

# A preliminary report on hand preference with hand length, hand breadth and shape indices and its role in sexual dimorphism

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## Abstract

The hand is the most used and versatile part of body is of great scientific importance to investigators in the field of anthropometry, forensic pathology, orthopedic surgery and ergonomics. The aim of the present study is to provide an authentic data database on right and left hand length, hand breadth and hand shape indices of two different ethnic groups of a particular age and sex. And study its correlation with handedness and sexual dimorphism. The study was conducted on 300 Haryanvi Brahmins (150 each of either sex) and Kashmiri Pandits (150 each of either sex) of age group 18 year and above. The values for hand-length, hand breadth and hand shape indices were calculated for both the hands. Hand preference was established according to Edinburg inventory and five hand-preference determination groups were constituted after calculation of laterality score. The result were tabulated and subjected to statistical analyses. Mean values for hand-length handbreadth and hand shape indices in males are more, when assessed by sex. These values were found statistically significant ( $p \leq 0.01$ ). when relationship between laterality score (indicator of hand preference) and hand-length, handbreadth, and shape indices were examined, the values were found to be positively correlated for right hand-length, left hand-length, left shape index but the correlation was no statistically significant. Laterality score was negatively correlated with right hand breadth, left hand breadth and right shape index in Haryanvi Brahmins where as in Kashmiri Pandits it was positively correlated with right hand length, left hand length and left hand shape index. But the correlation was statistically significant in case of right hand breadth ( $p \leq 0.01$ ) and right shape index ( $p \leq 0.01$ ).

**Keywords:** Hand length, hand breadth, hand index, sexual dimorphism, hand preference.

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## INTRODUCTION

Increasing frequency of mass disasters' like tsunamis, plane crashes, earthquakes, genocides etc. has created problems in the determination of stature and identification of victims when only fragmented or dismembered human remains are available for investigations (Shahnaz Choudhary *et al.* 2014)<sup>1</sup>, (Dayal MR *et al.* 2008)<sup>2</sup>, (Krishan *et al.* 2008)<sup>3</sup>, (Barnabas D *et al.* 2008)<sup>4</sup> (Jasuja OP *et al.* 2004)<sup>5</sup>. In such cases the forensic experts has no choice but to use relatively less precise method of

reconstruction i.e. the mathematical method which is workable even if a part of body is available (Bhavna and Nath S, 2007)<sup>6</sup>. For past many years scientists, anatomists and anthropologists have laid focus on dimensional relativity between various body segments (Abdel Malik AK *et al.* 1990)<sup>7</sup>, (Bhatnagar DP. *et al.* 1984)<sup>8</sup> Accurate sexing of the remains primarily narrows down the pool of possible victim matches. Determination of race sex, age and stature remains the foremost criteria in establishing population-specific data based on anthropometric measurements in various population groups. Extensive work has been carried out by different researchers to estimates the stature from different hand measurements, and small bones of the hands (Jasuja OP and Singh G *et al.* 2004)<sup>5</sup>. Although researchers have attempted sex determination from small bones of the hands (Scyheuer and Elkington)<sup>9</sup> few systematic studies are available on determination of sex from the hand dimensions (Williams *et al.*, 2000)<sup>10</sup>. The hand length, hand breadth, hand shape index and other hand dimensions are sexually dimorphic marker (Kanchan *et al.* 2008)<sup>11</sup>. it is influence by prenatal

estrogen and testosterone levels. High prenatal levels of androgens (high testosterone/estrogen) which may have an early organizing effect on strength in men, and is likely to be widespread in human groups (fink *et al*)<sup>12</sup>. Hox A and Hox D genes are responsible for both Gonadal and digital differentiation (Kanchan *et al.* 2008)<sup>11</sup>. Left handedness is associated with high levels of androgens. High intrauterine levels of testosterone impede the growth of certain regions of the left hemisphere which leads to right hemisphere language dominance and increase in left handedness. The aim of the present study is to provide a database on right and left hand length, hand breadth and hand hand-shape indices of both the hands.

