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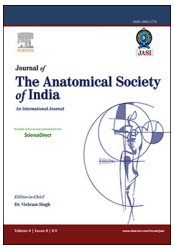

Original Article

Correlation of handedness with hand anthropometric measurements in Haryanvi Brahmins

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ABSTRACT

Introduction: Anthropometric studies have revealed that in comparison of the two halves of the human body, the values belonging to the right half are different than those of left half. This is due to effect of directionality and degree of handed preference, a functional property of hand, on anthropometric measurement of hand in healthy individual. In the present study, the aim is to provide authentic database on hand anthropometric measurements in Haryanvi Brahmins and to study its co-relation with handedness.

Methods: The present study was conducted on 300 Haryanvi Brahmins (150 of either sex of age 18 years) and above. Three hand measurements: hand length, hand breadth and shape index were taken with a digital sliding caliper. Handedness was determined according to Edinburgh Inventory which evaluates the direction and degree of hand preference.

Results: The mean values of hand parameters were significantly different between males and females, right handers and left handers. Hand breadth and shape index were found to be greater in the right hand in strong and weak right hand preference groups in Haryanvi Brahmins.

Discussion: Left hand preference groups displayed irregular and heterogenous characteristics with regard to hand parameters. When correlation between laterality score and hand parameters was examined no specific hand measurements were found to be indicators of hand preference in Haryanvi Brahmins.

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1. Introduction

No two individuals are exactly like in their measurable traits; even genetically identical twins (monozygotic) differ in some respects. These traits undergo change in varying degrees from birth to death, in health and disease, and since skeletal development is influenced by a number of factors producing differences in skeletal proportions between different geographical areas, it is desirable to have some means of giving quantitative expression to variations which such trait exhibit. Anthropometry constitutes the technique of expressing quantitatively the form of the human body.[1]

Hand preference is perhaps the most blatant behavioral asymmetry observed in human and is manifested by the preferential use of one limb more than the other for manual activities. Although hand preference is often used to subtype individuals into groups to investigate lateralized behaviors, our understanding remains limited with respect to the critical neural systems that mediate hand preference and the specific behavioral measures that discriminate right and left handers.[2]

Anthropometric studies have revealed that, in comparison of two halves of the body, the values belonging to the right half are different than those of left half. This is due to effect of directionality and degree of handed preference, a functional property of hand, on anthropometric measurement of hand in healthy individuals.[3,4]

Estimation of stature has a significant importance in the field of forensic anthropometry. Establishing the identity of an individual from mutilated, decomposed, & amputed body fragments has become an important necessity in recent times due to natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc. Many different body parts can be used in the estimation of stature. But there are inter-racial & inter-geographical differences in measurements & their correlation with stature.

Kulaksiz and Gozil,[5] Kar et al,[6] Oomen et al[7] (in males), Agnihotri et al,[8] Krishan & Sharma,[9] Danborno & Elukpo,[10] Ibeachu et al,[11] Krishan et al[12] studied the hand length and hand breadth in different populations and The mean values were more in males as compared to females and the difference in values between males and females was significant on both the sides.

In the present study, the aim is to provide an authentic database on hand anthropometric measurements in Haryanvi Brahmins and to study its co-relation with handedness. The study will also evaluate the sexual dimorphism in hand measurements and will establish its significance in forensic science, physical anthropology and other applied clinical sciences.

2. Aims and objectives

The aims of the study are:

1. To provide authentic database on hand measurements in males and females of Haryanvi Brahmins.
2. To study correlation of hand anthropometric measurements with handedness.
3. To establish significance of hand measurements in forensic science, physical anthropology, ergonomics and other applied clinical sciences.

3. Materials and method

The present study was conducted on 300 Haryanvi Brahmins (150 of either sex) of age 18 years and above. Prior informed consent for this study was obtained from subjects in writing, both in English and vernacular. The subjects with any apparent, physical hand anomalies, inflammation, trauma, deformities and surgery were excluded because of their unsuitability for this investigation. Subjects having any genetic, psychological, neurological or chronic diseases affecting hand parameters were excluded from the study.

