CHAPTER 7

RESULTS – MEASUREMENTS

7.1 Intra- and interobserver repeatability tests

An intra- and interobserver repeatability analysis was done to assess the accuracy of the measurements recorded on the hand bones before using them to determine stature and sexual dimorphism. The bones randomly selected from the total sample of 200 for this analysis included the metacarpal, proximal and distal phalanges of the thumb as well as the metacarpal, proximal, middle and distal phalanges of the little finger.

In the first instance, an intra-observer repeatability test was carried out whereby the original observer (O-O) randomly selected a sample of 36 out of the total sample of 200 individuals. The 7 dimensions of the hand bones recorded initially by the original observer on all 200 individuals, were re-measured on the metacarpal, proximal and distal phalanx of the thumb and the metacarpal, proximal, middle and distal phalanx of the little finger on the randomly selected sample of 36. The results for this paired analysis (seen as O-O in Table 7.1) showed no statistically significant differences in any of the seven dimensions for the bones of the thumb and little finger. This indicates that the measurements carried out by the original observer are repeatable.

Secondly, to test for the inter-observer repeatability test, a PhD student in Anthropology served as the second observer. She employed the same method used by the original observer to record the 7 hand bone dimensions on the same randomly selected sample of 36 individuals for all the bones of the thumb and little finger. The results for this paired analysis (O-L) of the original observer (O) and the second observer (L) are shown in Table 7.2. These results indicate that 7 measurements, all related to dimensions of the little finger, were significantly different ($p<0.05$).

The discrepancies in the midshaft region recorded by the second observer may be due to the calliper not being placed exactly at the halfway mark of the shaft. In the case of the base and head measurements, the maximum recording of the width or positioning of the calliper by

the second observer may explain the discrepancies in these readings. The anterior tilting of the head and the numerous ridges on the palmar surface of the head might have affected the method of recording the anteroposterior dimension of the head. It must be taken into account that the hand bones in general are relatively smaller than those of the rest of the skeleton. Furthermore, the dimensions of the little finger are relatively smaller in comparison with adjacent digits, especially the distal phalanx, making mistakes more likely. Special care therefore needs to be taken, especially when measuring the smaller bones.

Table 7.1: Paired *t*-Test statistics for the intra-observer test using the randomly selected bones of the thumb and little finger. All 7 dimensions of these bones are shown below. The measurements recorded by the original observer (O) were repeated by the same observer (O) at a different time

Paired observations for 7 dimensions thumb and little finger	t	df	Sig. (2-tailed)
(O) - (O) First metacarpal (thumb) length	0.86	35	0.40
(O) - (O) First metacarpal (thumb) base mediolateral	0.85	35	0.40
(O) - (O) First metacarpal (thumb) base anteroposterior	1.24	35	0.22
(O) - (O) First metacarpal (thumb) head mediolateral	-1.20	35	0.24
(O) - (O) First metacarpal (thumb) head anteroposterior	-0.30	35	0.76
(O) - (O) First metacarpal (thumb) midshaft mediolateral	-1.68	35	0.10
(O) - (O) First metacarpal (thumb) midshaft anteroposterior	-1.13	35	0.26
(O) - (O) Proximal phalanx (thumb) length	0.99	35	0.33
(O) - (O) Proximal phalanx (thumb) base mediolateral	1.08	35	0.29
(O) - (O) Proximal phalanx (thumb) base anteroposterior	-0.03	35	0.98
(O) - (O) Proximal phalanx (thumb) head mediolateral	-1.25	35	0.22
(O) - (O) Proximal phalanx (thumb) head anteroposterior	-0.22	35	0.83
(O) - (O) Proximal phalanx (thumb) midshaft mediolateral	1.60	35	0.12
(O) - (O) Proximal phalanx (thumb) midshaft anteroposterior	-0.54	35	0.59
(O) - (O) Distal phalanx (thumb) length	0.06	35	0.95
(O) - (O) Distal phalanx (thumb) base mediolateral	0.81	35	0.42
(O) - (O) Distal phalanx (thumb) base anteroposterior	-0.96	35	0.34
(O) - (O) Distal phalanx (thumb) head mediolateral	-0.81	35	0.42
(O) - (O) Distal phalanx (thumb) head anteroposterior	1.58	35	0.12
(O) - (O) Distal phalanx (thumb) midshaft mediolateral	-1.23	35	0.23
(O) - (O) Distal phalanx (thumb) midshaft anteroposterior	-0.67	35	0.51
(O) - (O) Fifth metacarpal (little finger) length	0.65	35	0.52
(O) - (O) Fifth metacarpal (little finger) base mediolateral	0.71	35	0.48
(O) - (O) Fifth metacarpal (little finger) base anteroposterior	0.30	35	0.77
(O) - (O) Fifth metacarpal (little finger) head mediolateral	1.21	35	0.23
(O) - (O) Fifth metacarpal (little finger) head anteroposterior	0.05	35	0.96
(O) - (O) Fifth metacarpal (little finger) midshaft mediolateral	-0.87	35	0.39
(O) - (O) Fifth metacarpal (little finger) midshaft anteroposterior	0.78	35	0.44
(O) - (O) Proximal phalanx (little finger) length	0.17	33	0.86
(O) - (O) Proximal phalanx (little finger) base mediolateral	0.86	34	0.40
(O) - (O) Proximal phalanx (little finger) base anteroposterior	-0.29	34	0.78
(O) - (O) Proximal phalanx (little finger) head mediolateral	0.12	34	0.90
(O) - (O) Proximal phalanx (little finger) head anteroposterior	-0.11	34	0.91
(O) - (O) Proximal phalanx (little finger) midshaft mediolateral	-0.78	34	0.44
(O) - (O) Proximal phalanx (little finger) midshaft anteroposterior	-0.89	34	0.38
(O) - (O) Middle phalanx (little finger) length	-0.86	35	0.40
(O) - (O) Middle phalanx (little finger) base mediolateral	0.70	35	0.49
(O) - (O) Middle phalanx (little finger) base anteroposterior	-2.10	35	0.04
(O) - (O) Middle phalanx (little finger) head mediolateral	0.49	35	0.62
(O) - (O) Middle phalanx (little finger) head anteroposterior	1.20	35	0.24
(O) - (O) Middle phalanx (little finger) midshaft mediolateral	0.10	35	0.92
(O) - (O) Middle phalanx (little finger) midshaft anteroposterior	-0.53	35	0.60
(O) - (O) Distal phalanx (little finger) length	-1.28	35	0.21
(O) - (O) Distal phalanx (little finger) base mediolateral	-0.75	35	0.46
(O) - (O) Distal phalanx (little finger) base anteroposterior	-0.39	35	0.70
(O) - (O) Distal phalanx (little finger) head mediolateral	-0.49	35	0.63
(O) - (O) Distal phalanx (little finger) head anteroposterior	0.04	35	0.97
(O) - (O) Distal phalanx (little finger) midshaft mediolateral	1.22	35	0.23

Table 7.2: Paired *t*-Test statistics for the inter-observer test using the randomly selected bones of the thumb and little finger. All 7 dimensions of these bones are shown below. The measurements recorded by the original observer (O) were repeated by the second observer (L) at a different time. Significant differences are indicated in bold print

Paired observations for 7 dimensions thumb and little finger	t	df	Sig. (2-tailed)
(O) - (L) First metacarpal (thumb) length	0.98	35	0.33
(O) - (L) First metacarpal (thumb) base mediolateral	0.30	35	0.76
(O) - (L) First metacarpal (thumb) base anteroposterior	0.18	35	0.86
(O) - (L) First metacarpal (thumb) head mediolateral	-0.41	35	0.68
(O) - (L) First metacarpal (thumb)head anteroposterior	0.80	35	0.43
(O) - (L) First metacarpal (thumb)midshaft mediolateral	-1.30	35	0.20
(O) - (L) First metacarpal (thumb) midshaft anteroposterior	0.24	35	0.81
(O) - (L) Proximal phalanx (thumb) length	0.52	35	0.61
(O) - (L) Proximal phalanx (thumb) base mediolateral	-0.54	35	0.59
(O) - (L) Proximal phalanx (thumb)base anteroposterior	-1.00	35	0.32
(O) - (L) Proximal phalanx (thumb) head mediolateral	-2.11	35	0.04
(O) - (L) Proximal phalanx (thumb) head anteroposterior	0.80	35	0.43
(O) - (L) Proximal phalanx (thumb) midshaft mediolateral	-0.58	35	0.57
(O) - (L) Proximal phalanx (thumb) midshaft anteroposterior	0.22	35	0.83
(O) - (L) Distal phalanx (thumb) length	-0.21	34	0.83
(O) - (L) Distal phalanx (thumb) base mediolateral	-0.77	34	0.45
(O) - (L) Distal phalanx (thumb) base anteroposterior	-1.02	34	0.31
(O) - (L) Distal phalanx (thumb) head mediolateral	-0.66	34	0.51
(O) - (L) Distal phalanx (thumb) head anteroposterior	-0.49	34	0.63
(O) - (L) Distal phalanx (thumb) midshaft mediolateral	-1.32	34	0.20
(O) - (L) Distal phalanx (thumb) midshaft anteroposterior	-1.77	34	0.08
(O) - (L) Fifth metacarpal (little finger) length	-0.47	35	0.64
(O) - (L) Fifth metacarpal (little finger) base mediolateral	0.38	35	0.71
(O) - (L) Fifth metacarpal (little finger) base anteroposterior	0.87	35	0.39
(O) - (L) Fifth metacarpal (little finger) head mediolateral	0.73	35	0.47
(O) - (L) Fifth metacarpal (little finger) head anteroposterior	0.19	35	0.85
(O) - (L) Fifth metacarpal (little finger) midshaft mediolateral	3.49	35	**0.00**
(O) - (L) Fifth metacarpal (little finger) midshaft anteroposterior	1.51	35	0.14
(O) - (L) Proximal phalanx (little finger) length	-0.87	33	0.39
(O) - (L) Proximal phalanx (little finger) base mediolateral	-5.41	34	**0.00**
(O) - (L) Proximal phalanx (little finger) base anteroposterior	1.34	34	0.19
(O) - (L) Proximal phalanx (little finger) head mediolateral	-1.00	34	0.32
(O) - (L) Proximal phalanx (little finger) head anteroposterior	-0.98	34	0.33
(O) - (L) Proximal phalanx (little finger) midshaft mediolateral	0.43	34	0.67
(O) - (L) Proximal phalanx (little finger) midshaft anteroposterior	-3.00	34	**0.01**
(O) - (L) Middle phalanx (little finger) length	-1.00	35	0.32
(O) - (L) Middle phalanx (little finger) base mediolateral	-3.37	35	**0.00**
(O) - (L) Middle phalanx (little finger) base anteroposterior	-2.02	35	**0.05**
(O) - (L) Middle phalanx (little finger) head mediolateral	-1.28	35	0.21
(O) - (L) Middle phalanx (little finger) head anteroposterior	-1.00	35	0.33
(O) - (L) Middle phalanx (little finger) midshaft mediolateral	-0.16	35	**0.87**
(O) - (L) Middle phalanx (little finger) midshaft anteroposterior	-3.41	35	**0.00**
(O) - (L) Distal phalanx (little finger) length	0.31	35	0.76
(O) - (L) Distal phalanx (little finger) base mediolateral	-0.53	35	0.60
(O) - (L) Distal phalanx (little finger) base anteroposterior	-0.11	35	0.91
(O) - (L) Distal phalanx (little finger) head mediolateral	-0.07	35	0.94
(O) - (L) Distal phalanx (little finger) head anteroposterior	6.59	35	**0.00**
(O) - (L) Distal phalanx (little finger) midshaft mediolateral	0.39	35	0.70

CHAPTER 8

RESULTS - DESCRIPTIVE STATISTICS, PEARSON'S CORRELATION ANALYSIS AND STATURE DETERMINATION

8.1 Introduction

In this section, the results of the basic descriptions as well as the analysis of variance (ANOVA) which were carried out on the hand and long bone data, are given. This analysis was done to establish whether hand and long bone dimensions display differences between males and females as well as between white and black South Africans. The descriptive analysis also gives an indication on whether these differences are statistically significant or not. Should the data not be statistically significant, then pooling of data can be considered.

The means, standard deviations and results of the ANOVA are given for all 7 dimensions of each hand bone and are reported firstly, between males and females (Tables 8.1 to 8.4) and secondly, between whites and blacks (Tables 8.5 to 8.8). The output of the ANOVA for length of five long bones, namely, humerus, radius, ulna, femur and tibia, is given firstly, between white males and white females (Table 8.9), secondly, between black males and black females (Table 8.10) and thirdly, between males in females in the South African population (Table 8.11).

Following a description of the data, a Pearson's correlation analysis is carried out to establish the strength of the relationship that each hand bone has to a long bone. Once a correlation has been established, a regression analysis is constructed and the regression coefficients obtained are then used to calculate a regression equation. The long bone length obtained from this calculation can then be entered into a second regression formula devised by Lundy and Feldesman (1987) and Dayal *et al*. (2008) for estimating stature of an individual.

8.1.1 Descriptive statistics for hand bones of South African males and females

A comparison of all 7 dimensions of each bone in the hand between the sexes is seen in Tables 8.1 to 8.4. The results are reported for metacarpals (Tables 8.1a,b), proximal

phalanges (Tables 8.2a,b), middle phalanges (Tables 8.3a,b) and distal phalanges (Tables 8.4a,b). The mean values (mm) recorded for all 7 dimensions on the metacarpals and phalanges are significantly greater ($p<0.01$) in males than in females. Thus, differences between the sexes are highly significant and constant for the total sample of hand bones measured.

8.1.2 Descriptive statistics for hand bones of South African whites and blacks

A comparison of the 7 dimensions of each hand bone between South African whites and blacks in the male and female group is seen in Tables 8.5 to 8.8. The results are also reported for the following series of hand bones, namely, metacarpals (Tables 8.5a,b), proximal phalanges (Tables 8.6a,b), middle phalanges (Tables 8.7a,b) and distal phalanges (Tables 8.8a,b). In contrast to the findings between the sexes, marked variation occurred when comparisons of the dimensions of the hand bones are made between whites and blacks. Due to these differences, each series of hand bones will be reported independently from each other.

Results for the metacarpals recorded in males (Tables 8.5a,b) indicate that in general, South African whites had significantly larger ($p<0.01$) dimensions than blacks. Out of a total of 35 measurements recorded, 16 were not statistically significant.

Metacarpal measurements for the female group also showed a trend towards significantly greater ($p<0.01$) dimensions in whites than in blacks, with the exception of 13 cases. Of these exceptions, six were significantly different at $p<0.01$ and two at $p<0.05$, namely, the mediolateral (ml) and anteroposterior (ap) midshaft dimension of the first metacarpal, anteroposterior (ap) midshaft dimension of the second and third metacarpals, mediolateral (ml) and anteroposterior (ap) midshaft dimensions of the fourth and fifth metacarpals respectively.

A comparison of the first row of bones in the phalangeal series, namely, the proximal phalanges between whites and blacks (Table 8.6a,b), shows that most dimensions are significantly greater ($p<0.01$) in whites than in blacks, except for three cases in the male group

and eight cases in the female group where the reverse is true. Of these exceptions, none of these differences in males were statistically significant while only two cases in the female group were significantly different ($p<0.01$). These included the length dimensions of the third ($p<0.01$) and fourth ($p<0.05$) proximal phalanges.

A comparison of middle phalangeal dimensions between whites and blacks (Table 8.7a,b) shows the values to be significantly greater in whites than in blacks with a few exceptions. These include two dimensions in the male group which were not statistically significantly different. Of the eight dimensions in females, which were larger in blacks than in whites, only three were significantly different ($p<0.01$). These include the anteroposterior (ap) midshaft dimensions of the third, fourth and fifth middle phalanges ($p<0.01$.

Findings of the distal phalanges (Table 8.8a,b) show all dimensions to be significantly greater in whites than in blacks except for two dimensions in males and 17 dimensions in females. These two dimensions are the anteroposterior (ap) midshaft dimension of the third and fifth distal phalanges.