### MATERIAL AND METHODS

The present study was conducted on 300 subjects of Haryanvi population (150 of either sex) and 300 subjects of Jammu and Kashmir population (150 of either sex) of age 18 years and above. The subjects belonged to the Brahmin community of the state of Haryana in Northern India and the Pandit community of Kashmir of the state of Jammu and Kashmir in Northern India. Prior informed consent of the 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 Edinburge inventory, which evaluates the direction and degree of hand preference (Oldfield RC *et al.*1971)<sup>13</sup>. Subjects were asked 10 questions dealing with their hand preferences in: 1) writing 2) drawing 3) throwing balls 4) knife without fork 7) spoon 8) Broom 9) Lightening matches and 10) Opening boxes. Subjects were asked to put a “+” in the column associated with the hand they were used to carry out activity. They were asked to put “+” in the associated

column if their preference for one hand was strong; and to put a “+” in both the columns if they are using both hand equally. A “++” in the right column was signed by 10 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.  $-100 \leq$  Geschwind score  $\leq +100$  (right hand preference decreases and left hand preference increases going from +100 to -100). Hand preference (table 1) was evaluated in 5 groups depending on the values of the Geschwind laterality score (Tan U, 1998)<sup>14</sup>. Hand length is defined as the distance between the midpoint of the distal wrist crease and the most anterior projecting point i.e. tip of the third digit (Pheasant S, 1990)<sup>15</sup>. Hand breadth is the distance between the outside projections of the ends of second and fifth metacarpals of the hand, with fingers extended and together (Pheasant S, 1990)<sup>15</sup>. Shape index is hand breadth multiplied by hundred and divided by hand length (Napier J, 1990)<sup>16</sup>. The measurements were taken from both hands from palmer side with digits fully stretched touching a flat hard surface and 2<sup>nd</sup> to 5<sup>th</sup> digits adducted with the thumb slightly extended. A digital sliding caliper (300 mm) was used to take all the measurements. All the data obtained were recorded, tabulated and subjected to statistical analysis using SPSS 13 PC + PROGRAM. The sexual differences in the hand-length, hand breadth and shape index of the hand in two ethnic groups and hand were evaluated by an unpaired t test. The right-left differences in the hand length, hand breadth and hand shape index in each sex and ethnic group were evaluated by an unpaired t-test. The differences of laterality in hand length, hand breadth and hand shape index taking into account the hand preference were evaluated by paired student t-test. The correlation between the hand preference and the hand length, hand breadth and hand shape index were evaluated by Spearmann correlation analysis.



Figure 1: Measurement of the hand-length

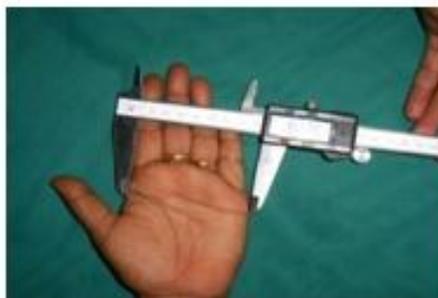


Figure 2: Measurement of the hand-breadth

**Table 1:** Determination of hand preference by direction and degree by Geschwind score

Hand Preference	Geschwind score	
	Minimum value	Maximum value
<b>Right hand</b>		
Strong	+80	+100
Weak	+20	+75
Ambidextrous	-15	+15
<b>Left hand</b>		
Weak	-75	-20
Strong	-100	-80

**Table 2:** Distribution of subjects by hand preference and sex in Haryanvi Brahmins

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
<b>Total</b>	<b>150</b>	<b>100</b>	<b>150</b>	<b>100</b>	<b>300</b>	<b>100</b>

