JOURNAL OF FORENSIC SCIENCES

J Forensic Sci, November 2012, Vol. 57, No. 6
doi: 10.1111/j.1556-4029.2012.02166.x
Available online at: onlinelibrary.wiley.com

TECHNICAL NOTE

ANTHROPOLOGY

Jianpin Tang,[1] *Ph.D.; Rui Chen,*[1] *M.S.; and Xiaoping Lai,*[1] *Ph.D.*

Stature Estimation from Hand Dimensions in a Han Population of Southern China*

ABSTRACT: To analyze the relationship between stature and hand dimensions for forensic applications, the stature and hand dimensions of 400 healthy adults aged between 20 and 25 years were measured in a Han population of Southern China. The mean values of the stature are 170.49 and 159.72 cm in the men and the women, respectively. The statistically significant differences between the right- and the left-hand dimensions were not observed in the men, whereas the bilateral differences are statistically significant in female hand dimensions. The correlation coefficients were found to be statistically significant for the hand dimensions in both the sexes. The hand length showed higher correlation coefficients than the hand breadth in both sexes. Linear and multiple regressions were developed in this study; multiple regressions showed higher correlation coefficients than linear regressions. Two regression models could be used to estimate the stature from the hand dimensions in this population.

KEYWORDS: forensic science, Chinese Han ethnic group, stature, hand length, hand breadth, forensic anthropology

Stature is helpful in identifying human fragmentary remains. Several researchers have analyzed the relationship between stature and the dimensions of body parts including cephalo-facial and craniofacial dimensions, and the dimensions of long bone, fragmentary bone, vertebral column, handprint, footprint, shoe, limb, hand, and foot dimensions (1–29). A number of studies have revealed the correlations between stature and foot dimensions in several populations (1–9,11,13,14,16,17,23). Previous studies have indicated that the regression equations for stature estimation from body parts are population specific (1–29), and the formulae of one population may provide unreliable estimates when applied to another population. Thus, analyzing the anthropometric relationship between stature and the dimensions of body parts is necessary, and the regression formulae for stature estimation from the dimensions of body parts in different populations should be also developed.

There has been little previous research on the estimation of stature from the hand dimensions in Chinese populations. In this study, the correlations between the living stature and hand dimensions were analyzed for forensic applications, and the regression formulae were developed for reconstructing the stature of fragmentary remains based on the hand dimensions.

Materials and Methods

A total of 400 healthy adults (185 men and 215 women) aged between 20 and 25 years were collected from a Chinese Han population in Guangdong Province of Southern China.

Stature and hand dimensions of each subject were measured in accordance with previous research (9,30). The stature of the subject was measured in standing posture with trunk against the vertical board and the head oriented in the Frankfort horizontal plane by using a standard stadiometer. The subject was also asked to stand barefooted on the board of the stadiometer with both feet in close contact with each other.

The hand of the subject was placed on the flat hard horizontal surface with the thumb in abducted position and other fingers in extended position. The hand length is the linear distance between the point inter-stylion and the most anterior projection of the middle finger (Fig. 1). The hand breadth is the linear distance between the radial side of the second metacarpophalyngeal joint and the ulnar side of the fifth metacarpophalyngeal joint (Fig. 2).

The statures and hand dimensions of all samples were measured by the same researcher. To minimize the technical measurement error, this researcher was trained for the anthropological measurement prior to measuring the stature and the hand dimensions. To obtain the reliability and reproducibility of measurement, the left-hand length of 18 women was measured by this researcher. The reliability and reproducibility were evaluated utilizing the intraclass correlation coefficient (ICC). This study yielded an ICC value of 0.976 indicating stronger agreement. Data were analyzed using the Statistical Product and Service Solutions (version 15 SPSS Inc., Chicago, IL) software package.

Results

The male stature ranged from 160.0 to 186.3 cm, and the mean value of the male stature is 170.49 cm with a standard deviation of 4.82. The female stature varied from 150.0 to 175.3 cm with a mean value of 159.72 cm and a standard deviation of 5.22.

Tables 1 and 2 show the statistical data of the hand dimensions in the men and women of this population, respectively. The mean values of the male hand dimensions were higher than those of the

[1]Department of Forensic Medicine, Guangdong Medical College, No. 1, Xincheng Street, Songshanhu, Dongguan 523808, Guangdong Province, China.

*Funding received from the Science and Technology Fund of Dongguan (Grant No. 2008108101052), China.