Hand Preference determination. Handedness was determined according to Edinburgh Inventory which evaluates the direction and degree of hand preference.[5]

Subjects were asked 10 questions dealing with their hand preferences in: 1. Writing 2. Drawing 3. Throwing balls 4. Using scissors 5. Using tooth brush 6. Knife without Fork 7. Spoon 8. Broom 9. Lighting matches 10. Opening boxes.

Subjects were asked to put a ''+'' in the column associated with the hand that they were used to carry out activity. They were asked to put ''++'' in the associated column if their preference for one hand was very strong; and to put a ''+'' in both columns if they are using both hand equally. A ''++'' in right column was assigned10 points, a ''+'' in the right column 5 points, a ''++'' in the left column −10 points and a ''+'' in the left column −5 points. The resultant sum of these points had been used to determine the Geschwind (laterality) score, an indicator of the direction and degree of hand preference (Table 1).

$-100 \leq$ Geschwind score $\leq +100$ (right hand preference decreases and left hand preference increases going from +100 to −100).

Hand preference was evaluated in 5 groups, depending on the value of the Geschwind laterality score.[13]

4. Somatometric measurements (in mm)

- Hand length: Defined as distance between the midpoint of the distal wrist crease and the most anterior projecting point i.e. the tip of the third digit.

Table 1 – Determination of hand preference by direction and degree by Geschwind score.

Hand preference	Geschwind score	
	Minimum value	Maximum value
Right hand		
Strong	+80	+100
Weak	+20	+75
Ambidextrous	−15	+15
Left hand		
Weak	−75	−20
Strong	−100	−80

- Hand breadth: The distance between the outside projections of the distal end of second and fifth metacarpals of the hand, with fingers extended and together.
- Shape index: Hand breadth X100/Hand length.

A digital sliding caliper (300 mm) was used to take the measurement.

The measurement was taken on both hands from palmar side with digits fully stretched touching on flat hard surface and 2nd to 5th digits adducted and thumb slightly extended. All the data so obtained was recorded tabulated and statistically analyzed using SPSS 13 PC + program.

5. Observations

The distribution of subjects by hand preference and sex in Haryanvi Brahmins is shown in Table 2.

The mean values of hand length (Table 3) were more in the left hand and the difference was statistically significant. The values of hand breadth and shape index were more in the right hand and the difference was statistically significant.

The values of hand length, hand breadth, shape index (Table 4) were found to be higher in men and their difference was found to be statistically highly significant.

In strong right handed individuals (Table 5), the mean values of hand breadth, shape index were higher on the right side and the difference was statistically significant. The values of hand length were higher on the left side and the difference was statistically significant in hand length.

In weak right handed individuals (Table 6), the values of hand breadth and shape index were higher on the right side, but the difference was statistically significant only in the hand breadth. The mean values of hand length were higher on the left side and the difference between right and left side was statistically significant.

In ambidextrous subjects (Table 7), the values of hand length and hand breadth were higher on the right side, but the difference was statistically significant only in hand breadth. The values of shape index were higher on left side and the difference was statistically insignificant.

Mean values of all the measurements were higher on the left side but the difference was not significant (Table 8).

In strong left handed individuals, the mean values of hand length and shape indices were higher on the right side. But the difference was statistically significant only in hand length. The values of hand breadth were higher on the left side but the difference was statistically insignificant (Table 9).

Table 3 – Right and left hand parameters (mm) in Haryanvi Brahmins (n = 300).

Parameters	Right hand	Left hand	p Value
Hand length	179.39 ± 12.26	180.39 ± 13.06	0.001*
Hand breadth	79.88 ± 7.67	78.23 ± 7.57	0.000*
Shape index	44.39 ± 3.48	43.36 ± 2.80	0.000*

*p ≤ 0.001 Highly significant.

Table 4 – Interpretation of hand parameters (mm) by sex in Haryanvi Brahmins.

