

Distribution and Inheritance of Selected Morpho-genetic Traits

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ABSTRACT The present study has been carried out to determine the inheritance and distribution of various morpho-genetic traits on 100 families of Panchkula (Haryana) comprising of 100 fathers and 100 mothers and their 255 children. Out of 255 children examined, 110 are sons and 145 daughters. The twelve morpho-genetic and behavioural traits studied include ear lobe attachment, tongue rolling, tongue folding, arm folding, hand clasping, handedness, thumb flexibility, mid phalangeal hair, digital hair, length of index finger relative to ring finger, length of second toe relative to great toe and iris colour. The results of the present study indicate that in majority of the traits there is greater influence of fathers on sons and mothers on daughters as regards to mode of inheritance and this has been found to be statistically significant. A comparison with the available studies on neighbouring populations for distribution of these traits have been made with fathers and mothers of the present study.

INTRODUCTION

According to Boyd 1950, various behavioural and morphological characters can be utilised profitably to investigate genetic variation within and among human populations, though the mode of inheritance of all these characters is still rather unclear. Since the morphological traits are a typical example of polygenic inheritance controlled by multiple genes, environment and their interaction, hence the inheritance of such traits is complicated and till today we are failing to reach a common agreement in establishing their heritability.

There had been a number of studies on the incidence of morpho-genetic traits reporting human variation. Dutta and Ganguli (1965) and Malhotra and Kanhare (1976) also pointed out the effect of isolation and genetic drift, ethnic, social, hierarchial and micro-evolutionary influences on the occurrence of such traits.

The present study is an attempt to observe the incidence and to study the inheritance of selected morpho-genetic traits from family data.

MATERIAL AND METHODS

The present study has been conducted on 100 families of Panchkula (Haryana) near Chandigarh. The data are comprised of 455 individuals including 100 fathers, 100 mothers and their 255 children. Out of 255 children surveyed 110 were sons and 145 daughters. The fathers of the present study ranged between 24-55 years and mothers between 22-51 years of age. Selected twelve morpho-genetic traits were studied on these family members.

RESULTS AND DISCUSSION

The parents (100 fathers and 100 mothers) belonging to 100 families of the present study are considered as unrelated male and female individuals for the purposes of comparison with other neighbouring populations worked out for frequencies of various morpho-genetic and behavioural traits. However, the number of required populations available for comparison is limited and in some traits even missing.

A quick glance at table 1 depicts that males and females of the present study are showing almost similar pattern of distribution for Ear lobe attachment, Arm folding, Hand clasping and Handedness as is observed in neighbouring populations chosen for comparison.

For the trait, presence of mid-phalangeal hair, data is available on the male populations only and the present study males (64.0%) lie within the range. However, 28.0 percent females of the present study are also showing presence of mid-phalangeal hair. The males of the present study (13.0 and 45.0) are lying within the range for the traits - length of index finger $II > IV$ and tongue rolling (Rollers) respectively whereas the females are showing higher percentage (17.0 and 57.0 respectively) as compared to neighbouring populations. The trait tongue folding (folders) has been found much more frequently in the

Table 1: Frequencies of various morpho-genetic traits in selected neighbouring populations

