%

DISCUSSION

The value of weight in discriminating sexual dimorphism has not been studied in Pakistani population, although some studies have been carried out in other parts of the world. The present study on the weights of calcaneum & talus provides us information on the sexual differences in the weight of these bones and tries to establish the importance of weight as a criterion for sex determination. The percentage of Calcanei & Tali sexed by identification points (I.P.), when their efficiency was tested on the

sample itself was quite high compared to the study of Singh & Singh²³. In the present study the percentages of identified right & left male calcanei using I.P were 96.8% & 90% respectively whereas in the study carried out by Singh & Singh the percentages of identifiable bones using I.P. were 63% & 57% only. Even after statistical calculations i.e. on applying D.P. these values remained the same (96.8% for right & 90% for left side) while in the study of Singh & Singh the percentage of identifiable bones fell by more than 50% (24% on the right & 28% on the left side) (Table V).

In case of female calcanei the percentages of identifiable bones with I.P. were 47.2 & 44.4% for right & left side respectively, these values were comparable to those cited by Singh & Singh²⁶ and on applying D.P. they fell to 0% in both the studies (Table VI).

For male tali the percentages of identifiable bones using I.P were 85.7% for both right & left sides, as compared to 77% & 42% reported by Singh & Singh. In the present study, the percentages of identifiable bones remained the same on the right side (85.7%) with only a slight reduction on the left side(71.4%) as compared to a significant reduction in the study of Singh & Singh²⁶. Where the percentages of identifiable bones fell from 63% to 24% on right and from 57% to 28% on the left side (Table VII).

In the present study percentage of identifiable female tali after applying D.P. fell markedly as compared to that reported by Singh & Singh²⁶ (from 22.40% on the right and 22.20% on the left side to 0% on both sides). Singh & Singh have reported a reduction from 46% and 42% to 28% and 8% on the right and left sides (Table VIII).

There was no significant reduction in the number of identifiable male bones in present study, even after applying D.P. as compared to study of Singh & Singh, this may be due to;

- i Better nutritional status of our population.
- ii Different dietary habits as people belonging to this part of the subcontinent have a higher

intake of proteins and calcium as compared to their Indian counterparts who are strictly vegetarians.

The reduction however was significant and comparable for female bones in both studies probably due to poor nutritional status of women in both populations resulting from multiple childbirths and male dominance for food.

The differences between mean weights of male and female calcanei & tali was statistically significant $P < .01$ which is different from the study of Singh & Singh where the difference was $P < .001$ for both right and left side. The present observations suggest that weight is an important discriminative factor in identification of a significant percentage of male calcanei & tali by using either I.P or D.P. Although a significant number of female bones could be identified using I.P. but on applying D. P. the percentage fell drastically

Our observations also indicate that there is a significant difference between the mean weights of bones of right & left sides. 92% of the right male & 87% of the right female calcanei were heavier than those of the left side, while 78.6% of right male & 97% of the right female tali were heavier than those of the left side (Table I & III). These findings are similar to those reported by Ahmed et al¹ who have also reported a right sided dominance.

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