Parameters		Sex		p Value
		Male	Female	
Hand length	Right	186.69 ± 10.46	172.09 ± 9.21	≤0.001**
	Left	188.08 ± 11.60	172.69 ± 9.42	≤0.001**
Hand breadth	Right	84.46 ± 6.52	75.30 ± 5.77	≤0.001**
	Left	82.21 ± 6.58	74.25 ± 6.32	≤0.001**
Shape index	Right	45.09 ± 2.61	43.70 ± 4.07	≤0.001**
	Left	43.83 ± 2.66	42.89 ± 2.87	≤0.01*

*p ≤ 0.01 Very significant.
**p ≤ 0.001 Highly significant.

Table 10 shows that laterality score was positively correlated with right hand length (0.015), left hand length (0.017), left shape index (0.018), but the correlation was not statistically significant.

Laterality score was negatively correlated with right hand breadth (−0.023), left hand breadth (−0.042), right shape index (−0.001), but the correlation was statistically insignificant.

6. Discussion

The human hand is the most used and versatile part of the body is of great scientific importance to investigators in the field of anthropometry, forensic pathology, orthopedic surgery and ergonomics.

Asymmetries tend to be more pronounced in adults than in children. They are generally more pronounced in the upper than the lower extremities and tend to be right side oriented i.e. right side tends to be larger than the left. Some evidence suggests that the latter is true even when handedness is controlled.[14]

The assessment of the physical dimension of the human hand provides a metric description to ascertain human-machine compatibility in the design of manual systems for

Table 2 – Determination of subjects by hand preference and sex.

Hand preference	Male (n)	Percentage (%)	Female (n)	Percentage (%)	Total (n)	Total (%)
Strong right	123	82	110	73.3	233	77.67
Weak right	25	16.67	29	19.3	54	18
Ambidextrous	1	0.6	2	1.3	3	1
Weak left	0	0	2	1.3	2	0.67
Strong left	1	0.6	5	3.3	6	2
Total	150	100	150	100	300	100

Table 5 – Right and left hand parameters (mm) in strong right handed Haryanvi Brahmins.

Parameters	Right hand (X ± SD)	Left hand (X ± SD)	p Value
Hand length (in mm)	179.42 ± 12.12	180.51 ± 12.79	≤0.01
Hand breadth (in mm)	79.76 ± 7.83	78.07 ± 7.78	≤0.001
Shape index	44.44 ± 2.86	43.35 ± 2.86	≤0.001

Table 6 – Right and left hand parameters in weak right handed Haryanvi Brahmins.

Parameters	Right hand (X ± SD)	Left hand (X ± SD)	p Value
Hand length (in mm)	180.36 ± 12.07	181.5 ± 12.8	≤0.01
Hand breadth (in mm)	80.93 ± 6.46	79.08 ± 6.15	≤0.001
Shape index	44.14 ± 5.56	43.52 ± 2.97	>0.05

the bare and gloved hand (e.g., design of the hand tools, knobs and controls, personal equipment, consumer appliances in the home and industry). Today there is a growing demand among professional hand tools users to have ergonomically designed products. To design any product for human use, engineers have to rely on anthropometric data, otherwise the resulting product may turn out to be ergonomically incompatible.[15]

Identification of human remains an essential element of any medico-legal investigation. The variations in hand dimensions can be attributed to the population and ethnic differences between the study population and the other earlier studies. Various techniques in forensic anthropology are still most commonly employed for identification of human remains. It is not uncommon to find the peripheral parts of the body such as hand and foot in mass disasters, and assault cases where the body is dismembered to conceal the identity of the victim. When an individual hand is recovered and brought for examination, dimensions of the hand, osteological and radiological examination can help in the determination of primary indicators of identification such as sex, age, stature, nation/state etc.

The present study was done to provide a database for hand anthropometry in Haryanavi brahmins & study its correlation with hand preference. 300 subjects were included in the study out of which 150 were males and 150 were females. Three hand measurements were taken and hand preference was determined using Edinburgh inventory. Questionnaires of hand preference are frequently used to identify handedness groups because (1) they are easier to administer than behavioral measures and (2) they provide the basis for assignment of individuals to handedness groups.[16] The data was recorded, tabulated and subjected to statistical analysis. The readings were compared with the previously published data.