Received 2 Nov. 2010; and in revised form 17 Aug. 2011; accepted 11 Sept. 2011.

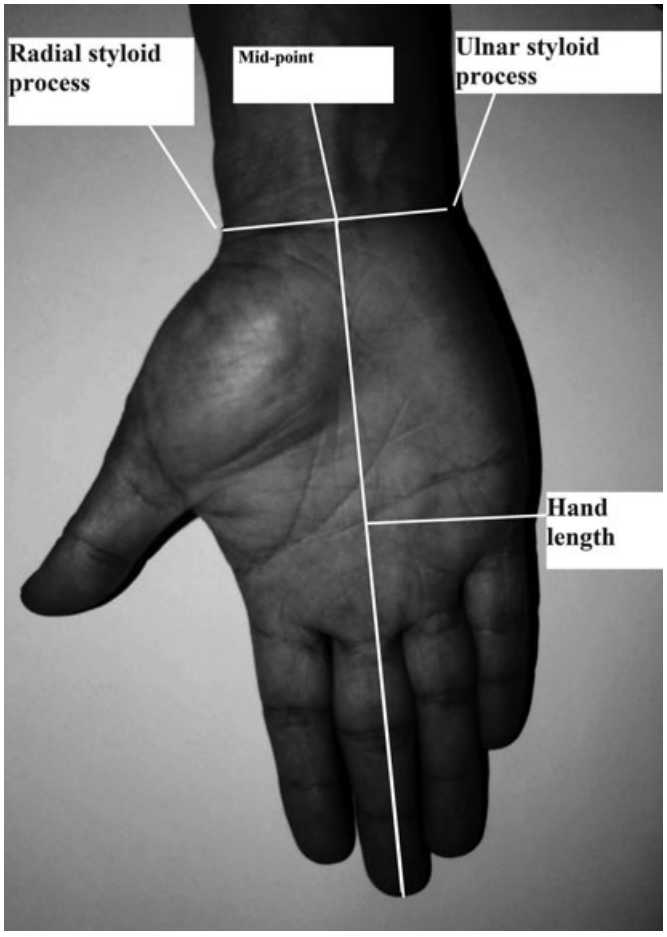

FIG. 1—*Measurement of the hand length.*

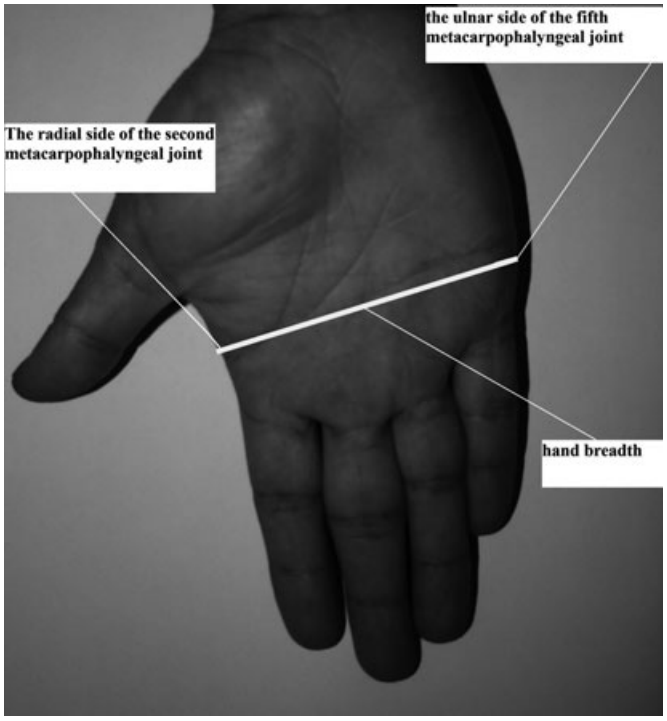

FIG. 2—*Measurement of the hand breadth.*

TABLE 1—*The hand length (cm) of both the sexes.*

	Male (n = 185)		Female (n = 215)	
	Right Side	Left Side	Right Side	Left Side
Minimum	15.9	15.8	15.0	15.0
Maximum	21.6	21.6	21.0	21.0
Mean	18.37	18.36	16.99	16.96
Std. deviation	0.88	0.87	0.96	0.95
Std. error	0.065	0.064	0.065	0.065
p	0.841		0.038	

All measurements in cm.