In summary, all 7 dimensions on each of the hand bones are significantly greater in males than in females. On the other hand, while the same dimensions tended to be greater in whites than in blacks, a large number of cases, especially in the female group, showed the opposite. Many of the observed differences were not significantly different either way. Thus, data for the white and black groups were pooled and only pooled data for males and females will used for further analyses in estimating stature and sexual dimorphism. Furthermore, as the population of origin for single hand bones will not be known in a forensic setting, it gives additional support to pooling of the data.

8.1.3 Descriptive statistics for the humerus, radius, ulna, femur and tibia

A comparison of long bone lengths between the sexes in the white (Table 8.9) and black groups (Table 8.10) indicate significantly greater ($p<0.01$) dimensions in males than in females. Pooling the data for whites and blacks (Table 8.11) also indicate significantly greater

($p<0.01$) long bone lengths in males than in females. For estimation of stature, data on length of long bones for whites and blacks will also be pooled.

8.2 DETERMINATION OF STATURE

The first step in estimating the height of an individual is to determine whether a correlation between the dependent and independent variables exists or not. If a correlation does exist, then the highest correlation value needs to be recorded as this would indicate the strength between the dependent and independent variables. In the present study, the correlation between each hand bone and each of the five long bones, namely, humerus, radius, ulna, femur and tibia will be assessed. Pearson's correlation statistics was employed to carry out this analysis.

8.2.1 Pearson's Correlation Coefficient

Pearson correlation coefficients (r) can only take on values from -1 to +1. If there is a positive sign in front of the value, then it indicates a positive correlation. In other words, as one variable increases, so too does the other one. A negative sign in front of the value indicates a negative correlation. This means that as one variable increases the other decreases. If the sign is ignored, the size of the absolute value should provide an indication of the strength of the relationship between the hand bones to the long bones. The ideal situation is when there is a perfect correlation, indicated by a -1 or +1. In this case the value of one of the variables can be used to accurately determine the value of the other variable. A correlation of zero is an indication that there is no relationship between the two variables under study. In other words, if the value of one variable is known then it cannot be used to predict the value of the other variable (Pallant 2001). The correlation results for males and females of the present study will now be reported.

8.2.1.1 Correlation results for males

In the present study, the relationships between the lengths of the hand bones (metacarpals, proximal, middle and distal phalanges) to the lengths of five long bones of the limbs (humerus, radius, ulna, femur and tibia) were determined. The results for South African males are shown in Table 8.12. Although the results indicate that most of the correlations are statistically significant (indicated by the 2-tailed test of significance), the correlation coefficients for each of the hand bones differ. The length of the first metacarpal is highly correlated to the humeral length (r=0.592) with the lowest correlation to radial length (r=0.459). The length of the second metacarpal is best correlated to radial length (r=0.785) and least correlated to humeral length (r=0.678). The correlation coefficients for the second metacarpal are higher than those observed for the first metacarpal suggesting that the second metacarpal is the bone of choice to regress to the radius. The lengths of the third and fourth metacarpals are best correlated to the tibia (r=0.745 and 0.663) and radius (r=0.744 and 0.619) and least correlated to the femur (r=0.439 and r=0.525 for the third and fourth metacarpals respectively). It is assumed that the hand bones would have a high correlation to upper limb bones as they form part of the same limb, rather than to a lower limb bone. This is clearly not the case with the third and fourth metacarpals. Similar to the results of the second metacarpal, the length of the fifth metacarpal was also best correlated to the radial length (r= 0.628), but least correlated to the femoral length (r=0.401). The results for the metacarpals show great variability, but in general, the best correlations are found with the radius.

With the exception of the first proximal phalanx, all proximal phalanges were best correlated to the tibia (r=0.511, r=0.631, r=0.682, r=0.715, r=0.593 for proximal phalanges two to five). The first proximal phalanx was best correlated to the humerus (r=0.535). In the case of proximal phalanges two to five, a lower limb rather than an upper limb bone seems to be strongly related in males.

The length of the second middle phalanx is best correlated to the femur (r=0.555), the third to the tibia (r=0.0.409), the fourth to the humerus (r=0.504) and the fifth to the tibia (r=0.472) lengths. The long bones found to be the least correlated are the ulna in the case of

the second (r=0.449) and fourth (r=0.279) middle phalanges and the femur in the case of the third (r=0.281) and fifth (r=0.279) middle phalanges.

The length of the first distal phalanx is best correlated to the tibial length (r=0.467) while the lengths of the second (r=0.462), third (r=0.291), fourth (r=0.521) and fifth (r=0.567) distal phalanges are best correlated to humeral length. The lengths of the distal phalanges are least correlated to femoral length in the case of the first (r=0.372) distal phalanx, to radial length in the case of the second (r=0.244), third (r=0.110 for radius and ulna) and fifth (r=0.235) distal phalanges and to tibial length in the case of the fourth (r=0.334) distal phalanx.

In general, the correlations for males are not very high. A correlation value of 0.5 would indicate that 50% of the length of one of the long limb bones, for example, the humerus, can be explained by the length of the fourth metacarpal. In other words, r=0.5 would account for 25% of the explanatory power (r^2). Higher correlation values are seen with the metacarpals and proximal phalanges, while lower correlations are seen in the middle and distal phalanges.

8.2.1.2 Correlation results for females

This section deals with the relationship between the lengths of the hand bones (metacarpals, proximal, middle, and distal phalanges) to the lengths of five long bones of the limbs (humerus, radius, ulna, femur, and tibia) for South African females. These results, which are shown in Table 8.13, are more consistent than those seen in males. The lengths of all hand bones are best correlated to radial length (ranging from r=0.432 to r=0.902). The highest correlation is found in the relationship of the second metacarpal to the radius (r=0.902) and the lowest correlation is seen in the fourth distal phalanx to the humerus (r=0.244).

Generally, correlations were high for the metacarpals, becoming gradually lower from proximal to distal phalanges. The hand bones showed a consistent pattern of being most closely correlated to radial length.

8.3 Regression analysis – direct and stepwise procedures

Once a correlation between the length of a hand bone and the length of a long bone has been established, the next step would be to regress, in a direct and stepwise manner, the length of an independent variable (e.g., a hand bone) to that of a dependent variable (e.g., long limb bone such as the humerus). In the direct approach, all variables are entered in no specific order into the analysis and the output, namely, the regression coefficient, prediction accuracy in percentage and standard error of the estimate (SEE), is given in the same order. In the case of the stepwise analysis, all independent variables are entered into the analysis and the computer generates the best predictor in a stepwise manner (Pallant 2001).

The direct analysis is done if the dimensions of, for example, all the hand bones are entered into the analysis in no specific order and regressed to each of the long bones. The output indicates the regression coefficient value as well as the percentage that the dimensions of the hand bones will contribute to the variation in dimension of a long bone. On the other hand, if only a single hand bone is available to regress to a long bone, then the direct approach can also be used. A stepwise approach is done when all the hand bones are available and these are entered in no specific order in the analysis, then a computer generated output will indicate which hand bone will be the best predictor from the entire series to regress to a long bone.

In both the direct and stepwise outputs, the R, R^2, adjusted R^2 and the standard error of the mean are given. The R value indicates the regression coefficient value. The R^2 value explains the percentage that a dimension contributes to the variation in the dependent variable, although where the R^2 value is reported with small sample sizes it is said to overestimate the true value in a population. The adjusted R^2 corrects this to provide a better estimate of the true population value and is often given when small samples are used (Pallant 2001). In the present study where there is a fairly large sample size, the R^2 rather than the adjusted R^2 value will be reported. In the regression results, some of the slopes will have a positive value which indicates that as the length of a hand bone increases the length of a long bone is also increasing. On the other hand, if the value of the slope is negative, then it

indicates that as the length of a metacarpal increases the length of the long bone is reducing at the same time. Once the regression coefficient, slope, constant and the standard error of estimate is obtained, a regression equation is then calculated.

In the present study, the results for the regression analysis will be given separately for males and females. This will then be followed by the calculation of a regression formula for males and females.

8.3.1 Regression analysis in South African males

8.3.1.1 Metacarpals

Table 8.14 shows the results of the direct and stepwise regression analysis using metacarpal lengths to predict long bone length in South African males. In the direct approach where the lengths of all metacarpals are entered in no particular order into the analysis, the entire group of bones best correlates to the radius and its variation in length (R=0.820, R^2=67.3%), while the same group of hand bones has the weakest correlation to the humerus (R=0.722, R^2=52.1%).

On the other hand, when the metacarpals are entered individually into the analysis a different result is given for each bone. The first metacarpal is best correlated to the humerus (R=0.592, R^2=35.1%), the second metacarpal to the radius (R=0.785, R^2=61.6%), the third (R=0.745, R^2=55.6%) and fourth (R=0.663, R^2=44.0%) metacarpals to the tibia and the fifth metacarpal to the radius (R=0.628, R^2=39.4%). The second metacarpal thus seems to be the bone of preference in the entire series to predict radial or the tibial length if no other metacarpal is present. On the other hand, if the entire series of metacarpals are present, then all the metacarpals should be entered as a single group and regressed to radial length.

In the stepwise model 1 approach, the bone generated by the computer as the best predictor is the second metacarpal which has the highest correlation to the radius (R=0.785, R^2=61.6%). The second metacarpal can also be used to determine length of the humerus, ulna and femur although the correlations are much weaker than with the radius, while the third

metacarpal in the model 1 approach best correlates to the tibia (R=0.745, R^2=55.4%) with percentages less than that for the second metacarpal.

In the stepwise model 2 approach, one has the option of choosing two metacarpals to predict long bone length. While the first and second metacarpals can be used to predict humeral and radial length, the highest correlation value is seen with the radius (R=0.807, R^2=65.1%) rather than with the humerus (R=0.711, R^2=50.5%). The two hand bones that can be used to predict ulna, femoral and tibial length are the second and third metacarpals. These hand bones have the highest correlations to the ulna (R=0.791, R^2=62.5%) and the lowest to the femur (R=0.709, R^2=50.3%).

In the stepwise model 3 approach the option of three hand bones are given which can be used to predict radial, ulna and femoral length. In the case of the radius, it is the first, second and fourth metacarpal (R=0.818, R^2=67%), for the ulna it is the second, third and fourth metacarpal (R=0.803, R^2=64%) while the first, second and third metacarpal can be regressed to the femur (R=0.735, R^2=54%).

Table 8.15 gives the values for the slope and constant of metacarpals which will be used in calculating a regression equation in males. The direct analysis gives an overall indication of positive slope values. In other words, an increase in metacarpal length results in an increase in long bone length. In cases where a negative slope occurs, an inverse relationship of metacarpal length to long bone length takes place. Examples of these are the first metacarpal to the radius, the third metacarpal to the humerus and femur, the fourth metacarpal to all long bones except the femur and lastly, the fifth metacarpal to the femur. The results for individual metacarpals in the direct analysis indicate positive values for all long bones. In the stepwise model 1 analysis, positive slopes are given for the second and third metacarpals. For the stepwise model 2 results, there is a negative value for the third metacarpal to the femur. In the stepwise model 3 analysis, negative slopes are given for the third metacarpal to the femur and for the fourth metacarpal to the radius and ulna.

In conclusion, different metacarpals are linked to different long bones. This indicates great variation in males. However, in the stepwise analyses the second metacarpal seems to

be the ideal bone in the metacarpal series to regress to four of the five long bones in the model 1 results while in the stepwise model two approach it is selected for all five long bones. Additionally, the standard error of the estimate is fairly large (up to 13.9 mm).

8.3.1.2 Proximal phalanges

Table 8.16 shows the results of the direct and stepwise regression analysis using proximal phalangeal lengths to regress to long limb bone lengths in South African males. In the direct approach where all these bones are entered in no particular order into the analysis, the highest correlations are to tibial length (R=0.740, R^2=54.8%) and the lowest to the femur length (R=0.622, R^2=38.7%).

On the other hand, when the proximal phalanges are entered individually into the analysis a different result is obtained for each hand bone. The first proximal phalanx is best correlated to the humerus (R=0.535, R^2=28.7%). The rest of the proximal phalanges are best correlated to the tibia with results of R=0.631, R^2=39.8% (second proximal phalanx), R=0.682, R^2=46.5% (third proximal phalanx), R=0.715, R^2=51.1% (fourth proximal phalanx) and R=0.593, R^2=35.2% (fifth proximal phalanx). The fourth proximal phalanx seems to be the bone of preference in the entire series to regress to the tibial length. On the other hand, if the entire series of proximal phalanges are present, then all of them should be entered as a single group and regressed to tibial length as higher correlations are obtained.

In the stepwise model 1 approach, a different hand bone is generated by the computer as the best predictor for each of the five long bones. For example, the proximal phalanx that best predicts the humerus and femur is the second bone. The correlation values for the humerus are R=0.642, R^2=41.3% which is slightly higher than those of the femur (R=0.618, R^2=38.2%). The third proximal phalanx best predicts the ulna (R=0.648, R^2=42.0%) while the fourth proximal phalanx is linked to the radius (R=0.614, R^2=37.7%) and tibia (R=0.719, R^2=51.7%).

In the stepwise model 2 approach, the two bones generated by the computer as the best predictors for the tibia (R=0.735, R^2=54.0%) are the second and fourth proximal phalanges. The regression coefficient results for proximal phalanges are shown in Table 8.17.

In conclusion, it appears that the second, third and fourth proximal phalanges are the best predictors for long bones. The low correlation values for the first and fifth proximal phalanges indicate that they are not good predictors of any long bone lengths with standard errors of estimate up to 13.9 mm.

8.3.1.3 Middle phalanges

Table 8.18 shows the results of the direct and stepwise regression analysis using lengths of the middle phalanges to regress to long bone lengths in South African males. In the direct approach where the lengths of the entire series are entered in no particular order into the analysis, the group as a whole had the highest correlation to humeral length (R=0.635, R^2=40.3%) while the same group of hand bones had the lowest correlation to ulna length (R=0.558, R^2=31.2%).

When the middle phalanges are entered individually into the analysis a different result is given for each bone. The second middle phalanx is best correlated to the femur (R=0.535, R^2=30.8%), the third (R=0.409, R^2=16.7%) and fifth (R=0.472, R^2=22.2%) middle phalanges to the tibia and the fourth to the humerus (R=0.504, R^2=25.4%). The second middle phalanx seems to be the bone of preference in the entire series to regress to femoral length. On the other hand, if the entire series of middle phalanges are present, then all of them should be entered as a group and regressed to the tibial length as this yields far higher correlations than if just a single bone was entered into the anaysis.

In the stepwise model 1 approach, the hand bone generated by the computer as the best predictor differed for each of the long bones. For example, the second middle phalanx has the highest correlation to the humerus (R=0.575 R^2=33.1%) and femur (R=0.555, R^2=30.9%). The fourth middle phalanx has the highest correlation to the tibia (R=0.528, R^2=27.9%), radius (R=0.493, R^2=24.3%) and ulna (R=0.477, R^2=22.7%).

In the stepwise model 2 approach, the two hand bones generated by the computer as the best predictors for all five long bones are the second and fourth middle phalanges. The regression coefficient results for middle phalanges are shown in Table 8.19.

In conclusion, the second and fourth middle phalanges are the best bones in the middle phalangeal series to regress to that of a long bone. The standard error of the estimate is slightly higher than those of the proximal phalangeal series, reaching values of up to 14.8 mm.

8.3.1.4 Distal phalanges

Table 8.20 shows the results of the direct and stepwise regression analysis using lengths of the distal phalanges to regress to long bone lengths in South African males. In the direct approach where the lengths of the entire series are entered in no particular order into the analysis, the group as a whole presented with the highest correlation to humeral length (R=0.657, R^2=43.1%) while the same group of hand bones has the lowest correlation to tibia length (R=0.541, R^2=29.3%).

When the distal phalanges are entered individually into the analysis a different result is given for each bone. The first distal phalanx is best correlated to the tibia (R=0.467, R^2=21.8%) while the second (R=0.462, R^2=21.3%), third (R=0.291, R^2=0.08%), fourth (R=0.521, R^2=27.2%) and fifth (R=0.567, R^2=32.2%) distal phalanges are best correlated to the humerus. The fifth distal phalanx seems to be the bone of choice to regress to humeral length.