Table 7 – Right and left hand parameters (mm) in ambidextrous Haryanvi Brahmins.

Parameters	Right hand (x ± SD)	Left hand (x ± SD)	p Value
Hand length (in mm)	177.27 ± 20.61	175.33 ± 18.71	>0.05
Hand breadth (in mm)	75.30 ± 11.29	72.03 ± 11.29	≤0.001
Shape index	42.40 ± 2.30	42.50 ± 2.01	>0.05

Table 8 – Right and left hand parameters (mm) in weak left handed Haryanvi Brahmins.

Parameters	Right hand (x ± SD)	Left hand (x ± SD)	p value
Hand length	173.35 ± 1.06	177.05 ± 8.70	>0.05
Hand breadth	75.80 ± 3.82	75.9 ± 1.13	>0.05
Shape index	43.35 ± 2.05	43.45 ± 0.92	>0.05

Table 9 – Right and left hand parameters (mm) in strong left handed Haryanvi Brahmins.

Parameters	Right hand (x ± SD)	Left hand (x ± SD)	p value
Hand length	173.87 ± 17.34	170.51 ± 20.37	≤0.05
Hand breadth	79.24 ± 10.29	80.54 ± 9.54	>0.05
Shape index	45.61 ± 3.80	42.73 ± 2.11	>0.05

In Haryanvi Brahmins,the mean hand length values in males was 186.69 ± 10.46 on right side and 188.08 ± 11.60 on left side and in female it was 172.09 ± 9.21on right side and 172.69 ± 9.42 on left side.

The mean values were more in males as compared to females and the difference in values between males and females was significant on both the sides. This is in agreement with the studies done by Kulaksiz and Gozil,[5] Kar et al,[6] Oomen et al[7] (in males), Agnihotri et al,[8] Krishan & Sharma,[9] Danborno & Elukpo,[10] Ibeachu et al,[11] Krishan et al[12] (Table 11).

In the present study, values of mean hand length were found to be higher on the left side in males of Haryanvi Brahmins which is in agreement with the studies of Kulaksiz and Gozil[5] and Danborno & Elukpo[10] and in contradiction to the study of Krishan & Sharma.[9] The values were slightly higher on the left side in females of Haryanvi Brahmins which is in consonance with the studies of Kulaksiz and Gozil,[5]

Table 10 – Relationship between the Gecshwind score (laterality score) and hand parameters (Spearman correlation coefficient analysis) in Haryanvi Brahmins.

Parameters	Spearman correlation coefficient	Coefficient of significance
Right hand length	0.015	0.794
Left hand length	0.017	0.769
Right hand breadth	−0.023	0.692
Left hand breadth	−0.042	0.470
Right shape index	−0.001	0.993
Left shape index	0.018	0.756

Oomen et al,[7] Danborno & Elukpo[10] & Ibeachu et al.[11] (Table 11).

In Haryani Brahmins, the mean hand breadth values in males was 84.46 ± 6.52 on right side and 82.21 ± 6.58 on left side and in female it was 75.30 ± 5.77 on right side and 74.25 ± 6.32 on left side.

The values were more in males as compared to females and the difference in values between males and females was highly significant on both the sides (Table 12). This is in agreement with the studies done by Kulaksiz and Gozil,[5] Kar et al,[5] Agnihotri et al,[8] Danborno & Elukpo,[10] Ibeachu et al,[11] Krishan et al[12].

In the present study, values of mean hand breadth were found to be higher on the right side in both males and females in Haryanvi Brahmins. These results coincided with the studies done by Kulaksiz and Gozil,[5] Kar et al,[6] Agnihotri et a[8], Danborno & Elukpo,[10] Ibeachu et al,[11] Krishan et al[12] (Table 12).

A few more studies on hand measurements of Indian population have been carried out but sexual and ethnic variations have not been taken into consideration(Table 13).

Although the mean values of hand length and hand breadth in the present study are nearer to the study of Ahmad et al but the mean values of males of Haryana region in the study of Chandra et al are comparable to the values of Haryanvi Brahmins males in the present study (Tables 11 and 12).