**Table 3:** Distribution of subjects by hand preference and sex in Kashmiri Pandits

Hand Preference	Male (n)	Percentage (%)	Female (n)	Percentage (%)	Total (n)	Total (%)
Strong right	131	87.33	115	76.67	246	82
Weak right	13	8.67	24	16	37	12.33
Ambidextrous	2	1.33	7	4.67	2	0.67
Weak left	1	0.6	1	0.67	2	0.67
Strong left	5	3.3	3	2	8	2.67
<b>Total</b>	<b>150</b>	<b>100</b>	<b>150</b>	<b>100</b>	<b>300</b>	<b>100</b>

**Table 4:** Interpretation of defining values of the hand length, hand breadth and hand shape index by sex, hand and ethnic group

	Hand Parameter	Male	Female	p-value
<b>Haryanvi Brahmins</b>	Right hand length	186.69±10.46	172.09±9.21	≤0.001
	Left hand length	188.08±11.60	172.69±9.42	≤0.001
	Right hand breadth	84.46±6.52	75.30±5.77	≤0.001
	Left hand breadth	82.21±6.58	74.25±6.32	≤0.001
	Right hand S.I	45.09±2.61	43.70±4.07	≤0.001
	Left hand S.I	43.83±2.66	42.89±2.87	≤0.01
<b>Kashmiri Pandits</b>	Right hand length	181.79±8.92	170.84±9.57	≤0.001
	Left hand length	182.63±9.15	170.70±12.00	≤0.001
	Right hand breadth	82.99±5.44	75.82±6.23	≤0.001
	Left hand breadth	81.25±4.99	74.94±10.09	≤0.001
	Right hand S.I	43.05±1.65	43.32±2.06	≤0.001
	Left hand S.I	44.05±2.55	43.15±2.13	≤0.001

**Table 5:** Significance of right-left differences by sex in each ethnic group

	Right-left difference		p-value
	Haryanvi Brahmins	Female	
Hand Length	1.39±-1.14	-0.6±-0.21	≤0.001
Hand breadth	2.24±-0.06	1.05±-0.55	≤0.001
Hand S.I	1.26±-0.05	0.81±1.2	≤0.001
<b>Kashmiri Pandits</b>			
Hand Length	1.39±-1.14	0.14±-243	≤0.001
Hand breadth	1.74±-0.45	0.88±-3.80	≤0.001
Hand S.I	0.17±-0.07	-1.00±-0.9	≤0.001

**Table 6:** Right and left hand length, hand breadth and hand shape index in five groups evaluated by hand preference in Haryanvi Brahmins

Hand Preference		Right hand	Left hand	p-value
Strong right	Hand length	179.42±12.12	180.51±12.79	≤0.01
	Hand breadth	79.76±7.83	78.07±7.78	≤0.001
	Hand S.I	44.44±2.86	43.35±2.86	≤0.001
Weak right	Hand length	180.36±12.07	181.5±12.8	≤0.001
	Hand breadth	80.93±6.46	79.08±6.15	≤0.001
	Hand S.I	44.14±5.56	43.52±2.97	>0.05
Ambidextrous	Hand length	177.27±20.61	175.33±18.17	>0.05
	Hand breadth	73.30±11.29	72.03±11.29	≤0.001
	Hand S.I	42.40±2.30	42.50±2.01	>0.05
Weak left	Hand length	173.35±1.06	177.05±8.70	>0.05
	Hand breadth	75.80±3.82	75.9±1.13	>0.05
	Hand S.I	43.35±2.05	43.45±0.92	>0.05
Strong left	Hand length	173.87±17.34	170.51±20.37	>0.05
	Hand breadth	79.24±10.29	80.54±9.54	>0.05
	Hand S.I	45.61±3.80	42.73±2.11	>0.05

**Table 7:** Right and left hand length, hand breadth and hand shape index in five groups evaluated by hand preference in Kashmiri Pandits