TABLE 2—*The hand breadth of both the sexes.*

	Male (n = 185)		Female (n = 215)	
	Right Side	Left Side	Right Side	Left Side
Minimum	6.0	6.0	5.6	5.5
Maximum	11.3	11.4	8.9	8.7
Mean	8.34	8.33	7.21	7.12
Std. deviation	0.93	0.91	0.56	0.53
Std. error	0.068	0.067	0.038	0.036
p	0.834		0.000	

All measurements in cm.

female hand dimensions, and the differences in the hand dimensions between the males and the females were statistically significant in our population.

Table 3 lists the general linear regression equations derived from the hand dimensions in both sexes. The correlation coefficients were statistically significant for both the male and female hand dimensions.

Table 4 depicts the multiple regression equations derived from the combinations of the hand length and the hand breadth on the homo-lateral side. The correlation coefficients were statistically significant in all multiple regression equations.

The formulae were tested using data of several individuals of our sample and the means of hand dimensions. The results are shown in Tables 5–7.

Discussion

The mean value of male stature is higher than that of female stature in our population, and the results of this study as well as previous research indicate that males are taller than females (1–28). Small differences exist in the mean value of stature of both sexes between the present study and other references (1–28).

The results of the present study as well as previous research indicate that males have greater hand dimensions than females (1,7–9,11). The bilateral differences are not statistically significant in the male hand dimensions of our population. This result differs from the results of Krishan and Sharma (7) and Rastogi et al. (9); the bilateral variation is significant for hand breath in the population studied by Krishan and Sharma (7), and the right-hand dimensions were larger than those of the left hand in the populations studied by Rastogi et al. (9). The bilateral differences are not significant in the hand length of the males from other populations (8,11). The statistically significant difference between left- and right-hand breadth of the males is not observed by Habib and Kamal (11). The differences in the bilateral hand dimensions are statistically significant in the females of this population. This result

TABLE 3—*The linear regression equation for estimating stature.*

Male			Female		
Regression Equation	*R*	SEE	Regression Equation	*R*	SEE
S = 105.361 + 3.547RHL	0.650	5.641	S = 97.280 + 3.661RHL	0.646	5.047
S = 102.866 + 3.683LHL	0.664	5.639	S = 98.732 + 3.582LHL	0.629	5.156
S = 153.161 + 2.078RHB	0.379	2.959	S = 134.995 + 3.399RHB	0.349	4.524
S = 154.299 + 1.952LHB	0.368	3.052	S = 134.482 + 3.507LHB	0.345	4.676

S, stature; RHL, right-hand length; LHL, left-hand length; RHB, right-hand breadth; LHB, left-hand breadth, *R*, correlation coefficient; SEE, standard error of estimate.

TABLE 4—*The multiple regression equation for estimating stature.*

Male			Female		
Regression Equation	*R*	SEE	Regression Equation	*R*	SEE
S = 103.507 + 3.173RHL + 1.047RHB	0.677	5.504	S = 95.118 + 3.465RHL + 0.763RHB	0.650	5.288
S = 99.352 + 3.378LHL + 1.093LHB	0.693	5.532	S = 96.411 + 3.380LHL + 0.807LHB	0.633	5.433

S, stature; RHL, right-hand length; LHL, left-hand length; RHB, right-hand breadth; LHB, left-hand breadth; *R*, correlation coefficient; SEE, standard error of estimate.

TABLE 5—*Comparison of actual stature and stature estimated from hand dimensions in the females.*

	Estimated Stature Using Regression Equations						
Sample	LHL	LHB	LHL + LHB	RHL	RHB	RHL + RHB	Actual Stature
1	157.119	160.434	157.477	156.954	162.998	156.939	153.7
2	158.551	167.768	158.122	158.053	168.123	158.131	161.6
3	159.984	158.330	159.777	159.883	158.448	159.634	160.4
4	162.850	164.486	163.127	162.812	161.507	163.093	163.6
5	164.283	161.135	164.398	163.178	161.507	163.439	163.0
6	157.835	159.732	157.991	157.687	160.488	158.013	155.0
7	163.208	160.785	163.304	163.318	160.827	163.211	163.3

RHL, right-hand length; LHL, left-hand length; RHB, right-hand breadth; LHB, left-hand breadth.