In Haryanvi Brahmins,the mean shape index values in males was 45.09 ± 2.61 on right side and 43.83 ± 2.66 on left side and in female was 43.70 ± 2.60 on right side and 42.89 ± 2.87 on left side. The mean values were more in males as compared to females. The difference in values between males and females was highly significant on both the sides in both the endogamous groups which coincided with the studies done by Kulaksiz and Gozil5 & Danborno and Elukpo[10] (Table 14).

Table 13 – Comparison of studies on hand measurements carried out on different Indian ethnic groups.

Author	Population studied	Hand length	Hand breadth	Hand index
Chikhalkar et al[16] (2010)	Mumbai	189.38	75.37	
Chandra et al[17] (2013)	Haryana (Males)	186.52	84.29	45.19
Ahmad et al[18] (2014)	Kerala	177.9	77.3	
Present study	Haryanvi Brahmins	179.39	79.88	44.39

In the present study, values of mean shape index were found to be higher on the right side in both males and females in Haryanvi Brahmins which is in consonance with the studies done by Kulaksiz and Gozil[5] & Danborno and Elukpo.[10]

The mean hand length values were more on the left side as compared to right side in strong and weak right hand preference groups in both the present study in Haryanvi Brahmins and the study done by Kulaksiz & Gozil[5] (Table 15).

In rest of the hand preference groups in the present study & also in the study done by Kulaksiz & Gozil,[5] the mean values showed irregular results indicating no systematic correlation in these groups (Table 15).

Hand breadth was observed to be noticeably greater in right hand in those with strong & weak right hand preference

Table 11 – Comparison of right and left mean hand length (mm) of Haryanvi Brahmins with the previous studies in both the sexes.

Author	Population	Males		Females		p Value
		Right	Left	Right	Left	
Kulaksiz and Gozil[5]	Ankara (Turkey)	186.92 ± 8.31	187.34 ± 8.10	171.19 ± 7.64	171.44 ± 7.65	<0.001
Kar et al[6]	West Bengal	175.1 ± 8.5	175.9 ± 8.8	160.9 ± 7.0	160.6 ± 7.5	<0.001
Oomen et al[7]	Karnataka	190.60 ± 7.30	190.62 ± 7.10	173.28 ± 8.90	172.46 ± 8.70	<0.001
Agnihotri et al[8]	Mauritius	188.91 ± 8.80	189.00 ± 8.70	172.20 ± 9.20	172.20 ± 9.30	<0.001
Krishan & Sharma[9]	Himachal Pradesh (Rajputs)	182.4 ± 9.00	182.1 ± 9.1	168.3 ± 8.00	168.00 ± 8.30	<0.001
Danborno & Elukpo[10]	Zaria, Nigeria	198.5 ± 8.60	199.30 ± 9.30	185.10 ± 6.60	185.21 ± 7.70	≤0.001
Ibeachu et al[11]	University of Port Harcourt Nigeria	190.2 ± 0.8	190.9 ± 0.7	176.2 ± 0.7	176.9 ± 0.7	<0.001
Krishan et al[12]	Himachal Pradesh	182.70 ± 9.00	182.10 ± 9.00	168.10 ± 8.00	167.70 ± 8.00	≤0.001
Present study	Haryanavi Brahmins	186.69 ± 10.46	188.08 ± 11.60	172.09 ± 9.21	172.69 ± 9.42	≤0.001***

Table 12 – Comparison of right and left mean hand breadth (mm) of Haryanvi Brahmins with the previous studies in both the sexes.