Trait	Place	Population	Sex	No. Tested	Percentage	Author	
Ear Lobe Attachment (Attached)	Ludhiana	Jat Sikh	-	785	27.13	Kalia and Gupta, 1978	
		Brahmins	-	133	23.31	Kalia and Gupta, 1978	
		Khatri	-	191	17.28	Kalia and Gupta, 1978	
		Aroras	-	130	13.85	Kalia and Gupta, 1978	
		Vaishya	-	71	16.90	Kalia and Gupta, 1978	
		Miscellaneous	-	97	20.62	Kalia and Gupta, 1978	
	Karnal, Kurukshetra and Sonapat	Brahmins	M	100	60.00	Yadav et al., 1994	
			F	100	67.00	Yadav et al., 1994	
		Ambala, Yamunanagar, Karnal and Kurukshetra	Baniya	M	100	40.00	Yadav et al., 1994
				F	100	49.00	Yadav et al., 1994
		Lukhi (Distt. Kaithal)	Rajput	M	100	53.00	Yadav et al., 1994
				F	100	52.00	Yadav et al., 1994
	Mahendergarh, Jind, Hissar and Kurukshetra	Jat	M	182	38.46	Yadav et al., 1994	
			F	33	39.39	Yadav et al., 1994	
		Mahendergarh and Kurukshetra	Saini	M	146	20.55	Yadav et al., 1994
				F	52	21.15	Yadav et al., 1994
		Panchkula (Haryana)	Miscellaneous	M	100	36.00	Present Study
				F	100	29.00	Present Study
Tongue Folding (Folders)	Patiala	Khatri	M	100	4.00	Singh et al., 1979	
			F	130	3.85	Singh et al., 1979	
		Baniyas	M	86	3.49	Singh et al., 1979	
			F	109	4.60	Singh et al., 1979	
	Panchkula (Haryana)	Miscellaneous	M	100	31.00	Present Study	
			F	100	28.00	Present Study	
Tongue Rolling (Rollers)	Patiala	Khatri	M	100	47.00	Singh et al., 1979	
			F	130	52.30	Singh et al., 1979	
		Baniyas	M	86	48.84	Singh et al., 1979	
			F	109	52.29	Singh et al., 1979	
	Panchkula (Haryana)	Miscellaneous	M	100	45.00	Present Study	
			F	100	57.00	Present Study	
Arm Folding (Right Type)	Patiala	Khatri	M	100	54.00	Singh et al., 1979	
			F	130	47.69	Singh et al., 1979	
		Baniyas	M	86	31.40	Singh et al., 1979	
			F	109	35.78	Singh et al., 1979	
	Karnal, Kurukshetra and Sonapat	Brahmins	M	100	46.00	Yadav et al., 1994	
			F	100	60.00	Yadav et al., 1994	
		Ambala, Yamunanagar, Karnal and Kurukshetra	Baniya	M	100	51.00	Yadav et al., 1994
				F	100	56.00	Yadav et al., 1994
	Lukhi (Distt. Kaithal)	Rajput	M	100	40.00	Yadav et al., 1994	
			F	100	63.00	Yadav et al., 1994	
		Mahendergarh, Jind, Hissar and Kurukshetra	Jat	M	182	44.50	Yadav et al., 1994
				F	33	60.60	Yadav et al., 1994
	Mahendergarh and Kurukshetra	Saini	M	146	47.26	Yadav et al., 1994	
			F	52	42.31	Yadav et al., 1994	
		Panchkula (Haryana)	Miscellaneous	M	100	38.00	Present study
				F	100	33.00	Present study
Hand Clasping (Left Type)	Amritsar (City)	Jat	M	79	27.85	Bansal, 1968	
			F	48	37.50	Bansal, 1968	
		Khatri	M	48	27.30	Bansal, 1968	
			F	107	28.10	Bansal, 1968	
		Brahmins	M	26	30.70	Bansal, 1968	
			F	100	47.00	Yadav et al., 1994	
	Karnal, Kurukshetra and Sonapat	Brahmins	M	100	36.00	Yadav et al., 1994	
			F	100	35.00	Yadav et al., 1994	
	Ambala, Yamunanagar, Karnal and Kurukshetra	Bania	M	100	40.00	Yadav et al., 1994	
			F	100	40.00	Yadav et al., 1994	
		Lukhi (Distt. Kaithal)	Rajput	M	100	38.00	Yadav et al., 1994
				F	100	32.00	Yadav et al., 1994
	Mahendergarh, Jind, Hissar and Kurukshetra	Jat	M	182	43.41	Yadav et al., 1994	
			F	33	45.45	Yadav et al., 1994	
		Mahendergarh and	Saini	M	146	45.21	Yadav et al., 1994
				F	146	45.21	Yadav et al., 1994

Table 1: Contd.....

Trait	Place	Population	Sex	No. Tested	Percentage	Author
Handedness (Left Handed)	Kurukshetra		F	52	40.38	Yadav et al., 1994
	Panchkula (Haryana)	Miscellaneous	M	100	37.00	Present Study
			F	100	46.00	Present Study
	Delhi	Jats	M	109	02.75	Malhotra, 1976
		Rajputs	M	101	01.98	Malhotra, 1976
	Karnal, Kurukshetra, and Sonapat	Brahmin	M	100	03.00	Yadav et al., 1994
			F	100	05.00	Yadav et al., 1994
	Ambala, Yamunanagar, Karnal, and Kurukshetra	Banias	M	100	01.00	Yadav et al., 1994
			F	100	01.00	Yadav et al., 1994
	Lukhi (Distt. Kaithal)	Rajput	M	100	03.00	Yadav et al., 1994
			F	100	02.00	Yadav et al., 1994
	Mahendergarh, Jind, Hissar and Kurukshetra	Jat	M	182	04.95	Yadav et al., 1994
			F	33	03.03	Yadav et al., 1994
	Mahendergarh and Kurukshetra	Saini	M	146	02.05	Yadav et al., 1994
		F	52	01.92	Yadav et al., 1994	
Mid-phalangeal Hair (Present)	Panchkula (Haryana)	Miscellaneous	M	100	02.00	Present Study
			F	100	04.00	Present Study
	Delhi	Gujjar	M	106	50.94	Malhotra, 1976
		Jat	M	109	67.89	Malhotra, 1976
		Rajput	M	100	69.00	Malhotra, 1976
	Panchkula (Haryana)	Miscellaneous	M	100	64.00	Present Study
			F	100	28.00	Present Study
	Punjab	Ramgarhias	M	150	04.66	Singh and Bansal, 1963
			F	150	14.33	Singh and Bansal, 1963
	Length of Index Finger relative to Ring Finger (II>IV)	Panchkula (Haryana)	Miscellaneous	M	100	13.00
		F	100	17.00	Present study	