TABLE 6—*Comparison of actual stature and stature estimated from hand dimensions in the males.*

	Estimated Stature Using Regression Equations						
Sample	LHL	LHB	LHL + LHB	RHL	RHB	RHL + RHB	Actual Stature
1	174.685	173.623	176.382	174.528	173.525	175.641	175.3
2	171.000	170.696	171.030	171.330	170.824	171.424	171.5
3	168.423	171.086	168.880	168.143	170.824	168.569	167.3
4	168.055	170.891	168.433	168.498	171.0318	168.991	168.8
5	169.160	171.672	169.884	169.562	171.863	170.361	169.5
6	182.419	176.552	184.777	181.976	177.058	184.084	186.3
7	170.265	169.915	169.913	170.271	169.785	169.949	164.7

RHL, right-hand length; LHL, left-hand length; RHB, right-hand breadth; LHB, left-hand breadth.

is similar to those of Krishan and Sharma (7) and Rastogi et al. (9), and similar results were not found by Agnihotri et al. (8) and Habib and Kamal (11). Right-handed individuals were sampled by Krishan and Sharma (7) and Rastogi et al. (9), but the samples consisting of both right-handed and left-handed individuals were collected by the present study and other studies (8,11). Further investigation into the asymmetry of hand dimensions should be conducted.

General linear and multiple regression equations were derived from the bilateral hand dimensions in both sexes. The hand length showed a higher correlation coefficient for stature than the hand breadth in both sexes, and the similar result is also described by previous studies (7–9,11). Ours and others studies indicated that a more accurate stature could be estimated based on the hand length than from the hand breadth. The left-hand length shows higher correlation coefficient in the males of this population, and some references has reported different results (7,9). The regression equations derived from hand dimensions vary in different populations (1,7–9,11), and so do the correlation coefficients. The stature of the human remains should be estimated by the relevant regression formulae in different populations, and the relationship between the stature and the hand dimensions should be also surveyed in different populations.

The male hand dimensions showed higher correlation coefficients with stature than those of the females, and the left-hand length showed the highest correlation coefficient with stature in the males of our population, and the correlation coefficient of the left-hand breadth for stature was the lowest in the females of our population. The present study reveals that a more accurate stature could be

TABLE 7—*Comparison of actual stature and stature estimated from the means of hand dimensions.*

	Male			Female		
Estimated Stature Using Regression Equations For	Minimum Estimated Stature	Maximum Estimated Stature	Mean Estimated Stature	Minimum Estimated Stature	Maximum Estimated Stature	Mean Estimated Stature
LHL	161.257	182.419	170.485	152.462	173.954	159.483
RHL	161.404	181.976	170.519	152.195	174.161	159.48
LHB	166.011	176.552	170.559	153.771	164.993	159.452
RHB	165.629	176.642	170.492	154.029	165.246	159.502
Actual stature	160	186.3	170.49	150	175.3	159.72

RHL, right-hand length; LHL, left-hand length; RHB, right-hand breadth; LHB, left-hand breadth.

estimated from the male hand dimensions in our population. The multiple regression equation showed higher correlation coefficient than the linear regression equation, and this result is similar to results observed by other researchers (1,7–9,11). The multiple regression equation could provide a more accurate estimation of stature than the linear regression equation.

Comparisons of actual stature and stature estimated from regression equations were performed. The mean estimated stature was close to the actual stature. The estimated stature using multiple regression equations was more close to the actual stature than the estimated stature using linear regression equations. In addition, a more accurate stature could be estimated using regression equations from the hand length than the hand breadth.

Conclusion

Hand dimensions are useful parameters for estimating the stature in this Han population of Southern China. Both linear and multiple regression equations could be helpful in obtaining the approximate stature of dismembered human remains. However, a more accurate stature of the fragmented remains could be reconstructed using multiple regression equations. The regression equations derived from hand dimensions vary in different populations for forensic applications.