Author	Population	Males		Females		p Value
		Right	Left	Right	Left	
Kulaksiz & Gozil (2002)[5]	Ankara (Turkey)	85.54 ± 3.99	84.61 ± 4.31	76.61 ± 4.12	75.64 ± 3.93	<0.001
Kar et al[6]	West Bengal	82.3 ± 0.44	80.3 ± 0.41	73.0 ± 0.35	70.7 ± 0.35	≤0.001
Agnihotri et al (2006)[8]	Mauritius	84.50 ± 4.00	84.20 ± 4.00	74.8 ± 3.8	74.2 ± 3.7	<0.001
Danborno & Elukpo (2009)[10]	Zaria, Nigeria	89.00 ± 9.50	86.80 ± 9.20	78.20 ± 4.90	77.20 ± 4.60	<0.001
Krishan et al (2011)[12]	Himachal Pradesh (Rajputs)	82.30 ± 3.90	80.90 ± 4.30	74.00 ± 4.20	72.90 ± 4.30	<0.001
Ibeachu et al (2011)[11]	University of Port Harcourt, Nigeria	85.8 ± 0.3	84.3 ± 0.3	76.9 ± 0.3	75.8 ± 0.3	<0.001
Present study	Haryanvi Brahmins	84.46 ± 6.52	82.21 ± 6.58	75.30 ± 5.77	74.25 ± 6.32	≤0.001

Table 14 – Comparison of right and left mean shape index of Haryanvi Brahmins with the previous studies in both the sexes.

Author	Population	Males		Females		p Value
		Right	Left	Right	Left	
Kulaksiz and Gozil[5]	Ankara (Turkey)	45.80 ± 1.88	45.19 ± 2.03	44.78 ± 2.08	44.15 ± 1.99	<0.001
Danborno and Elukpo[10]	Nigerian	44.92 ± 5,15	43.65 ± 5.15	42.27 ± 2.67	41.74 ± 2.34	<0.001
Present study	Haryanvi Brahmins	45.09 ± 2.61	43.83 ± 2.66	43.70 ± 2.60	42.89 ± 2.87	≤0.001

Table 15 – Comparison of the right and left hand length (mm) in different hand preference groups of the present study with the previous studies.

Hand preference groups		Name of author	
		Kulaksiz & Gozil[5]	Present study
			Haryanvi Brahmins
Strong right handed	Rt	180.23 ± 11.46	179.42 ± 9.33
	Lt	180.91 ± 11.30	180.51 ± 12.79
Weak right handed	Rt	178.85 ± 10.90	180.36 ± 12.07
	Lt	179.20 ± 10.95	181.5 ± 12.8
Ambidextrous	Rt	177.82 ± 11.63	177.27 ± 20.61
	Lt	178.03 ± 12.99	175.33 ± 18.71
Weak left handed	Rt	179.74 ± 12.74	173.35 ± 1.06
	Lt	179.96 ± 12.35	177.05 ± 8.50
Strong left handed	Rt	178.38 ± 8.77	173.87 ± 17.34
	Lt	177.92 ± 9.33	170.51 ± 20.37

Table 16 – Comparison of the right and left hand breadth (mm) in different hand preference groups of the present study with the previous studies.

Hand preference		Name of author	
		Kulaksiz & Gozil[5]	Present study
			Haryanvi Brahmins
Strong right handed	Rt	82.46 ± 6.28	79.76 ± 7.83
	Lt	80.99 ± 6.34	78.07 ± 7.78
Weak right handed	Rt	81.00 ± 5.74	80.93 ± 6.46
	Lt	79.63 ± 5.69	79.08 ± 6.15
Ambidextrous	Rt	80.95 ± 6.32	80.95 ± 6.32
	Lt	80.07 ± 5.93	80.07 ± 5.93
Weak left handed	Rt	80.67 ± 6.74	75.80 ± 3.82
	Lt	81.30 ± 7.16	75.90 ± 1.13
Strong left handed	Rt	80.39 ± 6.53	79.24 ± 10.29
	Lt	80.89 ± 6.26	80.54 ± 9.54

($p < 0.01$) in Haryanvi Brahmins which is in accordance with the results shown by Kulkasiz and Gozil[5] (Table 16).

The mean hand breadth values showed insignificant differences on the right & left side in the ambidextrous group in the Haryanvi Brahmins and in the study of Kulkasiz & Gozil[5] though the values were more on the right side in both the studies. Hand breadth values were more in the left hand in strong and weak left handed groups in Haryanvi Brahmins which is in consonance with the study done by Kulkasiz & Gozil.[5] (Table 16).

