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Hand Index of the Male Khatris of Delhi (India)

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Abstract:

Human Hand act as a sensory and motor organ which is a versatile part of human body. Hand measurements are used in the fields of, forensic anthropology, bio-metrics, ergonomics, and reconstructive surgeries, mechanical studies and clinical practice. Many studies have been conducted to correlate hand index with the personality of the person and also to the predisposition to certain diseases. The main objective of this study was to classify Hand Index of the male Khatris. It was carried out on 160 apparently healthy male Khatris of age group 18-50yrs residing in Delhi. Sliding caliper was used to measure hand length (from interstylion to dactylion of middle finger) and hand breadth (from metacarpal radialis to metacarpal ulnare). Data was statistically analyzed and compared with that of other Indian populations as well as of the populations of other countries reported earlier. In this study hand lengths ranged from 15.20 cm to 22.10 cm (mean value =18.29±1.12) and hand breadth from 6.50 cm to 9.60 cm (mean value of 8.05 ± 0.49) .The mean hand Index of males belonging to Khatris was 44.13 falling in the category Mesocheir as per classification proposed by Martin and Seller (1957). It can be concluded that the male Khatris can be classified as Mesocheir who have long fingers with short palm. The morphological characteristic of hand belonging to any category depends on gender, ethnicity, socio-cultural domain, environment & genetic factors which differ from region to region. These studies greatly help in forming human anthropometric Atlas useful in the fields of criminal investigation and evolutionary studies. Hand dimensions are also useful in the identification of mutilated remains in disaster cases, in tracing the ethnicity and geographical origin of the person.

Keywords: *Hand Index, Ergonomics, Human Identification, Criminal investigation, Hand Classification, Mesocheir*

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Introduction

Being sensory as well as motor organ, human hand is a versatile part of the body which comprises 27 bones and 15 joints. Many studies have been carried out on the anthropometric dimensions of various body parts and also on hand dimensions. The study carried out by **Davies *et al.*, (1980)** measuring 28 hand landmarks on 92 Europeans and made a comparison of hand sizes with different ethnic groups and found that the hand dimensions of European females were significantly smaller than those of their West Indian counterparts. **Imrhan *et al.*, (1993)** studied the hand dimensions of Americans of Vietnamese origin, Bangladeshi males and compared with those of Mexican males (**Imrhan *et al.*, 2006)** and concluded that hand dimensions of Bangladeshi men were significantly smaller than the Mexican men.
Similarly, the study was carried out by **Mandahawi *et al.*, (2008)** on hand anthropometric among 235 Jordanian populations and compared with other populations viz Bangladeshis, Nigerians, Vietnamese Americans, Hong Kong, Chinese, United Kingdom residents, Americans, and Mexicans. The results showed significant differences between Jordanians and the other populations. Therefore, it can be inferred that the anthropometric dimensions vary across gender, race, and ethnic groups and also within a particular group due to environment, nutrition, physique & nature of work.

Anthropometric study of hand dimensions play a pivotal role in criminal investigations, biometrics, ergonomics, reconstructive surgeries, mechanical studies, clinical practice personality assessment and in the identification of mutilated remains
Various indices have been formulated and assessed to determine the race and sex of an individual such as cephalic index, facial index, mandibular canine index and hand index**.**

Chandra *et al.*, 2015 carried out a study for estimating hand index for male industrial workers for the designing of hand tools and equipments.

Based upon hand index (**Martin and Saller, 1957)** classified shape of the individual hand into five categories viz Hyperdolichocheir, Dolichocheir, Mesocheir, Brachycheir, and Hyperbrachycheir.

Methodology

Subjects

The study was conducted on 160 healthy male Khatris selected randomly from the age group of 18 – 50 years from Delhi, India. The volunteers with any kind of deformity in hand was excluded from the study. All the subjects were informed about the study design, measurements and privacy of data collected. Consent was taken from each subject before obtaining measurements.
All of the data were analyzed using SPSS v23. Descriptive statistics (including the mean and standard deviation) for the value of each hand dimensions were calculated and depicted in tables.

Anthropometric Measurements

- Hand Length (HL) = It is a straight distance from interstylion (isty) to dactylion (daIII) of the middle finger.
- Hand Breadth (HB) = It is a straight distance from metacarpal radialis (mr) to metacarpal ulnare (mu) as depicted in figures.