In the stepwise model 1 approach, the bone generated by the computer as the best predictor includes the first and fifth distal phalanges. The first distal phalanx is the best predictor for the radius (R=0.452, R^2=20.4%), ulna (R=0.471, R^2=22.2%), femur (R=0.559, R^2=31.2%) and tibia (R=0.490, R^2=24.0%). Regression coefficient values for the distal phalanges are seen in Table 8.21.

In conclusion, the fifth distal phalanx is selected as the best predictor for the humerus (R=0.600 R^2=36.0%). Futhermore, correlation values of distal phalangeal length to long bone length are low in comparison to the proximal and middle phalanges with standard error of the estimate up to 14.3 mm.

8.3.2 Regression analysis in South African females

8.3.2.1 Metacarpals

Table 8.22 shows the results of the direct and stepwise regression analysis using metacarpal lengths against the lengths of the long limb bones in South African females. In the direct approach where the lengths of all metacarpals are entered in no particular order into the analysis, the entire group of bones has the highest correlation to radial length (R=0.926, R^2=85.7%) while the same group of hand bones has the lowest correlation to humeral length (R=0.797, R^2=63.5%). These results are far higher than those reported for males for the same group of hand bones.

In comparison to the results for males where individual metacarpals were correlated to different long bones, the results in females indicate consistency throughout the analysis in that each metacarpal is best correlated to the radius. The values produced from the regression analysis for the individual metacarpals are R=0.827, R^2=68.4 % (first metacarpal), R=0.902, R^2=81.4 % (second metacarpal), R=0.844, R^2=71.2 % (third metacarpal), R=0.812, R^2=66.0 % (fourth metacarpal) and R=0.806, R^2=65.0 % (fifth metacarpal). From this series of hand bones, the highest percentage recorded is for the second metacarpal. This is also the hand bone that has the highest correlation to the radius. If the entire series of metacarpals are available, then they should be entered as a group and regressed to the radial length.

In the stepwise model 1 approach, the bone generated by the computer as the best predictor for all five long bones is the second metacarpal, which also has the highest correlation value to the radius (R=0.904, R^2=81.7%).

In the stepwise model 2 approach, the two hand bones generated by the computer as the best predictors vary for each long bone. For the humerus (R=0.780, R^2=60.8%) and femur (R=0.790, R^2=62.4.7%) it is the second and fourth metacarpals, for the radius (R=0.924, R^2=85.3%) and ulna (R=0.879, R^2=77.3%) it is the first and second metacarpals, while the second and fifth metacarpals can be used as predictors for the tibia (R=0.849, R^2=72.1%).

In the stepwise model 3 approach, the three hand bones selected also vary for the different long bones. For the humerus (R=0.792, R^2=62.8%), the bones selected are the first, second and fourth metacarpals, for the ulna (R=0.897, R^2=80.5%) it is the first, second and fifth metacarpals. The femur (R=0.841, R^2=70.7%) can be predicted using the second, third and fourth metacarpals while the second, third and fifth metacarpals are selected as predictors for the tibia (R=0.879, R^2=77.3%).

In the stepwise model 4 approach, there is the option of using four metacarpals to predict tibial length (R=0.906, R^2=82.1%). Except for the first metacarpal, all the other metacarpals are selected as predictors for this long bone. The results for the regression coefficients in females are shown in Table 8.23, which generally indicates positive slope values.

In conclusion, while the second metacarpal is correlated to all long bones, the best correlation is to the radius. Given the results on regression coefficients for the metacarpals, it is evident that increases in length of these bones result in a simultaneous increase in the length of a long bone. Fairly large standard errors of estimate up to 12.1 mm were obtained.

8.3.2.2 Proximal phalanges

Table 8.24 sets out the results for the direct and stepwise regression analysis using proximal phalangeal lengths to regress to long bone lengths in South African females. In the direct approach all proximal phalanges are entered into the analysis in no particular order. The highest correlations are obtained for the radius (R=0.788 and R^2=62.2%) and the lowest values for the femur (R=0.533, R^2=28.4%).

Entering the proximal phalanges individually into the direct analysis also produces high correlations to the radius. These high correlation values are given for the first (R=0.706 and R^2=49.9 %), second (R=0.648 and R^2=41.9 %), third (R=0.680 and R^2=46.3 %), fourth (R=0.717 and R^2=51.4 %) and fifth (R=0.597 and R^2=35.7%) proximal phalanges.

In the stepwise model 1 approach, the bone generated by the computer as the best predictor for the humerus (R=0.474, R^2=22.5%) and femur (R=0.461, R^2=21.2%) is the second

proximal phalanx. In the case of the radius (R=0.722, R^2=52.1%), ulna (R=0.695, R^2=48.3%) and tibia (R=0.601, R^2=36.1%) it is the fourth proximal phalanx.

In the stepwise model 2 approach, the two bones generated by the computer as the best predictors for the radius (R=0.777, R^2=60.4%) and ulna (R=0.734, R^2=53.8%) are the first and fourth proximal phalanges. In the case of the femur (R=0.511, R^2=26.1%) it is the first and second proximal phalanges. Regression coefficient values for proximal phalanges are shown in Table 8.25.

In conclusion, while the best correlation of each proximal phalanx varies for each long bone, the stepwise analysis indicates that the first, second and fourth proximal phalanges appear to be the hand bones of choice to predict the length of a long bone. This series of bones has standard errors of estimate up to 13.5 mm.

8.3.2.3 Middle phalanges

Table 8.26 shows the results for the direct and stepwise regression analysis using middle phalangeal lengths to predict long bone lengths in South African females. In the direct approach where the entire series is entered into the analysis in no particular order, the highest correlation is to radial length (R=0.694, R^2=48.1%) and the lowest correlation is to humeral length (R=0.488, R^2=23.8%).

Entering the middle phalanges individually into the direct analysis also gives the highest correlation to the radius in females. These regression values are given for the second (R=0.494, R^2=24.4%), third (R=0.654, R^2=42.7%), fourth (R=0.619, R^2=38.3%), and fifth (R=0.444, R^2=19.7%) middle phalanges. A comparison of these results indicates that the third bone in this series has the highest correlation values.

In the stepwise model 1 approach, the bone generated by the computer as the best one in the series to predict length of long bones is the third middle phalanx with the highest correlation being to the radius (R=0.651 R^2=42.3%).

In the stepwise model 2 approach, the two hand bones generated by the computer as the best predictors for the radius(R=0.682, R^2=46.5%) are the third and fifth middle phalanges.

In the case of the ulna (R=0.620, R^2=38.5%) and tibia (R=0.573, R^2=32.9%) the third and fourth middle phalanges are selected. Regression coefficient results for middle phalanges are shown in Table 8.27.

In conclusion, the third middle phalanx seems to be the ideal bone in the middle phalangeal series to predict radial length in females with standard error of the estimate up to 14.2 mm. On the other hand, if the entire series of middle phalanges is present, then this would be preferred over regression of a single bone.

8.3.2.4 Distal phalanges

Table 8.28 shows the results of the direct and stepwise regression analysis using distal phalangeal lengths to predict long bone lengths in South African females. In the direct approach the entire series of distal phalanges are entered into the analysis in no particular order. The highest correlations were to the radius (R=0.600, R^2=36.0%) and the lowest correlations were reported for the tibia (R=0.442, R^2=19.5%).

Entering the distal phalanges individually into the analysis also indicated high correlations to the radius. The regression values obtained are given for the first (R=0.474, R^2=22.4%), second (R=0.470, R^2=22.1%), third (R=0.507, R^2=25.7%), fourth (R=0.486, R^2=23.6%) and fifth (R=0.432, R^2=18.7%) distal phlanges. The hand bone with the best correlation value and highest percentage to predict radial length in this series of hand bones is the third distal phalanx.

In the stepwise model 1 approach, the bone generated by the computer as the best predictor is the first distal phalanx which has the highest correlation to the radius (R=0.583 R^2=34.0%). Regression coefficient results for distal phalanges are shown in Table 8.29.

In conclusion, the first distal phalanx is the bone of choice to predict any of the five long bones based on the stepwise analysis with the highest correlation being to the radius with standard error estimates up to 14.4 mm. On the other hand, if all five distal phalanges are available and they are entered individually into the analysis, then the third distal phalanx is the

bone of choice. The R values are generally low and standard error of the estimate is high reaching values of up to 14.5 mm.

8.4 Calculation of regression equations

When calculating a regression equation the following steps are followed:

1) The hand bone/s must first be identified
2) The length of the hand bone must then be measured
3) Tables 8.12 and 8.13 are then used to pair the hand bone with the highest correlation to a long bone
4) The regression coefficients (i.e. the slope and constant) and standard error of the estimate are then obtained from the regression tables in this study (Tables 8.14 to 8.21) for the specific hand bone that is to be regressed to a specific long bone
5) The following formula is then used:

y=mx+c

[where, y=length (mm) of a long bone (e.g. humerus), m= length (mm) of hand bone, x= slope and c=constant]

6) Once the length of a hand bone has been regressed to that of a long bone, the value obtained is inserted into a second equation developed by Lundy and Feldesman (1987) or Dayal *et al*. (2008). These authors have devised regression formulae for estimating living stature from long bones of the South African black and white groups.

Example

The hand bone of an unknown individual was found and identified as the first metacarpal. The length measurement of the first metacarpal is then taken, e.g., 45.86 mm. Once the length has been recorded, refer to Tables 8.12 and 8.13 to see which long bone length has the highest correlation value to the first metacarpal. In males (Table 8.12), the first metacarpal would be regressed to humeral length while in females (Table 8.13) it will be to radial length. The next step would be to look up the value of the slope and constant for the first

metacarpal which would be found in Table 8.15 for males and Table 8.23 for females. In males the value of the slope for the first metacarpal (MC1) is 2.717 and the constant is 205,515 (Table 8.15; metacarpal 1; humerus). In females the value of the slope is 3.233 and the constant is 92.970 (Table 8.23; metacarpal 1, radius). Once these values are obtained, then calculation of the regression equation for males and females is as follows:

For males, the formula using the first metacarpal will be:

Y (humeral length) = 45.86 (metacarpal length) x 2.717 (slope) + 205.515 (constant) ± S.E.E

= 330.12 ± 10.618 mm

For females, the formula using the first metacarpal will be:

Y (radial length) = 45.86 (metacarpal length) x 3.233 (slope) + 92.970 (constant) ± S.E.E

= 306.84 ± 5.818 mm

The height of an individual now needs to be calculated. In order to do this, the calculated long bone length (e.g. humeral length), is now inserted into an appropriate formula such as those devised by Lundy and Feldesman (1987) and Dayal et al. (2008).

Note:

The above example is for a single hand bone that is found. Ideally, the entire series such as the entire row of metacarpals is of greater value in that it increases the prediction accuracy.

In a case where all five metacarpals are available, and it is suspected that they belong to a male, the first step would be to measure their lengths (mm). The next step would be to go to Table 8.14. When all five metacarpals are available, they can be used to best predict the length of the radius (R=0.820, R^2=67.3%). Table 8.15 lists the values of the slope, constant and standard error of the estimate.

Measurements

metacarpal (MC) 1 length = 45.86mm (slope = -0.056)

metacarpal (MC) 2 length = 68.19mm (slope = 1.289)

metacarpal (MC) 3 length = 66.28mm (slope = 0.874)

metacarpal (MC) 4 length = 58.88mm (slope = -0.747)

metacarpal (MC) 5 length = 54.32mm (slope = 0.312)

the constant = 138.832

standard error of the estimate (SEE) = 5.16864

Using the following formula:

Y (humeral length) = [MC1 length x (slope)] + [MC2 length x (slope)] + [MC3 length x (slope)] + [MC4 length x (slope)] + [MC5 length x (slope)] + constant ± S.E.E

Insert the appropriate values into the above formula:

Y (radial length) = [45.86 x (-0.056)] + [68.19 x (1.289)] + [66.28 x (0.874)] + [58.88 x (-0.747)] + [54.32 x (0.312)] + 138.832 (constant) ± 5.168 (SEE)

Y (radial length) = [-256.816] + [87.89] + [57.93] - [43.98] + [16.95] + 138.832 (constant) ± 5.168 (SEE)

Y (radial length male) = 257.62 ± 5.168 mm

The calculated long bone length (i.e. radial length), is now inserted into the appropriate formulae of Lundy and Feldesman (1987) and Dayal *et al.* (2008) in order to estimate stature. It should once again be emphasized that it is better to use more than one hand bone as this increases the accuracy for predicting the length of a long bone.

Table 8.1a. Descriptive statistics comparing mean values (mm) of metacarpals (MC) 1 to 3 between males and females in South African whites and blacks

	WHITE				BLACK		
Variable	Sex	Mean	S.D.	P	Mean	S.D.	P
MC1 length	Male	46.21	2.59	0.0000	45.53	3.09	0.0000
	Female	42.64	2.65		42.48	2.75	
MC1 base ml	Male	16.38	1.33	0.0000	16.17	1.46	0.0000
	Female	15.04	1.55		14.37	0.94	
MC1 base ap	Male	16.61	1.73	0.0087	16.27	1.56	0.0000
	Female	15.62	1.91		14.26	1.15	
MC1 head ml	Male	15.91	1.59	0.0000	16.08	1.40	0.0000
	Female	14.30	1.16		14.29	1.10	
MC1 head ap	Male	15.36	1.39	0.0000	14.04	1.36	0.0000
	Female	13.67	1.42		12.66	1.04	
MC1 midshaft ml	Male	13.13	1.06	0.0000	12.85	1.12	0.0000
	Female	11.04	0.96		11.59	1.01	
MC1 midshaft ap	Male	9.19	0.78	0.0000	9.42	0.86	0.0000
	Female	8.01	0.89		8.39	0.81	
MC2 length	Male	68.60	3.63	0.0000	67.80	4.62	0.0000
	Female	64.30	3.25		64.11	4.42	
MC2 base ml	Male	18.70	1.45	0.0000	17.03	1.59	0.0000
	Female	16.30	1.16		15.37	1.40	
MC2 base ap	Male	17.94	1.60	0.0000	17.05	1.44	0.0000
	Female	15.79	1.31		15.38	1.19	
MC2 head ml	Male	15.55	1.50	0.0000	14.49	1.07	0.0000
	Female	13.87	1.11		13.29	0.97	
MC2 head ap	Male	15.36	1.06	0.0000	14.60	0.89	0.0000
	Female	14.01	0.99		13.27	0.91	
MC2 midshaft ml	Male	9.52	0.83	0.0000	9.00	0.71	0.0000
	Female	8.30	0.76		8.28	0.73	
MC2 midshaft ap	Male	9.76	0.81	0.0000	9.90	1.32	0.0000
	Female	8.32	0.79		8.78	0.82	
MC3 length	Male	65.85	3.90	0.0000	66.68	4.38	0.0000
	Female	61.90	3.61		62.80	4.04	
MC3 base ml	Male	14.87	0.84	0.0000	14.05	1.14	0.0000
	Female	13.46	1.16		12.81	0.84	
MC3 base ap	Male	18.14	1.27	0.0000	17.29	1.17	0.0000
	Female	16.04	1.48		15.46	0.90	
MC3 head ml	Male	14.57	1.28	0.0000	14.33	1.09	0.0000
	Female	13.12	1.22		12.95	0.89	
MC3 head ap	Male	15.44	0.99	0.0000	14.72	1.03	0.0000
	Female	13.75	1.04		13.27	0.85	
MC3 midshaft ml	Male	9.42	0.75	0.0000	9.15	0.70	0.0000
	Female	8.37	0.64		8.50	0.75	
MC3 midshaft ap	Male	10.10	0.89	0.0000	10.04	1.09	0.0000
	Female	8.63	0.78		9.06	0.85	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.1b. Descriptive statistics comparing mean values of metacarpals (MC) 4 and 5 between males and females in South African whites and blacks