Hand Preference		Right hand	Left hand	p-value
Strong right	Hand length	176.43±10.77	176.19±12.00	>0.05
	Hand breadth	79.85±7.05	78.38±9.08	≤0.01
	Hand S.I	45.07±7.05	42.98±1.72	≤0.01
Weak right	Hand length	176.39±11.39	177.70±12.65	≤0.05
	Hand breadth	77.93±6.05	77.37±5.86	≤0.05
	Hand S.I	44.20±2.47	43.49±2.39	≤0.05
Ambidextrous	Hand length	171.20±17.10	171.51±8.95	≤0.05
	Hand breadth	75.44±3.56	74.67±3.56	≤0.05
	Hand S.I	44.11±2.26	43.58±1.51	≤0.05
Weak left	Hand length	180.95±5.87	179.65±7.71	≤0.05
	Hand breadth	80.15±1.34	79.65±2.05	≤0.05
	Hand S.I	44.30±0.71	44.45±0.64	≤0.05
Strong left	Hand length	177.31±10.46	177.83±10.66	≤0.05
	Hand breadth	76.45±5.40	75.79±5.43	≤0.05
	Hand S.I	43.10±1.51	42.70±3.01	≤0.05

## RESULTS

The distribution of subjects by hand preference and sex in Haryanvi Brahmins and Kashmiri Pandits are shown in tables 2 and 3. Table 4 shows the sexual difference observed in each ethnic group and hand. The difference in values of Hand length, hand breadth and hand shape index in males and females were found to be highly significant in both the groups. When the right-left difference of hand length, hand breadth and hand shape index was interpreted by sex, it was found to be significant in both the ethnic groups (Table 5). When the groups formed by evaluation of hand preference were examined individually in Haryanvi Brahmins (Table 6), hand length, hand breadth and hand shape index in strong right handed individuals, mean value of hand breadth, shape index were higher on the right side and difference was statistically significant whereas the values of hand length was higher on left side and difference was also statistically significant. In weak right hand preference group, the values of hand breadth, 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 difference between right and left side was statistically significant in hand length. In ambidextrous individuals, the values of hand length, hand breadth were higher on the right side, but the difference was statistically significant only in hand breadth. The value of shape index was higher on left side and difference was statistically insignificant. The mean values of all the three parameters were higher on the left side and difference was not significant for weak left handed individuals. In strong left handed individuals, the mean values of hand length, shape index were higher on the right side. But difference was statistically significant only in hand length. When the groups formed by evaluation of hand preference were examined individually in Kashmiri Pandits (Table 7). Hand length, hand breadth and shape index were higher on right side, but the difference between right and left side was statistically significant only in hand breadth and

shape index. In weak right handed individuals, hand breadth and shape index were higher on the right but the difference was statistically insignificant whereas hand length mean value is higher on left side but difference was statistically significant only in hand length. In ambidextrous individuals, the values of hand breadth and shape index were higher on right but the difference was statistically insignificant where as the value of hand length is higher on the left side, but the difference was statistically insignificant. In weak left handed subjects,

the values of hand length and hand breadth were higher on the right side, but the difference was statistically insignificant whereas value of shape index was higher on the left side but difference was statistically insignificant. In strong left handed subjects, mean values of hand breadth, shape index were higher on the right side, but the difference was not statistically significant where as the mean value of hand length was higher on left but the difference was insignificant.

**Table 8** Relationship between Geschwind score and hand length, hand breadth, and hand shape index (Spearman correlation coefficient analysis) in both ethnic groups

Ethnic group	Parameters	Spearman correlation coefficient	Coefficient of significance
Haryanvi	Right hand length	0.015	0.793
Brahmins	Left hand length	0.017	0.769
Kashmiri	Right hand Length	0.074	0.199
Pandits	Left hand length	0.075	0.194
Haryanvi	Right hand breadth	-0.023	0.692
Brahmins	Left hand breadth	-0.042	0.470
Kashmiri	Right hand breadth	0.157	0.007
Pandits	Left hand breadth	0.095	0.101
Haryanvi	Right hand S.I	-0.001	0.993
Brahmins	Left hand S.I	0.018	0.756
Kashmiri	Right hand S.I	0.151	0.009
Pandits	Left hand S.I	0.031	0.589