M = Male, F = Female

present population (31.0 males and 28.0 females) in comparison to selected populations chosen (Table 1).

Table 2 depicts the distribution of twelve morpho-genetic and behavioural traits in 100 families. Out of fathers and mothers, 100 each, the number and percentage of parents with the trait have been depicted. The sex-wise distribution of total children belonging to these parents, have been shown. The number and percentage of sons and daughters showing the trait has also been exhibited separately.

The analysis of the results obtained from the present study (Table 2) regarding the heritability of twelve selected morpho-genetic and behavioural traits shows that the mode of transmission can be explained under three heads:

1. The traits transmitting in majority from mothers to daughters and fathers to sons.
2. The traits transmitting in majority from mothers to sons and fathers to daughters.
3. Transmission of the trait not influenced by either parent.

The present study results (Table 2) are show-

ing that majority of the traits (Ear lobe attachment, Tongue folding, Hand clasping, Arm folding, Mid-phalangeal hair and Length of Index finger relative to Ring finger) are following above mentioned first category of mode of transmission i.e. the trait is passing from fathers to majority of sons as compared to daughters and from mothers to majority of daughters as compared to sons. The distribution of these traits among sons and daughters in relation to either parent has also been found statistically significant as is evident from values of chi-square. The trait, presence of digital hair, is also showing almost the same trend i.e. it is being transmitted from fathers to majority of their sons as compared to daughters and this difference in distribution has been found statistically significant. The mothers having digital hair although are transmitting the trait more to their daughters as compared to sons, yet, the distribution has been found statistically non-significant (Table 2).

The two traits, Tongue rolling and Thumb flexibility are following the second category of mode of transmission as mentioned above. Both

Table 2: Distribution of various Morpho-genetic Traits among Family members of present study

Trait		Parents		Children		Value of χ^2	Level of Significance
		Total Parents (n=100)	No. of Parents with trait	Total no. of Children	Showing trait of the parent		
				S + D	Sons Daughters		
Ear lobe attachment (Attached)	F	36 (36.00)	36	80	24 (75.00)	16 (33.33)	13.8087
	M	29 (29.00)	29	32+48	12 (44.44)	23 (65.72)	02.8153
Tongue rolling (Rollers)	F	45 (45.00)	45	98	21 (53.84)	47 (79.66)	07.2966
	M	57 (57.00)	57	109	27 (72.97)	29 (40.27)	10.7690
Tongue folding (Folders)	F	31 (31.00)	31	70	23 (82.14)	19 (45.23)	10.1024
	M	28 (28.00)	28	53	7 (33.33)	28 (87.50)	17.0763
Arm Folding (Right Type)	F	38 (38.00)	38	78	18 (78.26)	19 (34.54)	12.9363
	M	33 (33.00)	33	72	11 (37.93)	31 (72.09)	08.3896
Hand Clasping (Left Type)	F	37 (37.00)	37	79	17 (60.72)	13 (25.49)	09.4811
	M	46 (46.00)	46	97	11 (28.21)	27 (46.55)	03.3584
Handedness (Left)	F	2 (2.00)	2	5	1 (33.33)	0	01.1849
	M	4 (4.00)	4	12	2 (28.57)	2 (40.00)	00.1705
Thumb Flexibility (Non-flexible)	F	28 (28.00)	28	63	4 (17.39)	23 (57.50)	10.2444
	M	34 (34.00)	34	69	21 (65.62)	9 (24.32)	12.2392
Mid-phalangeal Hair (Present)	F	64 (64.00)	64	119	38 (77.55)	21 (30.00)	27.2515
	M	28 (28.00)	28	58	7 (30.43)	23 (65.71)	07.0650
Digital Hair (Present)	F	67 (67.00)	67	139	49 (92.45)	11 (12.79)	95.9568
	M	49 (49.00)	49	102	19 (42.22)	33 (57.89)	02.4813
Length of Index Finger Relative to Ring Finger (II>IV)	F	13 (13.00)	13	28	7 (63.64)	5 (29.41)	04.2252
	M	17 (17.00)	17	31	3 (15.78)	13 (59.09)	08.5049
Length of Second toe Relative to Great Toe (II>I)	F	23 (23.00)	23	49	11 (64.71)	13 (40.62)	02.6038
	M	11 (11.00)	11	21	2 (28.57)	9 (64.28)	02.4396
Iris colour (Light Brown)	F	4 (4.00)	4	12	2 (28.57)	1 (20.00)	00.1664
	M	4 (4.00)	4	9	2 (50.00)	3 (60.00)	00.0399