	WHITE				BLACK		
Variable	Sex	Mean	S.D.	P	Mean	S.D.	P
MC4 length	Male	59.06	2.85	0.0000	58.71	4.25	0.0000
	Female	54.60	3.17		55.73	3.67	
MC4 base ml	Male	12.53	1.04	0.0000	11.46	1.05	0.0000
	Female	11.09	0.93		10.30	0.69	
MC4 base ap	Male	13.29	0.96	0.0000	12.88	1.12	0.0000
	Female	11.42	0.96		11.74	0.93	
MC4 head ml	Male	12.73	0.96	0.0000	12.24	0.89	0.0000
	Female	11.41	1.48		11.42	0.87	
MC4 head ap	Male	13.89	0.90	0.0000	13.27	1.14	0.0000
	Female	12.28	0.89		12.30	0.86	
MC4 midshaft ml	Male	7.88	0.86	0.0000	7.75	0.83	0.0000
	Female	6.63	0.59		6.98	0.68	
MC4 midshaft ap	Male	8.28	0.92	0.0000	8.59	0.88	0.0000
	Female	6.67	0.70		7.78	0.79	
MC5 length	Male	54.35	2.85	0.0000	54.30	3.58	0.0000
	Female	51.10	2.88		50.75	3.71	
MC5 base ml	Male	14.55	1.29	0.0000	13.45	1.29	0.0000
	Female	12.98	1.26		11.83	0.92	
MC5 base ap	Male	12.42	1.20	0.0000	11.66	1.08	0.0000
	Female	10.90	1.01		10.27	0.81	
MC5 head ml	Male	12.47	1.00	0.0000	11.94	0.98	0.0000
	Female	11.01	0.89		10.70	0.87	
MC5 head ap	Male	12.82	0.92	0.0000	12.22	0.78	0.0000
	Female	11.44	0.81		11.16	0.84	
MC5 midshaft ml	Male	8.58	0.88	0.0000	8.58	0.85	0.0000
	Female	7.21	0.71		7.76	0.81	
MC5 midshaft ap	Male	7.83	1.02	0.0000	7.80	1.08	0.0000
	Female	6.42	0.73		6.74	0.74	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.2a. Descriptive statistics comparing mean values (mm) of proximal phalanges (PP) 1 to 3 between males and females in South African whites and blacks

	WHITE				BLACK		
Variable	Sex	Mean	S.D.	P	Mean	S.D.	P
PP1 length	Male	31.24	1.84	0.0000	30.82	2.21	0.0000
	Female	28.32	1.84		28.70	2.54	
PP1 base ml	Male	17.33	1.20	0.0000	16.81	1.10	0.0000
	Female	15.34	0.96		14.83	0.97	
PP1 base ap	Male	12.57	1.03	0.0000	12.33	0.97	0.0000
	Female	10.76	0.77		10.74	0.77	
PP1 head ml	Male	13.43	0.98	0.0000	12.66	0.70	0.0000
	Female	11.91	0.71		11.34	0.71	
PP1 head ap	Male	9.98	1.15	0.0000	9.21	0.99	0.0000
	Female	8.78	1.02		8.00	0.79	
PP1 midshaft ml	Male	10.19	0.86	0.0000	9.46	0.77	0.0000
	Female	8.44	0.74		8.17	0.69	
PP1 midshaft ap	Male	6.86	0.61	0.0000	6.65	0.56	0.0000
	Female	5.50	0.53		5.70	0.54	
PP2 length	Male	40.97	2.42	0.0000	40.29	2.91	0.0004
	Female	38.37	2.28		38.16	2.86	
PP2 base ml	Male	17.26	1.47	0.0000	16.61	0.90	0.0000
	Female	15.51	1.11		14.93	1.10	
PP2 base ap	Male	12.67	0.80	0.0000	12.18	0.82	0.0000
	Female	11.32	0.72		10.96	0.69	
PP2 head ml	Male	12.33	0.86	0.0000	11.23	0.69	0.0000
	Female	11.07	0.79		10.30	0.65	
PP2 head ap	Male	8.99	0.79	0.0000	8.09	0.62	0.0000
	Female	7.86	0.65		7.33	0.55	
PP2 midshaft ml	Male	10.69	1.00	0.0000	9.84	0.81	0.0000
	Female	8.89	0.68		8.62	0.71	
PP2 midshaft ap	Male	7.19	0.64	0.0000	6.74	0.67	0.0000
	Female	6.06	0.62		5.86	0.46	
PP3 length	Male	45.63	2.33	0.0000	45.72	2.90	0.0003
	Female	42.34	2.16		43.49	3.07	
PP3 base ml	Male	17.27	1.02	0.0000	16.56	0.90	0.0000
	Female	15.50	0.93		14.82	0.93	
PP3 base ap	Male	13.37	0.73	0.0000	13.24	1.04	0.0000
	Female	11.80	0.67		11.92	0.63	
PP3 head ml	Male	12.84	0.72	0.0000	11.98	0.72	0.0000
	Female	11.53	0.82		11.03	0.76	
PP3 head ap	Male	9.15	0.65	0.0000	8.55	0.65	0.0000
	Female	8.18	0.91		7.69	0.62	
PP3 midshaft ml	Male	11.00	0.95	0.0000	10.34	0.98	0.0000
	Female	9.24	0.72		9.04	0.77	
PP3 midshaft ap	Male	7.87	0.84	0.0000	7.36	0.61	0.0000
	Female	6.68	0.66		6.56	0.58	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.2b. Descriptive statistics comparing mean values (mm) of proximal phalanges (PP) 4 and 5 between males and females in South African whites and blacks

	WHITE				BLACK		
Variable	Sex	Mean	S.D.	P	Mean	S.D.	P
PP4 length	Male	42.59	2.30	0.0000	43.05	2.81	0.0003
	Female	39.55	2.27		40.83	3.15	
PP4 base ml	Male	15.67	0.99	0.0000	14.92	1.03	0.0000
	Female	14.09	0.96		13.40	0.81	
PP4 base ap	Male	12.40	0.74	0.0000	12.21	0.80	0.0000
	Female	11.00	0.71		11.02	0.61	
PP4 head ml	Male	11.93	0.70	0.0000	11.27	0.65	0.0000
	Female	10.74	0.84		10.50	1.48	
PP4 head ap	Male	8.66	0.66	0.0000	7.94	0.67	0.0000
	Female	7.61	0.76		7.34	0.62	
PP4 midshaft ml	Male	10.32	0.92	0.0000	9.60	0.88	0.0000
	Female	8.57	0.80		8.42	0.75	
PP4 midshaft ap	Male	7.15	0.78	0.0000	6.88	0.63	0.0000
	Female	6.10	0.82		6.10	0.53	
PP5 length	Male	33.53	2.64	0.0000	33.58	2.59	0.0001
	Female	30.54	1.43		31.22	2.92	
PP5 base ml	Male	14.96	1.21	0.0000	14.38	0.85	0.0000
	Female	13.48	0.75		12.80	0.78	
PP 5 base ap	Male	10.99	0.83	0.0000	10.76	1.07	0.0000
	Female	9.64	0.60		9.51	0.66	
PP5 head ml	Male	10.10	0.77	0.0000	9.58	0.68	0.0000
	Female	8.82	0.65		8.62	0.58	
PP5 head ap	Male	7.42	0.92	0.0000	6.88	0.57	0.0000
	Female	6.30	0.61		6.00	0.51	
PP5 midshaft ml	Male	8.88	0.85	0.0000	8.47	0.80	0.0000
	Female	7.25	0.74		7.24	0.68	
PP5 midshaft ap	Male	5.88	0.68	0.0000	5.69	0.48	0.0000
	Female	4.77	0.48		4.96	0.51	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.3a. Descriptive statistics comparing mean values (mm) of middle phalanges (MP) 2 to 4 between males and females in South African whites and blacks

	WHITE				BLACK		
Variable	Sex	Mean	S.D.	P	Mean	S.D.	P
MP2 length	Male	24.63	1.84	0.0000	23.86	2.08	0.0024
	Female	22.68	1.51		22.52	2.15	
MP2 base ml	Male	14.07	0.99	0.0000	13.41	0.92	0.0000
	Female	12.64	0.83		11.91	0.69	
MP2 base ap	Male	9.85	0.63	0.0000	9.50	0.62	0.0000
	Female	8.72	0.58		8.56	0.50	
MP2 head ml	Male	10.42	0.89	0.0000	9.65	0.70	0.0000
	Female	9.53	0.81		8.83	0.54	
MP2 head ap	Male	6.62	0.83	0.0000	6.02	0.81	0.0000
	Female	6.09	0.83		5.33	0.55	
MP2 midshaft ml	Male	8.60	0.81	0.0000	8.06	0.80	0.0000
	Female	7.21	0.65		7.03	0.63	
MP2 midshaft ap	Male	5.14	0.53	0.0000	4.99	0.44	0.0000
	Female	4.34	0.42		4.44	0.36	
MP3 length	Male	29.36	1.69	0.0000	29.17	2.09	0.0002
	Female	27.40	1.93		27.57	2.06	
MP3 base ml	Male	14.71	1.00	0.0000	14.33	0.97	0.0000
	Female	13.43	0.93		13.09	1.14	
MP3 base ap	Male	10.54	0.70	0.0000	10.31	0.74	0.0000
	Female	9.50	0.73		9.48	0.58	
MP3 head ml	Male	10.89	0.85	0.0000	10.55	0.64	0.0000
	Female	10.05	0.84		9.59	0.58	
MP3 head ap	Male	6.86	0.75	0.0019	6.48	0.66	0.0000
	Female	6.35	0.83		5.88	0.59	
MP3 midshaft ml	Male	9.23	0.85	0.0000	8.83	0.81	0.0000
	Female	7.79	0.59		7.69	0.71	
MP3 midshaft ap	Male	5.62	0.59	0.0000	5.58	0.43	0.0000
	Female	4.65	0.50		4.93	0.41	
MP4 length	Male	28.17	1.85	0.0000	27.62	2.27	0.0338
	Female	26.11	2.67		26.66	2.16	
MP4 base ml	Male	13.85	0.93	0.0000	13.42	1.06	0.0000
	Female	12.56	0.88		12.25	0.78	
MP4 base ap	Male	9.99	0.60	0.0000	9.81	0.63	0.0000
	Female	8.86	0.67		8.98	0.57	
MP4 head ml	Male	10.49	0.95	0.0000	10.03	0.83	0.0000
	Female	9.53	0.69		9.32	0.60	
MP4 head ap	Male	6.48	0.64	0.0000	6.01	0.72	0.0006
	Female	5.68	0.76		5.48	0.79	
MP4 midshaft ml	Male	8.84	0.81	0.0000	8.21	0.85	0.0000
	Female	7.34	0.59		7.32	0.72	
MP4 midshaft ap	Male	5.32	0.92	0.0000	5.18	0.47	0.0000
	Female	4.22	0.44		4.61	0.44	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.3b. Descriptive statistics comparing mean values (mm) of the fifth middle phalanx (MP) between males and females in South African whites and blacks

	WHITE				BLACK		
Variable	Sex	Mean	S.D.	P	Mean	S.D.	P
MP5 length	Male	20.19	1.73	0.0011	20.49	1.97	0.0000
	Female	18.68	2.54		18.71	1.80	
MP5 base ml	Male	12.06	1.12	0.0000	11.55	0.95	0.0000
	Female	10.88	1.07		10.23	0.77	
MP5 base ap	Male	8.61	0.61	0.0000	8.45	0.62	0.0000
	Female	7.62	0.75		7.50	0.58	
MP5 head ml	Male	9.38	0.63	0.0000	8.83	0.61	0.0000
	Female	8.48	0.83		7.97	0.61	
MP5 head ap	Male	5.63	0.60	0.0000	5.14	0.49	0.0000
	Female	4.97	0.67		4.52	0.44	
MP5 midshaft ml	Male	7.64	0.66	0.0000	7.17	0.64	0.0000
	Female	6.35	0.69		6.22	0.57	
MP5 midshaft ap	Male	4.45	0.43	0.0000	4.52	0.39	0.0000
	Female	3.65	0.49		3.93	0.37	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.4a. Descriptive statistics comparing mean values (mm) of distal phalanges (DP) 1 to 3 between males and females in South African whites and blacks

	WHITE				BLACK		
Variable	Sex	Mean	S.D.	P	Mean	S.D.	P
DP1 length	Male	23.41	1.68	0.0000	23.11	1.24	0.0000
	Female	21.07	1.24		20.88	1.87	
DP1 base ml	Male	15.78	1.58	0.0000	15.19	1.02	0.0000
	Female	13.99	1.11		13.25	1.09	
DP1 base ap	Male	9.67	0.86	0.0000	9.27	0.82	0.0000
	Female	8.32	0.66		8.05	0.70	
DP1 head ml	Male	11.17	1.35	0.0000	10.51	1.09	0.0000
	Female	9.50	1.24		9.01	0.67	
DP1 head ap	Male	4.27	0.42	0.0000	4.11	0.48	0.0000
	Female	3.57	0.50		3.68	0.39	
DP1 midshaft ml	Male	8.78	0.91	0.0000	8.21	0.81	0.0000
	Female	7.66	0.92		7.28	0.64	
DP1 midshaft ap	Male	4.71	0.55	0.0000	4.87	0.56	0.0000
	Female	3.98	0.73		4.05	0.48	
DP2 length	Male	18.31	1.12	0.0000	17.51	1.32	0.0000
	Female	16.26	1.11		16.29	1.36	
DP2 base ml	Male	10.99	1.02	0.0000	10.89	0.98	0.0000
	Female	9.98	1.11		9.47	0.63	
DP2 base ap	Male	7.03	1.29	0.0027	6.50	0.81	0.0000
	Female	6.30	1.00		5.70	0.37	
DP2 head ml	Male	8.22	0.93	0.0000	7.75	1.08	0.0000
	Female	7.22	0.93		6.88	0.76	
DP2 head ap	Male	3.90	0.49	0.0000	3.73	0.60	0.0000
	Female	3.38	0.40		3.27	0.35	
DP2 midshaft ml	Male	5.56	0.69	0.0000	5.32	0.70	0.0000
	Female	4.77	0.55		4.79	0.53	
DP2 midshaft ap	Male	3.87	0.42	0.0000	3.87	0.40	0.0000
	Female	3.32	0.38		3.39	0.36	
DP3 length	Male	19.26	1.15	0.0000	18.68	1.23	0.0003
	Female	17.31	1.29		17.70	1.36	
DP3 base ml	Male	11.80	0.98	0.0000	11.48	0.92	0.0000
	Female	10.33	0.91		10.34	0.77	
DP3 base ap	Male	7.34	0.94	0.0000	6.96	0.81	0.0000
	Female	6.37	0.74		6.43	0.72	
DP3 head ml	Male	8.98	0.94	0.0000	8.60	1.09	0.0000
	Female	7.75	1.10		7.67	0.96	
DP3 head ap	Male	4.45	0.48	0.0000	4.29	0.51	0.0006
	Female	3.80	0.47		3.94	0.47	
DP3 midshaft ml	Male	5.85	0.66	0.0000	5.70	0.81	0.0014
	Female	5.00	0.64		5.22	0.61	
DP3 midshaft ap	Male	4.06	0.42	0.0000	4.04	0.42	0.0001
	Female	3.41	0.42		3.70	0.42	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.4b. Descriptive statistics comparing mean values (mm) of distal phalanges (DP) 4 and 5 between males and females in South African whites and blacks