When the relationship between Geschwind score (laterality score) and hand length, hand breadth and hand shape index were examined in both the ethnic groups (Table 8) by spearman correlation coefficient analysis indicate that laterality score was positively correlated with right and length 0.015, left hand length 0.017, left shape index 0.018, but the correlation was not statistically significant whereas it was negatively correlated with right hand breadth 0.023, left hand breadth -0.42, right shape index -0.001, in Haryanvi Brahmins. Whereas the laterality score was positively correlated with hand length 0.074, left hand length 0.075, left hand breadth 0.157, left hand shape index 0.031. But the correlation was statistically significant in case of hand breadth  $p \leq 0.01$  and right hand shape index  $\leq 0.01$ . for Kashmiri Pandits.

## 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 ( Malina RM

*et al.*1984)<sup>17</sup> 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 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 (Kar SK, *et al.*2003)<sup>18</sup>. The present study was done to provide a database for hand anthropometry in two different endogamous groups and study its correlation with hand preference. 600 subjects were included in the study out of which 300 were Haryanvi Brahmins (150 of either sex) and 300 were Kashmiri Pandits (150 of either sex). Eight hand measurements were taken and hand preference was determined using Edinburgh inventory. Questionnaires of hand preference are frequently used to identify handedness groups because<sup>1</sup> they are easier to administer than behavioral measures and<sup>2</sup> they provide the basis for assignment of individuals to handedness groups. (Corey Dm, Hurly Mm *et al.*2001)<sup>19</sup>. The data was recorded, tabulated and subjected to statistical analysis. The readings were compared with the previously published data.

**Table 9:** Comparative evaluation of hand length in males and in females

Author	Population	Males		Females		P value
		Right	Left	Right	Left	
Kulaksiz and Gozil <sup>20</sup>	Ankara (Turkey)	186.92±8.31	187.34±8.10	171.19±7.64	171.44±7.65	<0.001
Kar <i>et al</i> <sup>18</sup>	West Bengal	175.1±8.5	175.9±8.8	160.9±7.0	160.6±7.5	<0.001
Oomen <i>Et al</i> <sup>21</sup>	Karnataka	190.60±7.30	190.62±7.10	173.28±8.90	172.46±8.70	<0.001
Agnihotri <i>et al</i> <sup>22</sup>	Mauritius	188.91±8.80	189.00±8.70	172.20±9.20	172.20±9.30	<0.001
Krishan and Sharma <sup>23</sup>	Himachal Pradesh (Rajputs)	182.4±9.00	182.1±9.1	168.3 ± 8.00	168.00±8.30	<0.001
Danborno and Elukpo <sup>23</sup>	Zaria, Nigeria	198.5±8.60	199.30±9.30	185.10±6.60	185.21±7.70	≤0.001
Ibeachu <i>et al</i> <sup>25</sup>	University of Port Harcourt Nigeria	190.2±0.8	190.9±0.7	176.2±0.7	176.9±0.7	<0.001
Krishan <i>et al</i> <sup>26</sup>	Himachal Pradesh	182.70±9.00	182.10±9.00	168.10±8.00	167.70±8.00	≤0.001

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±9.21 on right side and 172.69±9.42 on left side. In Kashmiri Pandits, the mean hand length values in males were 181.79±8.92 on right side and 183.63±9.15 on left side and in females it was 170.84±9.57 on right side and 170.70±12.00 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 in both the endogamous groups. This is in agreement with the studies done by Kulaksiz and Gozil<sup>20</sup>, Kar *et al*<sup>18</sup>, Oomen *et al*<sup>21</sup> (in males), Agnihotri *et al*<sup>22</sup>, Krishan and Sharma<sup>23</sup>, Danborno and Elukpo<sup>24</sup>, Ibeachu *et al*<sup>25</sup>, Krishan *et*