References

1. Sanli SG, Kizlkanat ED, Boyan N, Ozsahin E, Bozkir MG, Soames R, et al. Stature estimation based on hand length and foot length. Clin Anat 2005;18:589–96.
2. Özaslan A, İşcan MY, Özaslan İ, Tuğcu H, Koç S. Estimation of stature from body parts. Forensic Sci Int 2003;132:40–5.
3. Atamturk D, Duyar I. Age-related factors in the relationship between foot measurements and living stature and body weight. J Forensic Sci 2008;53:1296–300.
4. Sen J, Ghosh S. Estimation of stature from foot length and foot breadth among the Rajbanshi: an indigenous population of North Bengal. Forensic Sci Int 2008;181:55. e1–6.
5. Ozden H, Balci Y, Demirüstü C, Turgut A, Ertugrul M. Stature and sex estimate using foot and shoe dimensions. Forensic Sci Int 2005;147:181–4.
6. Agnihotri AK, Purwar B, Googoolye K, Agnihotri S, Jeebun N. Estimation of stature by foot length. J Forensic Leg Med 2007;14:279–83.
7. Krishan K, Sharma A. Estimation of stature from dimensions of hands and feet in a North Indian population. J Forensic Leg Med 2007;14:327–32.
8. Agnihotri AK, Agnihotri S, Jeebun N, Googoolye K. Prediction of stature using hand dimensions. J Forensic Leg Med 2008;15:479–82.
9. Rastogi P, Nagesh KR, Yoganarasimha K. Estimation of stature from hand dimensions of north and south Indians. Leg Med 2008;10:185–9.
10. Bidmos MA. Fragmentary femora: evaluation of the accuracy of the direct and indirect methods in stature reconstruction. Forensic Sci Int 2009;192:131.e1–5.
11. Habib SR, Kamal NN. Stature estimation from hand and phalanges lengths of Egyptians. J Forensic Leg Med 2010;17:156–60.
12. Krishan K. Estimation of stature from cephalo-facial anthropometry in north Indian population. Forensic Sci Int 2008;181:52.e1–6.
13. Krishan K. Determination of stature from foot and its segments in a North Indian population. Am J Forensic Med Pathol 2008;29:297–303.
14. Zeybek G, Ergur I, Demiroglu Z. Stature and gender estimation using foot measurements. Forensic Sci Int 2008;181:54.e1–5.
15. Krishan K, Kumar R. Determination of stature from cephalo-facial dimensions in a North Indian population. Leg Med 2007;9:128–33.
16. Kanchan T, Menezes RG, Moudgil R, Kaur R, Kotian MS, Garg RK. Stature estimation from foot dimensions. Forensic Sci Int 2008;179:241.e1–5.
17. Krishan K. Estimation of stature from footprint and foot outline dimensions in Gujjars of North India. Forensic Sci Int 2008;175:93–101.
18. Menezes RG, Kanchan T, Kumar GP, Rao PP, Lobo SW, Uysal S, et al. Stature estimation from the length of the sternum in South Indian males: a preliminary study. J Forensic Leg Med 2009;16:441–3.
19. Agnihotri AK, Kachhwaha S, Jowaheer V, Singh AP. Estimating stature from percutaneous length of tibia and ulna in Indo-Mauritian population. Forensic Sci Int 2009;187:109.e1–3.
20. Steyn M, Smith JR. Interpretation of ante-mortem stature estimates in South Africans. Forensic Sci Int 2007;171:97–102.
21. Nagesh KR, Pradeep Kumar G. Estimation of stature from vertebral column length in South Indians. Leg Med 2006;8:269–72.
22. Bidmos MA. Stature reconstruction using fragmentary femora in South Africans of European descent. J Forensic Sci 2008;53:1044–8.
23. Ilayperuma I, Nanayakkara G, Palahepitiya N. Prediction of personal stature based on the hand length. Galle Med J 2009;14:15–8.
24. Bidmos MA. Estimation of stature using fragmentary femora in indigenous South Africans. Int J Legal Med 2008;122:293–9.
25. Bidmos M. Adult stature reconstruction from the calcaneus of South Africans of European descent. J Forensic Leg Med 2006;13:247–52.
26. Bidmos MA. Metatarsals in the estimation of stature in South Africans. J Forensic Leg Med 2008;15:505–9.
27. Maijanen H. Testing anatomical methods for stature estimation on individuals from the W. M. Bass donated skeletal collection. J Forensic Sci 2009;54:746–52.
28. Adams BJ, Herrmann NP. Estimation of living stature from selected anthropometric (soft tissue) measurements: applications for forensic anthropology. J Forensic Sci 2009;54:753–60.
29. Pelin C, Zağyapan R, Yazıcı C, Kürkçüoğlu A. Body height estimation from head and face dimensions: a different method. J Forensic Sci 2010;55:1326–30.
30. Okunribido OO. A survey of hand anthropometry of female rural farm workers in Ibadan, western Nigeria. Ergonomics 2000;43:282–92.

Additional information and reprint requests:
Jianpin Tang, Ph.D.
No. 1, Xincheng Street, Songshanhu
Dongguan 523808, Guangdong
China
E-mail: tangjianpin@hotmail.com