	WHITE				BLACK		
Variable	Sex	Mean	S.D.	P	Mean	S.D.	P
DP4 length	Male	19.29	1.20	0.0000	18.59	1.26	0.0008
	Female	17.30	1.44		17.65	1.39	
DP4 base ml	Male	11.64	0.88	0.0000	11.25	1.04	0.0000
	Female	10.46	1.16		10.04	0.67	
DP4 base ap	Male	7.07	0.76	0.0000	6.73	0.92	0.0012
	Female	6.40	0.85		6.20	0.63	
DP4 head ml	Male	8.84	0.84	0.0000	8.31	1.12	0.0000
	Female	7.75	0.94		7.40	0.85	
DP4 head ap	Male	4.43	0.44	0.0000	4.18	0.55	0.0065
	Female	3.88	0.44		3.90	0.43	
DP4 midshaft ml	Male	5.75	0.60	0.0000	5.49	0.73	0.0000
	Female	4.91	0.55		4.93	0.55	
DP4 midshaft ap	Male	4.05	0.77	0.0000	3.94	0.37	0.0000
	Female	3.45	0.49		3.57	0.32	
DP5 length	Male	17.74	0.99	0.0000	16.70	1.27	0.0000
	Female	15.44	1.28		15.21	1.28	
DP5 base ml	Male	10.01	0.77	0.0000	9.74	0.74	0.0000
	Female	8.84	1.05		8.52	0.59	
DP 5 base ap	Male	6.36	0.68	0.0000	6.03	0.76	0.0000
	Female	5.74	0.99		5.27	0.50	
DP5 head ml	Male	6.79	0.78	0.0000	6.24	0.92	0.0005
	Female	5.80	0.92		5.63	0.69	
DP5 head ap	Male	3.87	0.46	0.0000	3.66	0.40	0.0000
	Female	3.35	0.44		3.29	0.30	
DP5 midshaft ml	Male	4.37	0.55	0.0000	4.31	0.58	0.0000
	Female	3.74	0.50		3.79	0.41	
DP5 midshaft ap	Male	3.43	0.34	0.0000	3.48	0.36	0.0000
	Female	2.90	0.34		3.08	0.31	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.5a. Descriptive statistics comparing mean values (mm) of metacarpals (MC) 1 to 3 between whites and blacks in South African males and females

	MALE				FEMALE		
Variable	Group	Mean	S.D.	P	Mean	S.D.	P
MC1 length	White	46.21	2.59	0.2405	42.64	2.65	0.0769
	Black	45.53	3.09		42.48	2.75	
MC1 base ml	White	16.38	1.33	0.4492	15.04	1.55	0.0112
	Black	16.17	1.46		14.37	0.94	
MC1 base ap	White	16.61	1.73	0.3023	15.62	1.91	0.0004
	Black	16.27	1.56		14.26	1.15	
MC1 head ml	White	15.91	1.59	0.5763	14.30	1.16	0.9605
	Black	16.08	1.40		14.29	1.10	
MC1 head ap	White	15.36	1.39	0.0000	13.67	1.42	0.0001
	Black	14.04	1.36		12.66	1.04	
MC1 midshaft ml	White	13.13	1.06	0.0000	11.04	0.96	0.0071
	Black	12.85	1.12		11.59	1.01	
MC1 midshaft ap	White	9.19	0.78	0.0000	8.01	0.89	0.0283
	Black	9.42	0.86		8.39	0.81	
MC2 length	White	68.60	3.63	0.3403	64.30	3.25	0.8166
	Black	67.80	4.62		64.11	4.42	
MC2 base ml	White	18.70	1.45	0.0000	16.30	1.16	0.0006
	Black	17.03	1.59		15.37	1.40	
MC2 base ap	White	17.94	1.60	0.0044	15.79	1.31	0.1036
	Black	17.05	1.44		15.38	1.19	
MC2 head ml	White	15.55	1.50	0.0000	13.87	1.11	0.0073
	Black	14.49	1.07		13.29	0.97	
MC2 head ap	White	15.36	1.06	0.0002	14.01	0.99	0.0002
	Black	14.60	0.89		13.27	0.91	
MC2 midshaft ml	White	9.52	0.83	0.0011	8.30	0.76	0.9061
	Black	9.00	0.71		8.28	0.73	
MC2 midshaft ap	White	9.76	0.81	0.5117	8.32	0.79	0.0045
	Black	9.90	1.32		8.78	0.82	
MC3 length	White	65.85	3.90	0.3193	61.90	3.61	0.2452
	Black	66.68	4.38		62.80	4.04	
MC3 base ml	White	14.87	0.84	0.0000	13.46	1.16	0.0018
	Black	14.05	1.14		12.81	0.84	
MC3 base ap	White	18.14	1.27	0.0008	16.04	1.48	0.0211
	Black	17.29	1.17		15.46	0.90	
MC3 head ml	White	14.57	1.28	0.3154	13.12	1.22	0.4833
	Black	14.33	1.09		12.95	0.89	
MC3 head ap	White	15.44	0.99	0.0006	13.75	1.04	0.0144
	Black	14.72	1.03		13.27	0.85	
MC3 midshaft ml	White	9.42	0.75	0.0739	8.37	0.64	0.3707
	Black	9.15	0.70		8.50	0.75	
MC3 midshaft ap	White	10.10	0.89	0.7833	8.63	0.78	0.0103
	Black	10.04	1.09		9.06	0.85	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.5b. Descriptive statistics comparing mean values (mm) of metacarpals (MC) 4 and 5 between whites and blacks in South African males and females

	MALE				FEMALE		
Variable	Group	Mean	S.D.	P	Mean	S.D.	P
MC4 length	White	59.06	2.85	0.6314	54.60	3.17	0.1039
	Black	58.71	4.25		55.73	3.67	
MC4 base ml	White	12.53	1.04	0.0000	11.09	0.93	0.0000
	Black	11.46	1.05		10.30	0.69	
MC4 base ap	White	13.29	0.96	0.0488	11.42	0.96	0.0952
	Black	12.88	1.12		11.74	0.93	
MC4 head ml	White	12.73	0.96	0.0094	11.41	1.48	0.9675
	Black	12.24	0.89		11.42	0.87	
MC4 head ap	White	13.89	0.90	0.0031	12.28	0.89	0.9228
	Black	13.27	1.14		12.30	0.86	
MC4 midshaft ml	White	7.88	0.86	0.4474	6.63	0.59	0.0077
	Black	7.75	0.83		6.98	0.68	
MC4 midshaft ap	White	8.28	0.92	0.0843	6.67	0.70	0.0000
	Black	8.59	0.88		7.78	0.79	
MC5 length	White	54.35	2.85	0.9391	51.10	2.88	0.6095
	Black	54.30	3.58		50.75	3.71	
MC5 base ml	White	14.55	1.29	0.0000	12.98	1.26	0.0000
	Black	13.45	1.29		11.83	0.92	
MC5 base ap	White	12.42	1.20	0.0013	10.90	1.01	0.0010
	Black	11.66	1.08		10.27	0.81	
MC5 head ml	White	12.47	1.00	0.0095	11.01	0.89	0.0906
	Black	11.94	0.98		10.70	0.87	
MC5 head ap	White	12.82	0.92	0.0006	11.44	0.81	0.0939
	Black	12.22	0.78		11.16	0.84	
MC5 midshaft ml	White	8.58	0.88	0.9855	7.21	0.71	0.0006
	Black	8.58	0.85		7.76	0.81	
MC5 midshaft ap	White	7.83	1.02	0.8965	6.42	0.73	0.0334
	Black	7.80	1.08		6.74	0.74	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.6a. Descriptive statistics comparing mean values (mm) of proximal phalanges (PP) 1 to 3 between whites and blacks in South African males and females

	MALE				FEMALE		
Variable	Group	Mean	S.D.	P	Mean	S.D.	P
PP1 length	White	31.24	1.84	0.3065	28.32	1.84	0.3913
	Black	30.82	2.21		28.70	2.54	
PP1 base ml	White	17.33	1.20	0.0255	15.34	0.96	0.0101
	Black	16.81	1.10		14.83	0.97	
PP1 base ap	White	12.57	1.03	0.2367	10.76	0.77	0.8749
	Black	12.33	0.97		10.74	0.77	
PP1 head ml	White	13.43	0.98	0.0000	11.91	0.71	0.0001
	Black	12.66	0.70		11.34	0.71	
PP1 head ap	White	9.98	1.15	0.0005	8.78	1.02	0.0057
	Black	9.21	0.99		8.00	0.79	
PP1 midshaft ml	White	10.19	0.86	0.0000	8.44	0.74	0.0672
	Black	9.46	0.77		8.17	0.69	
PP1 midshaft ap	White	6.86	0.61	0.0774	5.50	0.53	0.0667
	Black	6.65	0.56		5.70	0.54	
PP2 length	White	40.97	2.42	0.2126	38.37	2.28	0.6807
	Black	40.29	2.91		38.16	2.86	
PP2 base ml	White	17.26	1.47	0.0091	15.51	1.11	0.0104
	Black	16.61	0.90		14.93	1.10	
PP2 base ap	White	12.67	0.80	0.0037	11.32	0.72	0.0137
	Black	12.18	0.82		10.96	0.69	
PP2 head ml	White	12.33	0.86	0.0000	11.07	0.79	0.0000
	Black	11.23	0.69		10.30	0.65	
PP2 head ap	White	8.99	0.79	0.0000	7.86	0.65	0.0000
	Black	8.09	0.62		7.33	0.55	
PP2 midshaft ml	White	10.69	1.00	0.0000	8.89	0.68	0.0606
	Black	9.84	0.81		8.62	0.71	
PP2 midshaft ap	White	7.19	0.64	0.0009	6.06	0.62	0.0716
	Black	6.74	0.67		5.86	0.46	
PP3 length	White	45.63	2.33	0.8737	42.34	2.16	0.0329
	Black	45.72	2.90		43.49	3.07	
PP3 base ml	White	17.27	1.02	0.0004	15.50	0.93	0.0005
	Black	16.56	0.90		14.82	0.93	
PP3 base ap	White	13.37	0.73	0.4651	11.80	0.67	0.3701
	Black	13.24	1.04		11.92	0.63	
PP3 head ml	White	12.84	0.72	0.0000	11.53	0.82	0.0025
	Black	11.98	0.72		11.03	0.76	
PP3 head ap	White	9.15	0.65	0.0000	8.18	0.91	0.0028
	Black	8.55	0.65		7.69	0.62	
PP3 midshaft ml	White	11.00	0.95	0.0010	9.24	0.72	0.1767
	Black	10.34	0.98		9.04	0.77	
PP3 midshaft ap	White	7.87	0.84	0.0007	6.68	0.66	0.3309
	Black	7.36	0.61		6.56	0.58	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.6b. Descriptive statistics comparing mean values (mm) of proximal phalanges (PP) 4 and 5 between whites and blacks in males and females

	MALE				FEMALE		
Variable	Group	Mean	S.D.	P	Mean	S.D.	P
PP4 length	White	42.59	2.30	0.3776	39.55	2.27	0.0220
	Black	43.05	2.81		40.83	3.15	
PP4 base ml	White	15.67	0.99	0.0003	14.09	0.96	0.0002
	Black	14.92	1.03		13.40	0.81	
PP4 base ap	White	12.40	0.74	0.2372	11.00	0.71	0.9246
	Black	12.21	0.80		11.02	0.61	
PP4 head ml	White	11.93	0.70	0.0000	10.74	0.84	0.3234
	Black	11.27	0.65		10.50	1.48	
PP4 head ap	White	8.66	0.66	0.0000	7.61	0.76	0.0555
	Black	7.94	0.67		7.34	0.62	
PP4 midshaft ml	White	10.32	0.92	0.0001	8.57	0.80	0.3325
	Black	9.60	0.88		8.42	0.75	
PP4 midshaft ap	White	7.15	0.78	0.0522	6.10	0.82	0.9869
	Black	6.88	0.63		6.10	0.53	
PP5 length	White	33.53	2.64	0.9216	30.54	1.43	0.1559
	Black	33.58	2.59		31.22	2.92	
PP5 base ml	White	14.96	1.21	0.0073	13.48	0.75	0.0000
	Black	14.38	0.85		12.80	0.78	
PP 5 base ap	White	10.99	0.83	0.2430	9.64	0.60	0.2995
	Black	10.76	1.07		9.51	0.66	
PP5 head ml	White	10.10	0.77	0.0006	8.82	0.65	0.1056
	Black	9.58	0.68		8.62	0.58	
PP5 head ap	White	7.42	0.92	0.0008	6.30	0.61	0.0084
	Black	6.88	0.57		6.00	0.51	
PP5 midshaft ml	White	8.88	0.85	0.0141	7.25	0.74	0.9450
	Black	8.47	0.80		7.24	0.68	
PP5 midshaft ap	White	5.88	0.68	0.0999	4.77	0.48	0.0554
	Black	5.69	0.48		4.96	0.51	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.7a. Descriptive statistics comparing mean values (mm) of middle phalanges (MP) 2 to 4 between whites and blacks in South African males and females

	MALE				FEMALE		
Variable	Group	Mean	S.D.	P	Mean	S.D.	P
MP2 length	White	24.63	1.84	0.0562	22.68	1.51	0.6737
	Black	23.86	2.08		22.52	2.15	
MP2 base ml	White	14.07	0.99	0.0009	12.64	0.83	0.0060
	Black	13.41	0.92		11.91	0.69	
MP2 base ap	White	9.85	0.63	0.0069	8.72	0.58	0.1331
	Black	9.50	0.62		8.56	0.50	
MP2 head ml	White	10.42	0.89	0.0000	9.53	0.81	0.0000
	Black	9.65	0.70		8.83	0.54	
MP2 head ap	White	6.62	0.83	0.0004	6.09	0.83	0.0000
	Black	6.02	0.81		5.33	0.55	
MP2 midshaft ml	White	8.60	0.81	0.0012	7.21	0.65	0.1559
	Black	8.06	0.80		7.03	0.63	
MP2 midshaft ap	White	5.14	0.53	0.1283	4.34	0.42	0.2027
	Black	4.99	0.44		4.44	0.36	
MP3 length	White	29.36	1.69	0.6263	27.40	1.93	0.6625
	Black	29.17	2.09		27.57	2.06	
MP3 base ml	White	14.71	1.00	0.0562	13.43	0.93	0.1114
	Black	14.33	0.97		13.09	1.14	
MP3 base ap	White	10.54	0.70	0.1237	9.50	0.73	0.8897
	Black	10.31	0.74		9.48	0.58	
MP3 head ml	White	10.89	0.85	0.0234	10.05	0.84	0.0020
	Black	10.55	0.64		9.59	0.58	
MP3 head ap	White	6.86	0.75	0.0079	6.35	0.83	0.0018
	Black	6.48	0.66		5.88	0.59	
MP3 midshaft ml	White	9.23	0.85	0.0176	7.79	0.59	0.4586
	Black	8.83	0.81		7.69	0.71	
MP3 midshaft ap	White	5.62	0.59	0.6710	4.65	0.50	0.0028
	Black	5.58	0.43		4.93	0.41	
MP4 length	White	28.17	1.85	0.1883	26.11	2.67	0.2780
	Black	27.62	2.27		26.66	2.16	
MP4 base ml	White	13.85	0.93	0.0333	12.56	0.88	0.0684
	Black	13.42	1.06		12.25	0.78	
MP4 base ap	White	9.99	0.60	0.1507	8.86	0.67	0.3336
	Black	9.81	0.63		8.98	0.57	
MP4 head ml	White	10.49	0.95	0.0116	9.53	0.69	0.1152
	Black	10.03	0.83		9.32	0.60	
MP4 head ap	White	6.48	0.64	0.0011	5.68	0.76	0.2142
	Black	6.01	0.72		5.48	0.79	
MP4 midshaft ml	White	8.84	0.81	0.0002	7.34	0.59	0.8714
	Black	8.21	0.85		7.32	0.72	
MP4 midshaft ap	White	5.32	0.92	0.3662	4.22	0.44	0.0000
	Black	5.18	0.47		4.61	0.44	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.7b. Descriptive statistics comparing mean values (mm) of the fifth middle phalanx (MP) between whites and blacks in South African males and females

	MALE				FEMALE		
Variable	Group	Mean	S.D.	P	Mean	S.D.	P
MP5 length	White	20.19	1.73	0.4401	18.68	2.54	0.9472
	Black	20.49	1.97		18.71	1.80	
MP5 base ml	White	12.06	1.12	0.0178	10.88	1.07	0.0009
	Black	11.55	0.95		10.23	0.77	
MP5 base ap	White	8.61	0.61	0.1917	7.62	0.75	0.3928
	Black	8.45	0.62		7.50	0.58	
MP5 head ml	White	9.38	0.63	0.0000	8.48	0.83	0.0008
	Black	8.83	0.61		7.97	0.61	
MP5 head ap	White	5.63	0.60	0.0000	4.97	0.67	0.0002
	Black	5.14	0.49		4.52	0.44	
MP5 midshaft ml	White	7.64	0.66	0.0006	6.35	0.69	0.3516
	Black	7.17	0.64		6.22	0.57	
MP5 midshaft ap	White	4.45	0.43	0.3855	3.65	0.49	0.0023
	Black	4.52	0.39		3.93	0.37	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.8a. Descriptive statistics comparing mean values (mm) of distal phalanges (DP) 1 to 3 between whites and blacks in South African males and females