*al*<sup>26</sup> (Table 9). In the present study, values of mean hand length were found to be higher on the left side in males of Haryanvi Brahmins and Kashmiri Pandits which is in agreement with the studies of Kulaksiz and Gozil<sup>20</sup> and Danborno and Elukpo<sup>24</sup> and in contradiction to the study of Krishan and Sharma<sup>23</sup>. 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<sup>20</sup>, Oomen *et al*<sup>21</sup>, Danborno and Elukpo<sup>24</sup> and Ibeachu *et al*<sup>25</sup>. In Kashmiri Pandits females, the values were the values were slightly more on the right side which is in consonance with the studies done by Kar *et al*<sup>18</sup>, Oomen *et al*<sup>21</sup>, Krishan and Sharma<sup>23</sup> (Table 9).

**Table 10:** Comparative evaluation of hand breadth in males and in females

Author	Population	Males		Females		p value
		Right	Left	Right	Left	
Kulaksiz and Gozil (2002) <sup>20</sup>	Ankara (Turkey)	85.54±3.99	84.61±4.31	76.61±4.12	75.64±3.93	<0.001
Kar <i>et al</i> <sup>18</sup>	West Bengal	82.3±0.44	80.3±0.41	73.0±0.35	70.7±0.35	≤0.001
Agnihotri <i>et al</i> (2006) <sup>22</sup>	Mauritius	84.50±4.00	84.20±4.00	74.8±3.8	74.2±3.7	<0.001
Danborno and Elukpo (2009) <sup>24</sup>	Zaria, Nigeria	89.00±9.50	86.80±9.20	78.20±4.90	77.20±4.60	<0.001
Krishan <i>et al</i> (2011) <sup>26</sup>	Himachal Pradesh (Rajputs)	82.30±3.90	80.90±4.30	74.00±4.20	72.90±4.30	<0.001
Ibeachu <i>et al</i> (2011) <sup>25</sup>	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
	Kashmiri Pandits	82.99±5.44	81.25±4.99	75.82±6.23	74.94±10.09	≤0.001

In Haryanvi 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. In Kashmiri Pandits, the mean hand breadth values in males were 82.99±5.44 on right side and 81.25±4.99 on left side and in females it was 75.82±6.23 on right side and 74.94±10.09 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 in both the

endogamous groups (Table 6.2). This is in agreement with the studies done by Kulaksiz and Gozil<sup>20</sup>, Kar *et al*<sup>18</sup>, Agnihotri *et al*<sup>22</sup>, Danborno and Elukpo<sup>24</sup>, Ibeachu *et al*<sup>25</sup>, Krishan *et al*<sup>26</sup>. 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 as well as in Kashmiri Pandits. These results coincided with the studies done by Kulaksiz and Gozil<sup>20</sup>, Kar *et al*<sup>18</sup>, Agnihotri *et al*<sup>22</sup>, Danborno and Elukpo<sup>24</sup>, Ibeachu *et al*<sup>25</sup>, Krishan *et al*<sup>26</sup> (Table 10).

**Table 11:** Comparative evaluation of hand shape index in males and in females

Author	Population	Males		Females		P value
		Right	Left	Right	Left	
Kulaksiz and Gozil <sup>20</sup>	Ankara (Turkey)	45.80±1.88	45.19±2.03	44.78±2.08	44.15±1.99	<0.001
Danborno and Elukpo <sup>24</sup>	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
	Kashmiri Pandits	43.05±1.65	44.05±2.55	43.32±2.06	43.15±2.13	≤0.001

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. In Kashmiri Pandits, the mean hand length values in males were 43.05±1.65 on right side and 44.05±2.55 on left side and in females it was 43.32±2.06 on right side and 43.15±2.13 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 sides in both the endogamous groups which coincided with the studies done by Kulaksiz and Gozil<sup>20</sup> and Danborno and Elukpo<sup>24</sup> (Table 11). 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<sup>20</sup> and Danborno and Elukpo<sup>24</sup>. But in Kashmiri Pandits, values of shape index were more in the left hand in males and in the right hand in females (Table 11).