Figure No. 1: Hand measurements using Sliding Calliper

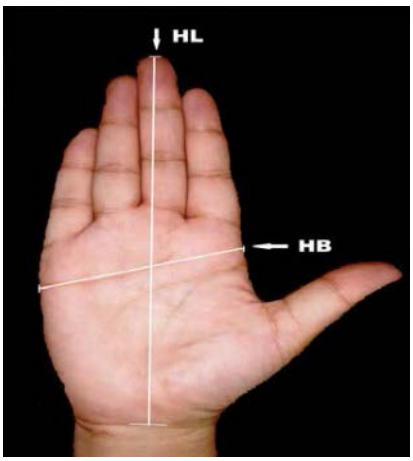

Figure No. 2: Human hand illustrating anthropometric measurements; Hand Length (HL) and Hand Breadth (HB).

Techniques for Obtaining Measurements

Standard anthropometric technique and landmark given by **(Vallois, 1965; Martin & Saller, 1957)** was followed for obtaining measurements. A sliding caliper was used for anthropometric measurements.

Subjects were asked to wash their hands with soap & water, made to sit in a relaxed state on the chair, asked to place their hand straight on a flat surface on the table

in front of them. Hand length and hand breadth were taken using a sliding caliper. All the measurements were repeated thrice and the mean value was taken for statistical analysis. The measurements were taken during the time period 9.00 – 12.00 to eliminate diurnal variations and uniformly by one investigator in the same way and under the same conditions to avoid any error.

Hand Index

Hand index is the percentage variation between the hand breadths to the hand length. It can also be defined as a measure to describe the shape of the hand.

According to **Martin and Saller, (1957)** it can be classified into five types which are as follows:

1. Hyperdolichocheir (hdch) hands have very long fingers and narrow smaller palm
2. Dolichocheir (dch) hands have long fingers and narrow small palm
3. Mesocheir (mch) hands have long fingers but short small palm
4. Brachycheri (bch) hands have short fingers and long large palm.
5. Hyperbrachycheir (hbch) hands have short fingers with broader large palm

Hand index was calculated from hand dimensions using the formulae:

$$\textbf{Hand Index} = \frac{Hand\ breadth\ (mr-mu)}{Hand\ length\ (sty-da)} \times 100$$

The values of hand index were used to determine hand types. Based on the hand index, the hand phenotype was classified as shown in Table I

Table No. 1: Hand Classification according to Martin & Saller (1957).

S.No.	Hand Index	Hand Classification
1.	≤ 40.9	Hyperdolichocheir (hdch)
2.	41.0 – 43.9	Dolichocheir (dch)
3.	44.0 – 46.9	Mesocheir (mch)
4.	47.0 – 49.9	Brachycheir (bch)
5.	≥ 50.0	Hyperbrachycheir (hbch)

Results and Discussion

This research provides important new information regarding the hand index, hand shape and hand phenotype in the population of Delhi, India. All the measurements were expressed in centimetres. The data obtained from measurement were computed and analysed using SPSS (Statistical Package for Social Sciences, version 23.0) computer software.

Table No. 2: Descriptive Statistics of Hand Measurements

Parameter	Mean (cm)	Standard deviation	Mini. (cm)	Maxi. cm)
Hand Length	**18.29**	**1.12**	**15.20**	**22.10**
Hand Breadth	**8.05**	**0.49**	**6.50**	**9.60**

The average hand length for the Khatris population was 18.29 ± 1.12 and the average hand breadth was 8.05 ± 0.49 of Delhi state, while the average hand index of hand for physically fit males was 44.13. It belongs to Mesocheir (mch) group whose have longer fingers with short and small palm.

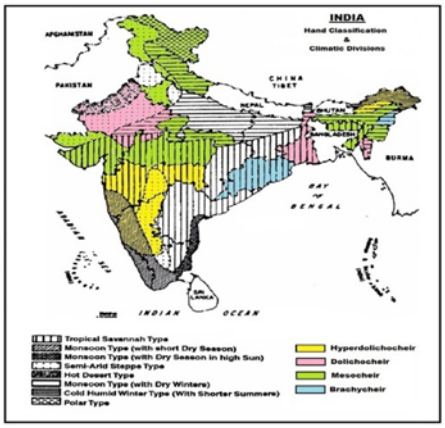

Figure No. 3: Represents State Wise Hand Classification and Climatic divisions of India.