	MALE				FEMALE		
Variable	Group	Mean	S.D.	P	Mean	S.D.	P
DP1 length	White	23.41	1.68	0.3101	21.07	1.24	0.5634
	Black	23.11	1.24		20.88	1.87	
DP1 base ml	White	15.78	1.58	0.0288	13.99	1.11	0.0012
	Black	15.19	1.02		13.25	1.09	
DP1 base ap	White	9.67	0.86	0.0187	8.32	0.66	0.0466
	Black	9.27	0.82		8.05	0.70	
DP1 head ml	White	11.17	1.35	0.0087	9.50	1.24	0.0168
	Black	10.51	1.09		9.01	0.67	
DP1 head ap	White	4.27	0.42	0.0863	3.57	0.50	0.2063
	Black	4.11	0.48		3.68	0.39	
DP1 midshaft ml	White	8.78	0.91	0.0013	7.66	0.92	0.0206
	Black	8.21	0.81		7.28	0.64	
DP1 midshaft ap	White	4.71	0.55	0.0468	3.98	0.73	0.6017
	Black	4.87	0.56		4.05	0.48	
DP2 length	White	18.31	1.12	0.0016	16.26	1.11	0.9080
	Black	17.51	1.32		16.29	1.36	
DP2 base ml	White	10.99	1.02	0.0600	9.98	1.11	0.0078
	Black	10.89	0.98		9.47	0.63	
DP2 base ap	White	7.03	1.29	0.0181	6.30	1.00	0.0002
	Black	6.50	0.81		5.70	0.37	
DP2 head ml	White	8.22	0.93	0.0227	7.22	0.93	0.0529
	Black	7.75	1.08		6.88	0.76	
DP2 head ap	White	3.90	0.49	0.1324	3.38	0.40	0.1621
	Black	3.73	0.60		3.27	0.35	
DP2 midshaft ml	White	5.56	0.69	0.0972	4.77	0.55	0.8159
	Black	5.32	0.70		4.79	0.53	
DP2 midshaft ap	White	3.87	0.42	0.9375	3.32	0.38	0.4099
	Black	3.87	0.40		3.39	0.36	
DP3 length	White	19.26	1.15	0.0202	17.31	1.29	0.1482
	Black	18.68	1.23		17.70	1.36	
DP3 base ml	White	11.80	0.98	0.1046	10.33	0.91	0.9552
	Black	11.48	0.92		10.34	0.77	
DP3 base ap	White	7.34	0.94	0.0364	6.37	0.74	0.6893
	Black	6.96	0.81		6.43	0.72	
DP3 head ml	White	8.98	0.94	0.0703	7.75	1.10	0.7293
	Black	8.60	1.09		7.67	0.96	
DP3 head ap	White	4.45	0.48	0.1165	3.80	0.47	0.1457
	Black	4.29	0.51		3.94	0.47	
DP3 midshaft ml	White	5.85	0.66	0.3126	5.00	0.64	0.0772
	Black	5.70	0.81		5.22	0.61	
DP3 midshaft ap	White	4.06	0.42	0.8437	3.41	0.42	0.0012
	Black	4.04	0.42		3.70	0.42	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.8b. Descriptive statistics comparing mean values (mm) of distal phalanges (DP) 4 and 5 between whites and blacks in South African males and females

	MALE				FEMALE		
Variable	Group	Mean	S.D.	P	Mean	S.D.	P
DP4 length	White	19.29	1.20	0.0070	17.30	1.44	0.2445
	Black	18.59	1.26		17.65	1.39	
DP4 base ml	White	11.64	0.88	0.0489	10.46	1.16	0.0334
	Black	11.25	1.04		10.04	0.67	
DP4 base ap	White	7.07	0.76	0.0571	6.40	0.85	0.1881
	Black	6.73	0.92		6.20	0.63	
DP4 head ml	White	8.84	0.84	0.0111	7.75	0.94	0.0684
	Black	8.31	1.12		7.40	0.85	
DP4 head ap	White	4.43	0.44	0.0182	3.88	0.44	0.8642
	Black	4.18	0.55		3.90	0.43	
DP4 midshaft ml	White	5.75	0.60	0.0572	4.91	0.55	0.8867
	Black	5.49	0.73		4.93	0.55	
DP4 midshaft ap	White	4.05	0.77	0.3987	3.45	0.49	0.1586
	Black	3.94	0.37		3.57	0.32	
DP5 length	White	17.74	0.99	0.0000	15.44	1.28	0.4164
	Black	16.70	1.27		15.21	1.28	
DP5 base ml	White	10.01	0.77	0.0920	8.84	1.05	0.0886
	Black	9.74	0.74		8.52	0.59	
DP 5 base ap	White	6.36	0.68	0.0301	5.74	0.99	0.0054
	Black	6.03	0.76		5.27	0.50	
DP5 head ml	White	6.79	0.78	0.0024	5.80	0.92	0.3272
	Black	6.24	0.92		5.63	0.69	
DP5 head ap	White	3.87	0.46	0.0203	3.35	0.44	0.3971
	Black	3.66	0.40		3.29	0.30	
DP5 midshaft ml	White	4.37	0.55	0.5727	3.74	0.50	0.5555
	Black	4.31	0.58		3.79	0.41	
DP5 midshaft ap	White	3.43	0.34	0.4361	2.90	0.34	0.0092
	Black	3.48	0.36		3.08	0.31	

Total sample=200, S.D. = standard deviation, ap = anteroposterior, ml = mediolateral
P = level of significance

Table 8.9: Descriptive statistics comparing mean values (mm) of long bone lengths between males and females in South African whites

Variable	Sex	Mean	SD	t	Sig. (2-tailed) P
Humeral length maximum	Male	338.73	17.55	7.15	0.00
	Female	314.76	14.95		
Radial length	Male	254.09	13.13	9.41	0.00
	Female	229.16	12.53		
Ulna length	Male	272.42	13.17	9.95	0.00
	Female	245.90	12.68		
Femur length maximum	Male	471.93	36.45	4.98	0.00
	Female	441.51	21.39		
Tibial length	Male	390.06	21.01	6.77	0.00
	Female	361.00	20.58		

Total sample=200, S.D.=standard deviation, P = level of significance

Table 8.10: Descriptive statistics comparing mean values (mm) of long bone lengths between males and females in South African blacks

Variable	Sex	Mean	SD	t	Sig. (2-tailed) P
Humeral length maximum	Male	327.53	30.15	5.68	0.00
	Female	300.34	15.29		
Radial length	Male	259.44	12.64	10.12	0.00
	Female	232.44	13.85		
Ulna length	Male	278.57	11.14	10.59	0.00
	Female	250.90	14.58		
Femur length maximum	Male	460.00	20.66	6.24	0.00
	Female	433.05	22.29		
Tibial length	Male	393.84	19.63	6.97	0.00
	Female	362.22	25.11		

Sample size=200, S.D.=standard deviation, P = level of significance

Table 8.11: Descriptive statistics comparing mean values (mm) of long bone lengths between males and females for the South African population

Variable	Sex	Mean	SD	t	Sig. (2-tailed) P
Humeral length maximum	Male	332.89	25.43	8.25	0.00
	Female	307.47	16.70		
Radial length	Male	256.88	13.09	13.74	0.00
	Female	230.82	13.25		
Ulna length	Male	275.63	12.48	14.32	0.00
	Female	248.42	13.83		
Femur length maximum	Male	465.71	29.75	7.57	0.00
	Female	437.24	22.15		
Tibial length	Male	392.03	20.28	9.76	0.00
	Female	361.62	22.87		

Sample size=200, S.D.=standard deviation, P = level of significance

Table 8.12: Pearson's correlation coefficients between the bones of the hand (metacarpals and phalanges) and the long bones (humerus, radius, ulna, femur, tibia) in South African males

		Humerus	Radius	Ulna	Femur	Tibia
Metacarpal 1 (n=94)	Pearson Correlation	.592(**)	.459(**)	.510(**)	.511(**)	.480(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Metacarpal 2 (n=94)	Pearson Correlation	.678(**)	.785(**)	.772(**)	.684(**)	.742(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Metacarpal 3 (n=94)	Pearson Correlation	.512(**)	.744(**)	.719(**)	.439(**)	.745(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Metacarpal 4 (n=94)	Pearson Correlation	.561(**)	.619(**)	.600(**)	.525(**)	.663(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Metacarpal 5 (n=93)	Pearson Correlation	.549(**)	.628(**)	.623(**)	.401(**)	.619(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Proximal Phalanx 1 (n=94)	Pearson Correlation	.535(**)	.457(**)	.491(**)	.482(**)	.511(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Proximal Phalanx 2 (n=92)	Pearson Correlation	.581(**)	.530(**)	.572(**)	.594(**)	.631(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Proximal Phalanx 3 (n=94)	Pearson Correlation	.546(**)	.594(**)	.619(**)	.531(**)	.682(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Proximal Phalanx 4 (n=94)	Pearson Correlation	.535(**)	.607(**)	.615(**)	.441(**)	.715(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Proximal Phalanx 5 (n=90)	Pearson Correlation	.514(**)	.498(**)	.498(**)	.412(**)	.593(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Middle Phalanx 2 (n=92)	Pearson Correlation	.535(**)	.450(**)	.449(**)	.555(**)	.482(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Middle Phalanx 3 (n=94)	Pearson Correlation	.364(**)	.390(**)	.306(**)	.281(**)	.409(**)
	Sig. (2-tailed)	.000	.000	.003	.006	.000
Middle Phalanx 4 (n=93)	Pearson Correlation	.504(**)	.455(**)	.424(**)	.429(**)	.496(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Middle Phalanx 5 (n=90)	Pearson Correlation	.329(**)	.444(**)	.442(**)	.279(**)	.472(**)
	Sig. (2-tailed)	.002	.000	.000	.008	.000
Distal Phalanx 1 (n=94)	Pearson Correlation	.445(**)	.418(**)	.442(**)	.372(**)	.467(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Distal Phalanx 2 (n=91)	Pearson Correlation	.462(**)	.244(*)	.282(**)	.372(**)	.228(*)
	Sig. (2-tailed)	.000	.020	.007	.000	.029
Distal Phalanx 3 (n=90)	Pearson Correlation	.291(**)	.110	.110	.211(*)	.145
	Sig. (2-tailed)	.005	.303	.304	.046	.173
Distal Phalanx 4 (n=89)	Pearson Correlation	.521(**)	.360(**)	.360(**)	.430(**)	.334(**)
	Sig. (2-tailed)	.000	.001	.001	.000	.001
Distal Phalanx 5 (n=88)	Pearson Correlation	.567(**)	.235(*)	.258(*)	.505(**)	.299(**)
	Sig. (2-tailed)	.000	.028	.015	.000	.005

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 8.13: Pearson's correlation coefficients between the bones of the hand (metacarpals and phalanges) and the long bones (humerus, radius, ulna, femur, tibia) in South African females.

		Humerus	Radius	Ulna	Femur	Tibia
Metacarpal 1 (n=98)	Pearson Correlation	0.612(**)	.827(**)	.790(**)	.594(**)	.631(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Metacarpal 2 (n=98)	Pearson Correlation	.713(**)	.902(**)	.858(**)	.724(**)	.771(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Metacarpal 3 (n=98)	Pearson Correlation	.573(**)	.844(**)	.773(**)	.650(**)	.714(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Metacarpal 4 (n=98)	Pearson Correlation	.448(**)	.812(**)	.698(**)	.456(**)	.584(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Metacarpal 5 (n=97)	Pearson Correlation	.581(**)	.806(**)	.660(**)	.574(**)	.485(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Proximal Phalanx 1 (n=97)	Pearson Correlation	.420(**)	.706(**)	.646(**)	.466(**)	.500(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Proximal Phalanx 2 (n=98)	Pearson Correlation	.482(**)	.648(**)	.562(**)	.459(**)	.513(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Proximal Phalanx 3 (n=97)	Pearson Correlation	.338(**)	.680(**)	.634(**)	.412(**)	.522(**)
	Sig. (2-tailed)	.001	.000	.000	.000	.000
Proximal Phalanx 4 (n=97)	Pearson Correlation	.362(**)	.717(**)	.678(**)	.404(**)	.592(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Proximal Phalanx 5 (n=95)	Pearson Correlation	.381(**)	.597(**)	.561(**)	.403(**)	.441(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Middle Phalanx 2 (n=95)	Pearson Correlation	.372(**)	.494(**)	.459(**)	.447(**)	.407(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Middle Phalanx 3 (n=97)	Pearson Correlation	.433(**)	.654(**)	.599(**)	.497(**)	.557(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Middle Phalanx 4 (n=95)	Pearson Correlation	.378(**)	.619(**)	.567(**)	.414(**)	.510(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
Middle Phalanx 5 (n=94)	Pearson Correlation	.330(**)	.444(**)	.400(**)	.313(**)	.361(**)
	Sig. (2-tailed)	.001	.000	.000	.002	.000
Distal Phalanx 1 (n=98)	Pearson Correlation	.354(**)	.474(**)	.420(**)	.419(**)	.337(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.001
Distal Phalanx 2 (n=95)	Pearson Correlation	.328(**)	.470(**)	.410(**)	.349(**)	.314(**)
	Sig. (2-tailed)	.001	.000	.000	.001	.002
Distal Phalanx 3 (n=95)	Pearson Correlation	.257(*)	.507(**)	.381(**)	.286(**)	.322(**)
	Sig. (2-tailed)	.012	.000	.000	.005	.001
Distal Phalanx 4 (n=92)	Pearson Correlation	.244(*)	.486(**)	.395(**)	.259(*)	.281(**)
	Sig. (2-tailed)	.019	.000	.000	.013	.007
Distal Phalanx 5 (n=86)	Pearson Correlation	.398(**)	.432(**)	.345(**)	.402(**)	.354(**)
	Sig. (2-tailed)	.000	.000	.001	.000	.001

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 8.14: Direct and stepwise regression showing the sequence of variable entry of metacarpals (MC) 1 to 5 into the analysis and standard error of the estimates (SEE) (mm), *R* and R^2 to estimate the length (mm) of a long bone in South African males

		Humerus	Radius	Ulna	Femur	Tibia
All MC	R	0.722	0.820	0.811	0.749	0.782
Direct	R^2	0.521	0.673	0.658	0.560	0.612
	SEE	9.20442	5.16864	5.57831	10.55606	7.11019
MC 1	R	0.592	0.459	0.510	0.511	0.480
	R^2	0.351	0.211	0.260	0.261	0.230
	SEE	10.61863	7.81528	7.97720	13.31537	9.75856
MC 2	R	0.678	0.785	0.772	0.684	0.742
	R^2	0.460	0.616	0.596	0.467	0.550
	SEE	9.68835	5.44944	5.89334	11.30427	7.45728
MC 3	R	0.512	0.744	0.719	0.439	0.745
	R^2	0.262	0.553	0.518	0.192	0.556
	SEE	11.32250	5.88279	6.44281	13.91958	7.41296
MC 4	R	0.561	0.619	0.600	0.525	0.663
	R^2	0.315	0.383	0.360	0.275	0.440
	SEE	10.90682	6.90868	7.42137	13.18625	8.32086
MC 5	R	0.549	0.628	0.623	0.401	0.619
	R2	0.302	0.394	0.388	0.160	0.383
	SEE	10.86055	6.87769	7.29371	14.26282	8.76542
Stepwise	R	0.679	0.785	0.774	0.683	0.745
Model 1	R^2	0.461	0.616	0.599	0.467	0.554
	SEE	9.54258	5.47883	5.90967	11.36334	7.45098
Predictors		MC2	MC2	MC2	MC2	MC3
Stepwise	R	0.711	0.807	0.791	0.709	0.782
Model 2	R^2	0.505	0.651	0.625	0.503	0.611
	SEE	9.1975	5.25089	5.73948	11.03407	6.99847
Predictors		MC2	MC2	MC2	MC2	MC3
		MC1	MC1	MC3	MC3	MC2
Stepwise	R		0.818	0.803	0.735	
Model 3	R^2		0.669	0.644	0.540	
	SEE		5.14431	5.62622	10.67212	
Predictors			MC2	MC2	MC2	
			MC1	MC3	MC3	
			MC4	MC4	MC1	