## CONCLUSION

In present study, hand breadth was significantly greater in right hand as compared to the left in both the endogamous groups. This indicates right handed individuals have broader right hand when compared to left. Whereas hand length was more in left hand as compared to right in Haryanvi Brahmins and Kashmiri Pandits indicating that activity has little effect on hand length. (table5) Shape index was higher in men indicating that Haryanvi Brahmin females possess more delicate and narrower hands as compared to males who have coarser and broader hands. In Kashmiri Pandits, left shape index was higher in men whereas right shape index was higher in women indicating that Kashmiri Pandits males have wider and coarse left hand whereas females have narrower and delicate left hand (table 7). All the parameters were found to be sexually dimorphic in both the ethnic groups (table 5). On comparing the right hand parameters in Haryanvi Brahmins and Kashmiri Pandits It is concluded that right hand length was significantly higher in Haryanvi Brahmins. When left hand was compared in both the endogamous groups, the left hand length was found significantly higher in Haryanvi Brahmins. Hand preference wise investigation of all the five groups in both the ethnic groups shows that hand length was significantly greater in the left hand as compare with right in strong and weak right hand

groups(table6and7) whereas in left hand preference groups displayed irregular properties. In Kashmiri Pandits, there were no significant differences in right and left hand length values in various hand preference groups. In Haryanvi Brahmins, hand breadth was significantly higher on right side in strong and weak right handed as well as ambidextrous (table 6) individuals whereas in persons with left hand preference, hand breadth values were more in the left hand though the difference on the right and left side was not significant. In Kashmiri Pandits, hand breadth was significantly higher on the right side in strong right handed individuals (table 7) and in rest of the groups though the values were higher on the right side but the differences were insignificant on two sides. Shape index value were significantly higher on the right side in strong right hand preference groups in both Haryanvi Brahmins and Kashmiri Pandits (table 6and7) and weak right hand preference group, the values were more on the right hand preference groups in both the ethnic groups (table 5) and in weak right hand preference group, the values were more on right, but the difference between sides was insignificant. In left handed groups, the values were more in the left hand in weak left handed and in the right hand in strong left handed groups in both in Haryanvi Brahmins and in Kashmiri Pandits but the difference in values on the two sides were not significant. Thus hand preference has a potent influence on hand length, hand breadth, and shape index and environmental and genetic factors and anatomical asymmetry may play a role in determination of potency. Left-handed groups displayed irregular characteristics with regard to all the three parameters.

1. A baseline data on hand anthropometry has been established in males and females of two different endogamous groups (Haryanvi Brahmins and Kashmiri Pandits) which will be helpful to anthropologists and forensic experts in cases of mass disasters for personal identification.
2. The mean values of right and left hand lengths were significantly higher in Haryanvi Brahmins.
3. 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 in both the endogamous groups (Haryanvi Brahmins and Kashmiri Pandits).

4. Since majority of the subjects use their right hand, it is usually found to be shorter and noticeably wider than the left hand in both the endogamous groups irrespective of handedness of an individual.
5. Males usually have broader and coarser hands as compared to females. In Haryanvi Brahmins this is true for both the right and left hands whereas in Kashmiri Pandits this is true only for the left hands. This suggests that environmental factors are also influential in hand anthropometric measurements.
6. Hand breadth and shape index were found to be greater in the right hand disrespected to preference groups in Haryanvi Brahmins and Kashmiri Pandits.
7. 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.
8. Left hand preference groups displayed irregular and heterogeneous characteristics with regard to hand parameters.
9. When relationship between laterality score and hand parameters was examined the values for right hand breadth, right shape index, right and left were found to be indicators of hand preference in Kashmiri pundits only.

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