Table 17 – Comparison of the right and left shape index in different hand preference groups of the present study with the previous studies.

Hand preference groups		Name of author	
		Kulaksiz & Gozil[5]	Present study
			Haryanvi Brahmins
Strong right handed	Rt	45.76 ± 2.05	44.44 ± 2.86
	Lt	44.76 ± 1.91	43.35 ± 2.86
Weak right handed	Rt	45.31 ± 2.10	44.14 ± 5.56
	Lt	44.45 ± 2.10	43.52 ± 2.97
Ambidextrous	Rt	45.51 ± 1.58	42.40 ± 2.30
	Lt	45.01 ± 1.95	42.50 ± 2.01
Weak left handed	Rt	44.87 ± 6.74	43.35 ± 2.05
	Lt	45.16 ± 2.14	43.45 ± 0.92
Strong left handed	Rt	45.03 ± 2.24	45.61 ± 3.80
	Lt	45.45 ± 2.15	42.73 ± 2.11

The shape index was found to be higher in the right hand in strong and weak right hand preference groups in Haryanvi Brahmins and these results were similar to the study done by Kulkasiz and Gozil.[5] Thus, the right hand was coarser than the left hand in persons with right hand preference.

In ambidextrous and left handed groups, the shape index values were more on the right side in the study of Kulkasiz and Gozil[5] whereas the values were more in the left hand in ambidextrous Haryanvi Brahmins (Table 17).

In weak left handed groups, the shape index values were more in the left hand in the two studies whereas in strong left handed group, the values were more in the right hand in Haryanvi Brahmin which is in contrast to the results of Kulkasiz & Gozil[5] where values were more in on the left side.

Table 18 – Comparison of correlation between Geschwind score (laterality score) and hand parameters (Spearman coefficient analysis) in the present study with the previous studies.

Parameters	Kulaksiz & Gozil[5]	Haryanvi Brahmins	Kulaksiz & Gozil[5]	Haryanvi Brahmins
Right hand length	0.0435	0.015	0.390	0.794
Left hand length	0.0640	0.017	0.206	0.769
Right hand breadth	0.0580	−0.023	0.251	0.692
Left hand breadth	−0.0282	−0.042	0.577	0.470
Right hand shape index	0.0587	−0.001	0.245	0.993
Left hand shape index	−0.1242	0.018	0.014	0.756

This difference in results could be because of the less number of left handed subjects taken in the present study (Table 17).

When correlation between Geschwind score (laterality score) and hand parameters was examined, the values were found to be insignificant in Haryanvi Brahmins. This is in contradiction with the study of Kulkasiz & Gozil[5] where correlation was found to be significant in case of left hand shape index (Table 18).

7. Conclusion

1. A baseline data on hand anthropometry has been established in males and females of Haryanvi Brahmins which will be helpful to anthropologists and forensic experts in cases of mass disasters for personal identification.
2. Since the mean values of hand parameters were significantly different between males and females, right handers and left handers, hence the hand tools should be designed separately to fit the males and females Haryanvi Brahmins.
3. Since majority of the subjects use their right hand, it is usually found to be shorter and noticeably wider than the left hand irrespective of handedness of an individual.
4. Males usually have broader and coarser hands as compared to females. In Haryanvi Brahmins this is true for both the right and left hands. This suggests that environmental factors are also influential in hand anthropometric measurements.
5. Hand breadth and shape index were found to be greater in the right hand in strong and weak right hand preference groups in Haryanvi Brahmins.
6. No significant difference in hand parameter values on right and left hand were obtained among ambidextrous subjects except in case of hand breadth in Haryanvi Brahmins.
7. Left hand preference groups displayed irregular and heterogenous characteristics with regard to hand parameters.
8. Between laterality score and hand parameters, no specific hand measurements were found to be indicators of hand preference in Haryanvi Brahmins.
9. This study has succeeded in establishing standard values of hand dimensions for various ethnic groups of Haryana state of India which will not only serve as a useful tool in forensic investigation and clinical practice, but also relevant to ergo-design applications of hand tools and devices for industries of the state.

Conflicts of interest

All authors have none to declare.

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