Table 8.15: Direct and stepwise regression coefficients (slope and constant) and standard error of the estimates (SEE) (mm) of metacarpals (MC) 1 to 5 to estimate the length (mm) of a long bone in South African males

	Humerus	Radius	Ulna	Femur	Tibia
Direct					
MC 1	1.304	-0.056	0.364	1.407	0.080
MC 2	1.854	1.289	1.320	3.173	1.048
MC 3	-0.651	0.874	0.793	-1.322	1.108
MC 4	-0.061	-0.747	-0.901	0.748	-0.150
MC 5	0.503	0.312	0.398	-1.172	0.121
Constant	163.470	138.832	145.394	292.368	244.747
SEE	9.20442	5.16864	5.57831	10.55606	7.11019
Metacarpal 1					
Slope	2.717	1.407	1.648	2.755	1.857
Constant	205.515	190.611	197.857	339.951	306.009
SEE	10.61863	7.81528	7.97720	13.31537	9.75856
Metacarpal 2					
Slope	2.100	1.624	1.684	2.489	1.939
Constant	186.949	144.347	158.571	296.522	258.864
SEE	9.68835	5.44944	5.89334	11.30427	7.45728
Metacarpal 3					
Slope	1.580	1.533	1.563	1.591	1.942
Constant	225.486	153.476	169.769	360.865	262.361
SEE	11.32250	5.88279	6.44281	13.91958	7.41296
Metacarpal 4					
Slope	1.981	1.459	1.491	2.176	1.976
Constant	213.542	169.199	185.683	338.180	274.777
SEE	10.90682	6.90868	7.42137	13.18625	8.32086
Metacarpal 5					
Slope	2.155	1.674	1.753	1.881	2.085
Constant	213.493	164.265	178.233	364.301	278.030
SEE	10.86055	6.87769	7.29371	14.26282	8.76542
Stepwise Model 1					
MC 1					
MC 2	2.068	1.625	1.691	2.493	
MC 3					1.939
MC 4					
MC 5					
Constant	189.320	144.260	158.045	296.213	262.555
SEE	9.54258	5.47883	5.90967	11.36334	7.45098
Stepwise Model 2					
MC 1	1.233				
MC 2	1.601	1.098	1.204	3.432	1.051
MC 3		0.652	0.602	-1.161	1.097
MC 4					
MC 5					
Constant	164.506	136.961	151.304	309.207	246.707
SEE	9.1975	5.25089	5.73948	11.03407	6.99847
Stepwise Model 3					
MC 1				1.386	
MC 2		1.322	1.447	3.086	
MC 3		0.908	0.879	-1.384	
MC 4		-0.609	-0.658		
MC 5					
Constant		140.545	155.180	283.808	
SEE		5.14431	5.62622	10.67212	

Table 8.16: Direct and stepwise regression showing the sequence of variable entry of proximal phalanges (PP) 1 to 5 into the analysis and standard error of the estimate (SEE) (mm), *R* and R^2 to estimate the length (mm) of a long bone in South African males

		Humerus	Radius	Ulna	Femur	Tibia
All PP Direct	R	0.664	0.631	0.659	0.622	0.740
	R^2	0.440	0.398	0.435	0.387	0.548
	SEE	10.22718	7.07855	7.30164	12.75499	7.70705
PP 1	R	0.535	0.457	0.491	0.482	0.511
	R^2	0.287	0.209	0.241	0.232	0.261
	SEE	11.13048	7.82358	8.08167	13.57384	9.55929
PP 2	R	0.581	0.530	0.572	0.594	0.631
	R^2	0.337	0.281	0.327	0.352	0.398
	SEE	10.84185	7.48127	7.65327	12.56490	8.68560
PP 3	R	0.546	0.594	0.619	0.531	0.682
	R^2	0.299	0.353	0.383	0.282	0.465
	SEE	11.03811	7.07720	7.28345	13.12682	8.13681
PP 4	R	0.535	0.607	0.615	0.441	0.715
	R^2	0.287	0.368	0.378	0.194	0.511
	SEE	11.13017	6.99215	7.31734	13.90157	7.77650
PP 5	R	0.514	0.498	0.498	0.412	0.593
	R^2	0.264	0.248	0.248	0.169	0.352
	SEE	11.33092	7.69598	8.17271	14.38101	8.94246
Stepwise Model 1	R	0.642	0.614	0.648	0.618	0.719
	R^2	0.413	0.377	0.420	0.382	0.517
	SEE	10.23072	7.02791	7.22319	12.50968	7.77657
Predictors		PP2	PP4	PP3	PP2	PP 4
Stepwise Model 2	R					0.735
	R^2					0.540
	SEE					7.62945
Predictors						PP4 PP2

Table 8.17: Direct and stepwise regression coefficients (slope and constant) and standard error of the estimate (SEE) (mm) of the proximal phalanges (PP) 1 to 5 to estimate the length (mm) of a long bone in South African males

	Humerus	Radius	Ulnar	Femur	Tibia
Direct					
PP 1	0.779	-0.096	0.110	0.855	-0.362
PP 2	3.316	0.242	0.253	3.419	0.643
PP 3	-1.483	0.847	1.269	-0.103	0.993
PP 4	0.408	1.033	0.780	-0.227	1.551
PP 5	0.588	0.214	0.129	-0.045	0.416
Constant	202.401	158.006	163.918	317.433	250.282
SEE	10.22718	7.07855	7.30164	12.75499	7.70705
Proximal Phalanx 1					
Slope	3.411	1.946	2.201	3.606	2.747
Constant	224.443	194.827	205.227	354.524	306.006
SEE	11.13048	7.82358	8.08167	13.57384	9.55929
Proximal Phalanx 2					
Slope	2.828	1.712	1.951	3.392	2.583
Constant	215.441	185.669	194.332	328.775	286.352
SEE	10.84185	7.48127	7.65327	12.56490	8.68560
Proximal Phalanx 3					
Slope	2.730	1.982	2.178	3.117	2.874
Constant	205.474	164.567	173.925	323.896	259.800
SEE	11.03811	7.07720	7.28345	13.12682	8.13681
Proximal Phalanx 4					
Slope	2.715	2.055	2.194	2.628	3.059
Constant	213.861	167.069	179.444	353.754	260.042
SEE	11.13017	6.99215	7.31734	13.90157	7.77650
Proximal Phalanx 5					
Slope	2.557	1.667	1.771	2.448	2.486
Constant	244.725	199.021	213.882	384.493	307.464
SEE	11.33092	7.69598	8.17271	14.38101	8.94246
Stepwise Model 1					
PP 1				3.620	
PP 2	3.156				
PP 3			2.324		
PP 4		2.146			3.156
PP 5					
Constant	202.480	163.076	167.077	319.822	255.767
SEE	10.23072	7.02791	7.22319	12.50968	7.77657
Stepwise Model 2					
PP 1					
PP 2					1.046
PP 3					
PP 4					2.267
PP 5					
Constant					251.364
SEE					7.62945

Table 8.18: Direct and stepwise regression showing the sequence of variable entry of middle phalanges (MP) 2 to 5 into the analysis and standard error of the estimate (SEE) (mm), *R* and R^2 to estimate the length (mm) of a long bone in South African males

		Humerus	Radius	Ulna	Femur	Tibia
All MP	R	0.635	0.567	0.558	0.623	0.601
Direct	R^2	0.403	0.322	0.312	0.388	0.362
	SEE	10.39432	7.48465	7.88246	12.40385	9.26484
MP 2	R	0.535	0.450	0.449	0.555	0.482
	R^2	0.286	0.203	0.202	0.308	0.232
	SEE	11.16954	7.91818	8.35206	12.79881	9.82609
MP 3	R	0.364	0.390	0.306	0.281	0.409
	R^2	0.133	0.152	0.094	0.079	0.167
	SEE	12.27303	8.10256	8.83124	14.86691	10.14807
MP 4	R	0.504	0.455	0.424	0.429	0.496
	R^2	0.254	0.207	0.180	0.184	0.246
	SEE	11.44316	7.83989	8.40615	14.06331	9.67028
MP 5	R	0.329	0.444	0.442	0.279	0.472
	R^2	0.108	0.197	0.196	0.078	0.222
	SEE	12.35341	7.96941	8.33353	14.80081	9.98934
Stepwise	R	0.575	0.493	0.477	0.555	0.528
Model 1	R^2	0.331	0.243	0.227	0.309	0.279
	SEE	10.81078	7.76637	8.20483	12.95552	9.67440
Predictors		MP2	MP4	MP4	MP2	MP4
Stepwise	R	0.619	0.562	0.550	0.593	0.597
Model 2	R^2	0.384	0.315	0.302	0.352	0.356
	SEE	10.43734	7.43129	7.84252	12.61879	9.19406
Predictors		MP2	MP4	MP4	MP2	MP4
		MP4	MP2	MP2	MP4	MP2

Table 8.19: Direct and stepwise regression coefficients (slope and constant) and standard error of the estimates (SEE) (mm) of the middle phalanges (MP) 2 to 5 to estimate the length (mm) of a long bone in South African males

	Humerus	Radius	Ulna	Femur	Tibia
Direct					
MP 2	3.403	1.197	1.451	4.170	1.636
MP 3	-0.546	0.280	-0.365	-0.979	0.196
MP 4	2.697	1.226	1.332	3.369	1.773
MP 5	-1.172	0.404	0.649	-1.827	0.567
Constant	212.675	175.624	198.801	337.369	284.821
SEE	10.39432	7.48465	7.88246	12.40385	9.26484
Middle Phalanx 2					
Slope	3.520	1.986	2.089	4.243	2.686
Constant	245.227	207.057	222.914	363.875	326.152
SEE	11.16954	7.91818	8.35206	12.79881	9.82609
Middle Phalanx 3					
Slope	2.505	1.789	1.480	2.266	2.373
Constant	257.023	202.861	230.227	400.150	321.820
SEE	12.27303	8.10256	8.83124	14.86691	10.14807
Middle Phalanx 4					
Slope	3.160	1.894	1.862	3.159	2.614
Constant	242.184	202.481	221.702	378.383	318.461
SEE	11.44316	7.83989	8.40615	14.06331	9.67028
Middle Phalanx 5					
Slope	2.287	2.097	2.185	2.284	2.840
Constant	284.403	212.784	229.382	420.661	333.695
SEE	12.35341	7.96941	8.33353	14.80081	9.98934
Stepwise Model 1					
MP 2	3.818			4.347	
MP 3					
MP 4		2.276	2.300		3.108
MP 5					
Constant	238.389	191.667	209.405	361.676	304.373
SEE	10.81078	7.76637	8.20483	12.95552	9.67440
Stepwise Model 2					
MP 2	2.952	1.383	1.476	3.423	1.831
MP 3					
MP 4	1.803	1.573	1.549	1.923	2.176
MP 5					
Constant	208.816	177.821	194.630	330.141	286.047
SEE	10.43734	7.43129	7.84252	12.61879	9.19406

Table 8.20: Direct and stepwise regression showing the sequence of variable entry of distal phalanges (DP) 1 to 5 into the analysis and standard error of the estimates (SEE) (mm), *R* and R^2 to estimate the length (mm) of a long bone in South African males

		Humerus	Radius	Ulna	Femur	Tibia
All DP	R	0.657	0.568	0.587	0.604	0.541
Direct	R^2	0.431	0.323	0.344	0.364	0.293
	SEE	10.04404	7.64473	8.09223	12.34664	9.86875
DP 1	R	0.445	0.418	0.442	0.372	0.467
	R^2	0.198	0.175	0.196	0.139	0.218
	SEE	11.79925	7.99286	8.32004	14.37616	9.83274
DP 2	R	0.462	0.244	0.282	0.372	0.228
	R^2	0.213	0.060	0.080	0.139	0.098
	SEE	11.71338	8.54028	9.01645	14.10518	13.09722
DP 3	R	0.291	0.110	0.110	0.211	0.145
	R^2	0.084	0.012	0.012	0.044	0.021
	SEE	12.68089	8.92948	9.40688	14.92736	11.09677
DP 4	R	0.521	0.360	0.360	0.430	0.334
	R2	0.272	0.129	0.130	0.185	0.112
	SEE	11.08863	8.42090	8.86729	13.44774	10.64633
DP 5	R	0.567	0.235	0.258	0.505	0.299
	R^2	0.322	0.055	0.066	0.255	0.090
	SEE	10.72367	8.64931	9.13573	13.39970	10.69489
Stepwise	R	0.600	0.452	0.471	0.559	0.490
Model 1	R^2	0.360	0.204	0.222	0.312	0.240
	SEE	10.38900	8.07774	8.59156	12.51951	9.97223
Predictors		DP5	DP1	DP1	DP1	DP1

Table 8.21: Direct and stepwise regression coefficients (slope and constant) and standard error of the estimates (SEE) (mm) of distal phalanges (DP) 1 to 5 to estimate the length (mm) of a long bone in South African males

	Humerus	Radius	Ulna	Femur	Tibia
Direct					
DP 1	0.466	3.097	3.371	0.046	4.147
DP 2	2.230	0.389	1.001	1.968	-0.449
DP 3	-4.194	-3.413	-3.817	-4.356	-3.245
DP 4	2.394	3.973	4.059	2.377	2.772
DP 5	4.909	-1.848	-2.052	6.055	-0.215
Constant	229.809	197.976	208.443	364.321	316.325
SEE	10.04404	7.64473	8.09223	12.34664	9.86875
Distal Phalanx 1					
Slope	3.996	2.503	2.792	3.924	3.536
Constant	237.264	196.919	208.521	375.088	308.907
SEE	11.79925	7.99286	8.32004	14.37616	9.83274
Distal Phalanx 2					
Slope	4.977	1.755	2.164	4.615	2.091
Constant	241.253	223.903	234.804	384.188	353.971
SEE	11.71338	8.54028	9.01645	14.10518	13.09722
Distal Phalanx 3					
Slope	3.233	0.828	0.870	2.704	1.364
Constant	269.334	239.558	257.164	415.907	365.752
SEE	12.68089	8.92948	9.40688	14.92736	11.09677
Distal Phalanx 4					
Slope	5.394	2.587	2.729	5.107	3.010
Constant	228.302	206.222	221.909	370.186	334.464
SEE	11.08863	8.42090	8.86729	13.44774	10.64633
Distal Phalanx 5					
Slope	6.024	1.704	1.987	6.388	2.736
Constant	226.816	225.964	239.340	356.548	344.321
SEE	10.72367	8.64931	9.13573	13.39970	10.69489
Stepwise					
Model 1					
DP 1		2.781	3.120		3.813
DP 2					
DP 3					
DP 4					
DP 5	6.167			6.680	
Constant	224.540	190.879	201.226	352.085	303.167
SEE	10.38900	8.07774	8.59156	12.51951	9.97223

Table 8.22: Direct and stepwise regression showing the sequence of variable entry of metacarpals (MC) 1 to 5 into the analysis and standard error of the estimates (SEE) (mm), *R* and R^2 to estimate the length (mm) of a long bone in South African females