On viewing the map of India, it can be inferred that the northern states predominated by Mesocheir group of hands whereas southern states shows Hyperdolichocheir category. There is a mix combination of Dolichocheir & Mesocheir and Dolichocheir & Brachycheir respectively (Figure 3) in Eastern and western states. Studies were carried out to observe the correlative effect of climate divisions of India with the hand categories. It has been observed that the different types of hand categories when superimposed on the climatic divisions of India as depicted by **(Bhasin & Bhasin, 2002)** shows that the Hyperdolichocheir hand classification coincides with

cold humid winter type (with shorter summers), Monsoon type (with dry winters), Monsoon type (with short dry season), Tropical savannah type and Semi-Arid steppe type; Dolichocheir category correlates with Hot dessert type, Semi-Arid steppe type, Monsoon type (with dry winters) and Tropical savannah type; Mesocheir correlates with Polar type, Monsoon type (with dry winters), Tropical savannah type and Semi-Arid steppe type; and similarly, Brachycheir coincides with the Monsoon type (with dry winters) and Tropical savannah type.

Therefore, the cold climate generally favors Mesocheir hand classification whereas hot climatic is directly correlate to Dolichocheir hand. So, it can be deduced that along with environmental and climatic condition, many factors such as food habits, culture, occupation and lifestyle do play a role in the morphological dimensions of hand. It is suggested that more research are needed to throw light on the hand categories with the climatic patterns which will help in identify the adaptive identification of the population.

Table No. 3: Comparison of Hand Index within Different States of India

hdch = Hyperdolichocheir heir, dch = Dolichocheir, mch = Mesocheir, bch = Brachycheir

S. No.	States	Hand Index	Classification
1.	Present Study (Delhi)	44.13	mch
2.	Arunachal Pradesh	41.81	dch
3.	Assam	46.60	mch
4.	Gujarat	48.92	bch
5.	Haryana	45.19	mch
6.	Himachal Pradesh	44.51	mch
7.	Jammu & Kashmir	45.65	mch
8.	Karnataka	40.70	hdch
9.	Madhya Pradesh	44.62	mch
10.	Maharashtra	39.78	hdch
11.	Manipur	46.38	mch
12.	Meghalaya	46.15	mch
13.	Mizoram	43.60	dch
14.	Nagaland	49.73	bch
15.	Odisha	49.69	bch
16.	Tripura	45.26	mch
17.	Uttarakhand	44.23	mch
18.	West Bengal	43.75	dch
19.	Rajasthan	42.90	dch

On comparing the hand index with populations of 18 different states of India indicates that the Indian population belongs to any category of hand index except Hyperbrachycheir. Male population of 2 states (Karnataka & Maharashtra) belongs to Hyperdolichocheir hand classification, Rajasthan, Arunachal Pradesh, Mizoram & West Bengal belongs to Dolichocheir, Assam, Haryana, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Manipur, Meghalaya Tripura & Uttarakhand and Delhi belongs to Mesocheir hand classification whereas Gujarat, Nagaland & Odisha belongs to Brachycheir hand classification.

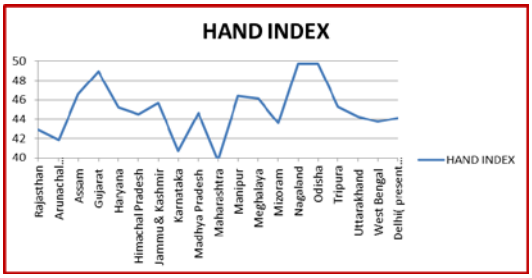

Figure No. 4: Variation of Hand Index among Male Population of Various States

Table No. 4: Comparison of Hand Index among Countries of the World

Dolichocheir(dch), Mesocheir(mch), Brachycheir(bch), Hyperbrachycheir(hbch)

S.No.	Countries	Hand Index (Male)	Hand Classification
1.	India (present study)	44.13	mch
2.	Algeria	52.06	hbch
3.	Australia	46.57	mch
4.	Bangladesh	46.03	mch
5.	China	46.93	mch
6.	Egypt	45.65	mch
7.	France	45.75	mch
8.	Iran	56.04	hbch
9.	Jordan	45.87	mch
10.	Korea	46.90	mch
11.	Mauriatus	44.44	mch
12.	Mexico	45.98	mch
13.	Malaysia	51.71	hbch
14.	Netherland	45.11	mch
15.	Nigeria	43.68	mch
16.	Norway	44.10	mch
17.	Philippine	49.62	bch
18.	Saudi Arabia	56.04	hbch
19.	Sri Lanka	55.47	hbch
20.	Slovakia	45.35	mch
21.	Sweden	45.34	mch
22.	Thailand	46.50	mch
23.	Turkey	45.95	mch
24.	USA	47.45	bch
25.	Vietnam	44.75	mch
26.	West Indies	44.56	mch