F = Father, M = Mother, S = Son, D = Daughter

Figures in parentheses indicate percentage

*S Statistically Significant

**NS Statistically Non-significant

these traits are transmitted from mothers to majority of their sons as compared to daughters whereas from fathers these are passed on in

majority to their daughters as compared to sons. The distribution of these traits among children from either parent has been found statistically

significant (Table 2).

The three morpho-genetic traits including length of Second toe relative to Great toe, Iris colour and handedness studied are covered under the third category of mode of transmission i.e. distribution of the trait in the children is not influenced by its presence in parent of either sex and the computed value of chi-square is also showing statistically non-significant differences (Table 2).

Attempt had also been made to observe the mode of inheritance of left handedness and blue iris colour in kindreds of cases found in the present study.

Two cases of left handedness (Fig. 1 and Fig. 2) could be studied upto three generations. From the first pedigree (Fig. 1) left handedness is showing autosomal dominant mode of inheritance. The second pedigree (Fig. 2) is depicting sporadic appearance of the trait and it might be governed by autosomal recessive allele.

Two individuals showing blue iris colour were followed upto three generations (Figs. 3 and 4). Although father and mother (I-1 and I-2) are showing presence of dark brown iris col-

our, the propositus (II-5) is the only individual having blue iris in the pedigree. Similarly in Fig. 4, the trait is absent in I and II generations and is appearing in the proposita (III-5) and her brother (III-6). The appearance of the trait is again sporadic and is not following particular mode of inheritance.

The results of the present study thus indicate hereditary influence in the expression of majority of morpho-genetic traits studied. Moreover the genetic contribution of the parents had been found to be unequal to the children belonging to different sex i.e. the traits are expressing more frequently in one sex. It is true in case of 9 morpho-genetic traits i.e. ear lobe attachment, tongue folding and rolling, hand clasping, arm folding, presence of mid-phalangeal hair, digital hair, length of index finger relative to ring finger and thumb flexibility.

From the review of literature only few studies are available on mode of inheritance of morpho-genetic traits, even some of the traits lack studies related to their genetics.

There had been a number of studies undertaken on the inheritance of ear lobe attachment. The earliest study of Hilden (1922) suggested autosomal dominant mode of inheritance. Chattopadhyay (1980) proposed that inheritance of ear lobe types are due to pair of allelomorphous autosomal genes, free type dominant over the gene for attached type. Further studies