		Humerus	Radius	Ulna	Femur	Tibia
All MC	R	0.797	0.926	0.907	0.846	0.910
Direct	R^2	0.635	0.857	0.823	0.717	0.828
	SEE	7.32868	4.00888	4.97223	8.05951	5.77430
MC 1	R	0.612	0.827	0.790	0.594	0.631
	R^2	0.374	0.684	0.624	0.353	0.399
	SEE	9.34768	5.81861	7.07333	11.86070	10.60585
MC 2	R	0.713	0.902	0.858	0.724	0.771
	R^2	0.508	0.814	0.736	0.524	0.595
	SEE	8.28382	4.45926	5.92749	10.17291	8.70401
MC 3	R	0.573	0.844	0.773	0.650	0.714
	R^2	0.329	0.712	0.597	0.422	0.509
	SEE	9.67949	5.55472	7.32097	11.20616	9.58143
MC 4	R	0.448	0.812	0.698	0.456	0.584
	R^2	0.201	0.660	0.487	0.208	0.341
	SEE	10.56093	6.03318	8.26321	13.12046	11.09916
MC 5	R	0.581	0.806	0.660	0.574	0.485
	R^2	0.337	0.650	0.436	0.329	0.235
	SEE	9.65938	6.13491	8.67872	12.13626	11.90087
Stepwise	R	0.713	0.904	0.859	0.724	0.776
Model 1	R^2	0.508	0.817	0.738	0.524	0.602
	SEE	8.32248	4.43651	5.91711	10.22371	8.58358
Predictors		MC2	MC2	MC2	MC2	MC2
Stepwise	R	0.780	0.924	0.879	0.790	0.849
Model 2	R^2	0.608	0.853	0.773	0.624	0.721
	SEE	7.47180	3.98971	5.53297	9.12976	7.22912
Predictors		MC2	MC2	MC2	MC2	MC2
		MC4	MC1	MC1	MC4	MC5
Stepwise	R	0.792		0.897	0.841	0.879
Model 3	R^2	0.628		0.805	0.707	0.773
	SEE	7.31940		5.15711	8.10085	6.54756
Predictors		MC2		MC2	MC2	MC2
		MC4		MC1	MC4	MC5
		MC1		MC5	MC3	MC3
Stepwise	R					0.906
Model 4	R^2					0.821
	SEE					5.84479
Predictors						MC2
						MC5
						MC3
						MC4

Table 8.23: Direct and stepwise regression coefficients (slope and constant) and standard error of the estimates (SEE) (mm) of metacarpals (MC) 1 to 5 to estimate the length (mm) of a long bone in South African females

	Humerus	Radius	Ulna	Femur	Tibia
Direct					
MC 1	0.942	1.120	1.507	0.624	0.669
MC 2	3.104	1.503	2.579	3.644	3.882
MC 3	0.688	0.286	1.055	3.246	3.157
MC 4	-2.760	0.045	-0.984	-4.626	-2.238
MC 5	0.101	0.058	-1.352	-0.716	-3.491
Constant	171.617	63.212	73.930	264.666	188.928
SEE	7.32868	4.00888	4.97223	8.05951	5.77430
Metacarpal 1					
Slope	2.729	3.233	3.443	3.310	3.262
Constant	190.697	92.970	99.766	295.021	223.231
SEE	9.34768	5.81861	7.07333	11.86070	10.60585
Metacarpal 2					
Slope	2.204	2.443	2.589	2.793	2.760
Constant	165.358	73.681	80.026	256.580	184.866
SEE	8.28382	4.45926	5.92749	10.17291	8.70401
Metacarpal 3					
Slope	1.787	2.303	2.352	2.528	2.574
Constant	195.445	86.967	99.657	278.278	201.586
SEE	9.67949	5.55472	7.32097	11.20616	9.58143
Metacarpal 4					
Slope	1.561	2.479	2.374	1.984	2.356
Constant	220.706	93.838	115.365	326.407	232.108
SEE	10.56093	6.03318	8.26321	13.12046	11.09916
Metacarpal 5					
Slope	2.091	2.535	2.316	2.578	2.003
Constant	200.375	101.492	128.361	304.606	260.173
SEE	9.65938	6.13491	8.67872	12.13626	11.90087
Stepwise Model 1					
MC 2	2.202	2.439	2.585	2.792	2.750
Constant	165.498	73.999	80.374	256.694	185.707
SEE	8.32248	4.43651	5.91711	10.22371	8.58358
Stepwise Model 2					
MC 1		1.205	1.320		
MC 2	3.815	1.784	1.867	4.814	-2.744
MC 4	-2.129			-2.669	
MC 5					4.763
Constant	179.312	64.843	70.342	274.015	196.126
SEE	7.47180	3.98971	5.53297	9.12976	7.22912
Stepwise Model 3					
MC 1	1.032		1.542		
MC 2	3.383		2.646	3.614	3.703
MC 3				3.096	1.935
MC 4	-2.299			-4.660	
MC 5			-1.226		-3.606
Constant	172.577		73.317	267.830	187.462
SEE	7.31940		5.15711	8.10085	6.54756
Stepwise Model 4					
MC 2					4.100
MC 3					3.239
MC 4					-2.201
MC 5					-3.429
Constant					193.024
SEE					5.84479

Table 8.24: Direct and stepwise regression showing the sequence of variable entry of proximal phalanges (PP) 1 to 5 into the analysis and standard error of the estimates (SEE) (mm), *R* and R^2 to estimate the length (mm) of a long bone in South African females

		Humerus	Radius	Ulna	Femur	Tibia
All PP	R	0.565	0.788	0.735	0.533	0.615
Direct	R^2	0.319	0.622	0.540	0.284	0.378
	SEE	9.93376	6.58907	8.06088	12.71758	11.00904
PP 1	R	0.420	0.706	0.646	0.466	0.500
	R^2	0.177	0.499	0.417	0.217	0.250
	SEE	10.74584	7.36507	8.83879	13.11484	11.90683
PP 2	R	0.482	0.648	0.562	0.459	0.513
	R^2	0.232	0.419	0.315	0.211	0.263
	SEE	10.35382	7.88511	9.54503	13.10113	11.73771
PP 3	R	0.338	0.680	0.634	0.412	0.522
	R^2	0.114	0.463	0.401	0.170	0.273
	SEE	11.14588	7.62583	8.95944	13.50146	11.72385
PP 4	R	0.362	0.717	0.678	0.404	0.592
	R^2	0.131	0.514	0.459	0.163	0.351
	SEE	11.05382	7.22629	8.52704	13.53318	11.02685
PP 5	R	0.381	0.597	0.561	0.403	0.441
	R^2	0.145	0.357	0.315	0.162	0.195
	SEE	10.81125	8.34223	9.53232	13.33132	12.17230
Stepwise	R	0.474	0.722	0.695	0.461	0.601
Model 1	R^2	0.225	0.521	0.483	0.212	0.361
	SEE	10.36161	7.24506	8.35507	13.04313	10.91264
Predictors		PP2	PP4	PP4	PP2	PP4
Stepwise	R		0.777	0.734	0.511	
Model 2	R^2		0.604	0.538	0.261	
	SEE		6.63097	7.94253	12.70439	
Predictors			PP4	PP4	PP2	
			PP1	PP1	PP1	

Table 8.25: Direct and stepwise regression coefficients (slope and constant) and standard error of the estimates (SEE) (mm) of proximal phalanges (PP) 1 to 5 to estimate the length (mm) of a long bone in South African females

	Humerus	Radius	Ulna	Femur	Tibia
Direct					
PP 1	0.653	1.591	1.623	1.442	0.935
PP 2	3.482	0.774	0.067	2.359	0.562
PP 3	-1.554	0.379	0.358	-0.106	-0.380
PP 4	-1.030	0.725	1.617	-1.140	2.553
PP 5	1.800	0.439	0.102	1.562	-0.244
Constant	207.522	96.508	113.768	306.438	235.050
SEE	9.93376	6.58907	8.06088	2.71758	11.00904
Proximal Phalanx 1					
Slope	2.250	1.946	3.384	3.119	3.107
Constant	242.711	194.827	149.687	346.918	273.431
SEE	10.74584	7.36507	8.83879	13.11484	11.90683
Proximal Phalanx 2					
Slope	2.226	2.622	2.535	2.648	2.746
Constant	221.630	130.172	149.223	334.514	256.924
SEE	10.35382	7.88511	9.54503	13.10113	11.73771
Proximal Phalanx 3					
Slope	1.514	2.678	2.778	2.312	2.718
Constant	241.910	115.653	127.044	336.709	245.490
SEE	11.14588	7.62583	8.95944	13.50146	11.72385
Proximal Phalanx 4					
Slope	1.576	2.732	2.889	2.199	2.979
Constant	243.570	120.755	130.231	347.614	242.561
SEE	11.05382	7.22629	8.52704	13.53318	11.02685
Proximal Phalanx 5					
Slope	1.913	2.669	2.774	2.521	2.570
Constant	247.211	147.793	160.181	357.375	282.136
SEE	10.81125	8.34223	9.53232	13.33132	12.17230
Stepwise Model 1					
PP 2	2.315			2.808	
PP 4		2.747	2.935		2.978
Constant	218.203	119.890	128.047	328.304	242.200
SEE	10.36161	7.24506	8.35507	13.04313	10.91264
Stepwise Model 2					
PP 1		1.844	1.674	1.861	
PP 2				1.731	
PP 4		1.724	2.006		
Constant		108.508	117.717	316.457	
SEE		6.63097	7.94253	12.70439	

Table 8.26: Direct and stepwise regression showing the sequence of variable entry of middle phalanges (MP) 2 to 5 variables into the analysis and standard error of the estimates (SEE) (mm), *R* and R^2 to estimate the length (mm) of a long bone in South African females

		Humerus	Radius	Ulna	Femur	Tibia
All MP	R	0.488	0.694	0.635	0.544	0.582
Direct	R^2	0.238	0.481	0.403	0.295	0.339
	SEE	10.51108	7.62308	9.06152	12.77742	11.37170
MP 2	R	0.372	0.494	0.459	0.447	0.407
	R^2	0.138	0.244	0.211	0.199	0.166
	SEE	10.93960	9.01284	10.17761	13.09190	12.40922
MP 3	R	0.433	0.654	0.599	0.497	0.557
	R^2	0.188	0.427	0.359	0.247	0.310
	SEE	10.69703	7.87079	9.27629	12.86394	11.42045
MP 4	R	0.378	0.619	0.567	0.414	0.510
	R^2	0.143	0.383	0.322	0.172	0.260
g	SEE	10.78037	8.19651	9.54919	13.48752	11.74718
MP 5	R	0.330	0.444	0.400	0.313	0.361
	R^2	0.109	0.197	0.160	0.098	0.130
	SEE	11.30222	9.22123	10.59255	14.21647	12.86149
Stepwise	R	0.423	0.651	0.589	0.498	0.543
Model 1	R^2	0.179	0.423	0.347	0.248	0.295
	SEE	10.71605	7.89318	9.31015	12.96420	11.54082
Predictors		MP3	MP3	MP3	MP3	MP3
Stepwise	R		0.682	0.620		0.573
Model 2	R^2		0.465	0.385		0.329
	SEE		7.64659	9.09013		11.32428
Predictors			MP3	MP3		MP3
			MP5	MP4		MP4

Table 8.27: Direct and stepwise regression coefficients (slope and constant) and standard error of the estimates (SEE) (mm) of middle phalanges (MP) 2 to 5 to estimate the length (mm) of a long bone in South African females

	Humerus	Radius	Ulna	Femur	Tibia
Direct					
MP 2	1.275	0.625	0.851	1.779	0.642
MP 3	1.080	2.193	1.946	2.040	2.257
MP 4	0.283	0.621	0.791	0.264	0.983
MP 5	0.899	0.730	0.639	0.825	0.656
Constant	223.876	126.065	140.647	316.813	247.182
SEE	10.51108	7.62308	9.06152	12.77742	11.37170
Middle Phalanx 2					
Slope	2.361	2.760	2.837	3.523	2.980
Constant	253.355	168.094	181.994	356.014	294.527
SEE	10.93960	9.01284	10.17761	13.09190	12.40922
Middle Phalanx 3					
Slope	2.597	3.437	3.507	3.721	3.867
Constant	235.355	136.055	149.880	333.534	255.753
SEE	10.69703	7.87079	9.27629	12.86394	11.42045
Middle Phalanx 4					
Slope	1.822	2.671	2.721	2.540	2.883
Constant	258.928	160.162	174.586	368.930	286.259
SEE	10.78037	8.19651	9.54919	13.48752	11.74718
Middle Phalanx 5					
Slope	1.808	2.095	2.119	2.145	2.283
Constant	272.890	191.293	206.545	395.548	319.230
SEE	11.30222	9.22123	10.59255	14.21647	12.86149
Stepwise					
Model 1					
MP 3	2.558	3.456	3.468	3.808	3.811
Constant	236.322	135.545	150.882	330.764	257.194
SEE	10.71605	7.89318	9.31015	12.96420	11.54082
Stepwise					
Model 2					
MP 3		3.018	2.333		2.523
MP 4			1.318		1.495
MP 5		1.036			
Constant		128.168	147.276		253.105
SEE		7.64659	9.09013		11.32428

Table 8.28: Direct and stepwise regression showing the sequence of variable entry of distal phalanges (DP) 1 to 5 into the analysis and standard error of the estimates (SEE) (mm), *R* and R^2 to estimate the length (mm) of a long bone in South African females

		Humerus	Radius	Ulna	Femur	Tibia
All DP	R	0.495	0.600	0.536	0.513	0.442
Direct	R^2	0.245	0.360	0.287	0.263	0.195
	SEE	10.75109	9.02764	10.14532	13.32497	13.00060
DP 1	R	0.354	0.474	0.420	0.419	0.337
	R^2	0.125	0.224	0.176	0.175	0.113
	SEE	11.09019	9.12218	10.35052	13.54571	12.91585
DP 2	R	0.328	0.470	0.410	0.349	0.314
	R^2	0.108	0.221	0.168	0.122	0.098
	SEE	11.23967	9.22203	10.42380	13.93184	13.09722
DP 3	R	0.244	0.507	0.381	0.286	0.322
	R^2	0.059	0.257	0.145	0.082	0.104
	SEE	11.48434	9.01562	10.74986	14.49094	13.09369
DP 4	R	0.398	0.486	0.395	0.259	0.281
	R^2	0.159	0.236	0.156	0.067	0.079
	SEE	10.97460	9.22789	10.65546	14.47203	13.20502
DP 5	R	0.398	0.432	0.345	0.402	0.354
	R^2	0.159	0.187	0.119	0.162	0.125
	SEE	10.97460	9.49433	10.86264	13.57887	12.91634
Stepwise	R	0.435	0.583	0.532	0.486	0.427
Model 1	R^2	0.189	0.340	0.283	0.237	0.182
	SEE	10.84039	8.91060	9.89631	13.18908	12.74598
Predictors		DP1	DP1	DP1	DP1	DP1

Table 8.29: Direct and stepwise regression coefficients (slope and constant) and standard error of the estimates (SEE) (mm) of distal phalanges (DP) 1 to 5 to estimate the length (mm) of a long bone in South African females

	Humerus	Radius	Ulna	Femur	Tibia
Direct					
DP 1	3.746	3.521	4.107	5.599	3.692
DP 2	-1.125	-0.336	0.757	-0.852	-0.318
DP 3	-1.997	1.730	0.425	-0.256	-0.128
DP 4	-0.131	0.270	-0.062	-1.570	-0.479
DP 5	3.392	-0.183	-0.690	2.318	1.876
Constant	230.396	129.224	151.322	326.972	270.336
SEE	10.75109	9.02764	10.14532	13.32497	13.00060
Distal Phalanx 1					
Slope	2.664	3.112	3.038	3.961	2.929
Constant	250.838	165.159	182.598	352.549	300.466
SEE	11.09019	9.12218	10.35052	13.54571	12.91585
Distal Phalanx 2					
Slope	3.129	3.936	3.752	4.159	3.463
Constant	256.059	166.482	185.353	368.337	305.812
SEE	11.23967	9.22203	10.42380	13.93184	13.09722
Distal Phalanx 3					
Slope	2.263	3.936	3.292	3.213	3.310
Constant	266.577	161.447	188.455	379.051	303.654
SEE	11.48434	9.01562	10.74986	14.49094	13.09369
Distal Phalanx 4					
Slope	2.019	3.595	3.209	2.715	2.702
Constant	271.169	167.699	190.337	387.947	314.885
SEE	10.97460	9.22789	10.65546	14.47203	13.20502
Distal Phalanx 5					
Slope	3.695	3.526	3.092	4.628	3.788
Constant	248.982	175.845	198.308	363.706	302.880
SEE	10.97460	9.49433	10.86264	13.57887	12.91634
Stepwise					
Model 1					
DP 1	3.730	4.566	4.431	5.237	4.288
Constant	227.139	133.869	152.588	324.354	270.735
SEE	10.84039	8.91060	9.89631	13.18908	12.74598