Further comparison of hand index of the male population of Delhi was performed with male populations of 25 other countries across the globe as depicted in Table IV. It indicates that the male population of 25 other countries do not have the hand index category of Hyperdolichocheir and Dolichocheir. However, Delhi which is representative of India exhibit Mesocheir category of hands that is long fingers with short and small palm. On comparing with the Indian population, foreign countries show the existence of Hyperbrachycheir that is broader large palm but short fingers. There is significant variation in hand shape in various geographical zones. This shows that morphological characteristics of hand depend on many factors such as gender, ethnicity, socio-cultural domain, environment & genetic factors. From many research, it is believed that hereditary factors primarily affect the hand shape and then the environment plays a secondary role. This comparative data of hand index can help to determine the resident place of an unknown individual.

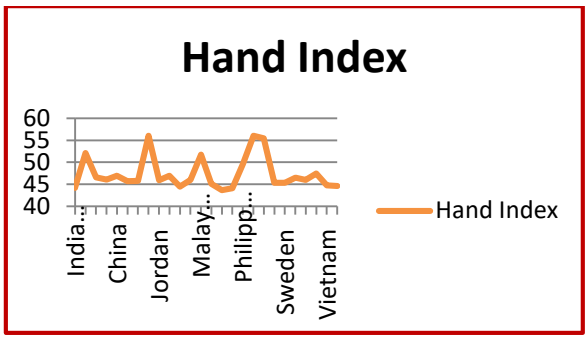

Figure No. 5: Variation of Hand Index among Male Population of Various Countries

The variations in hand anthropometry can be attributed to the population and ethnic differences between the study population and the other earlier studies in this domain. Population differences in anthropological studies have been noted and it is well realized that they need to be studied separately and in depth also to find out conclusive findings. Earlier studies have observed that various hand measurements tend to differ in various ethnic groups. However, owing to variability of dimensions according to the build of a person, individual hand parameters are not always reliable nation discriminators. The nation difference in the ratios of these parameters is independent of the body size, as the ratios are not significantly related to height and age.

Conclusion

This study deciphers a comparative hand anthropometric data (length, breadth, and index) for Indians. It is well established by many research that body size has an effect on individual parameters such as the linear dimensions of the body; they are not always reliable or accurate predictor of identification however ratios of these linear dimensions are not significantly related to height and age thus are independent of body size and thus provide better results.

Hand index obtained in the research study can be used in the population study and anthropological research. It has great application and implication in the forensic area for criminal identification. DNA technology to some greater extent has resolved the problem of identification by evaluating the genetic information from the unknown individual's cell and it gives the most reliable results. But DNA technology has its cons with respect to cost-effectiveness, skilled workers and availability of required machine in laboratories. Hence, this study has succeeded in establishing standard values of hand index which will serve as a useful tool in forensic domain. The data collected during this study can also be utilized in ergonomics to design products and interfaces or hand tools that will increase user satisfaction and comfort which eventually results in enhancing the productivity.

On comparing hand index with populations of 17 different states of India, it indicates that the Indian population belongs to any category of hand index except Hyperbrachycheir.

The northern states are predominated belong to Mesocheir group of hands whereas southern states shows Hyperdolichocheir category. Eastern and western states show a mix combination of Dolichocheir & Mesocheir and Dolichocheir & Brachycheir respectively. On correlating the hand categories with the climatic divisions of India it is revealed that cold climate area generally favors Mesocheir hand classification whereas hot climatic area belongs Dolichocheir hand classification. However, more studies are needed in this direction to validate its implication and applicability. It can be concluded that the Khatris male population of Delhi belongs to Mesocheir with hand index 44.13.

When comparing the hand index with male populations of 25 other countries across the globe it indicates that they do not have hand index category of Hyperdolichocheir and Dolichocheir. As compare to the Indian population, foreign countries show the existence of Hyperbrachycheir that is broader large palm but short fingers. Thus, it can be concluded that there is significant variation in hand shape in various geographical zones. However, the cause for these differences has not been thoroughly investigated. There are many authors who suggest for the further study with larger sample size and with increased number of hand variables for better accuracy and reliability keeping in mind the future dynamics of research. Therefore it can be concluded that in India male population of Delhi belongs to Mesocheir with hand index 44.13. The findings could be utilized by hand tools designers over countries to design fitted hand tools or equipment for workers from different nationalities.

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