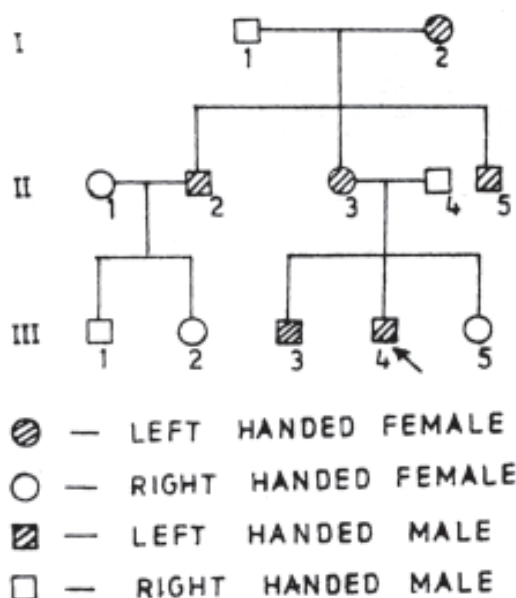


Fig. 1

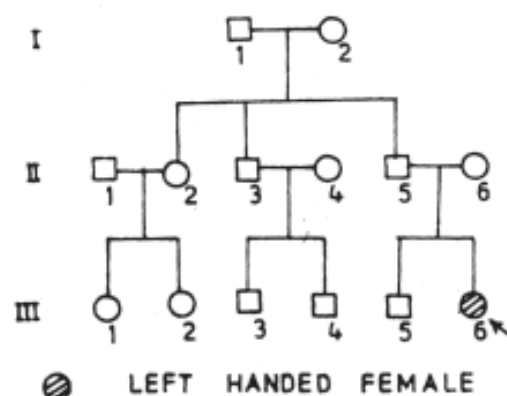


Fig. 2

Pedigrees showing inheritance of handedness

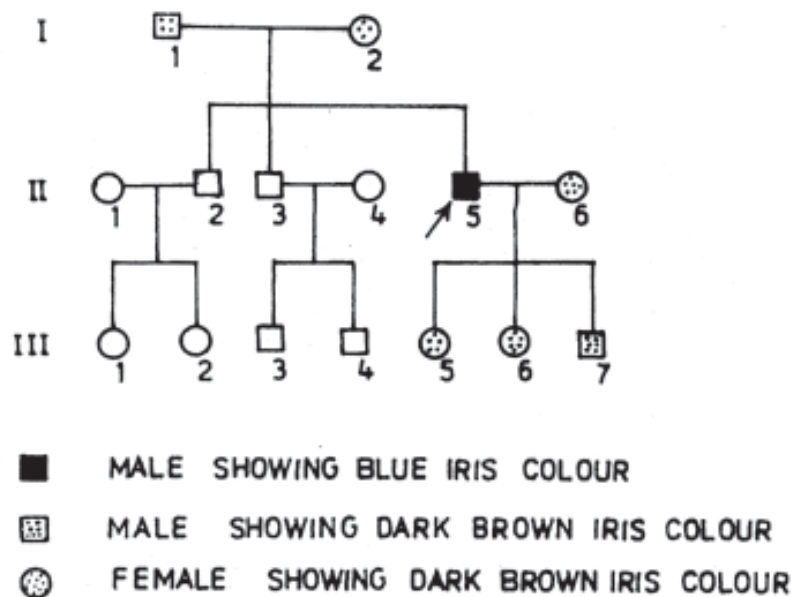


Fig. 3

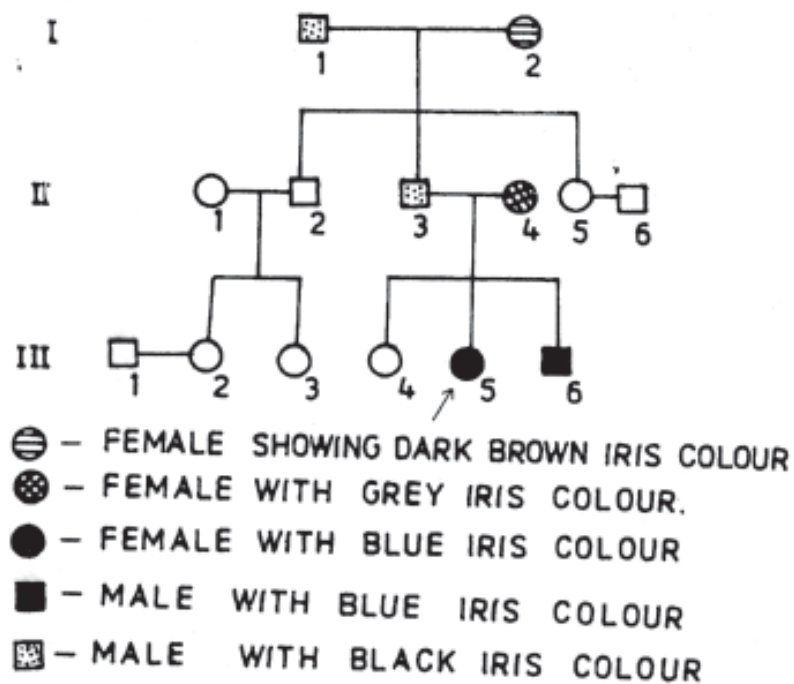


Fig. 4

Pedigrees showing inheritance of iris colour

undertaken by Suzuki (1950), Gates (1954) and Rao (1986) pointed out that heredity of ear lobe is more complicated and no simple mode of inheritance could be established.

According to Sharma and Vasishta (1976) tongue rolling and folding is highly hereditary. Sturtevant (1940) and Hsu (1948) had observed the possibility of this trait due to single Mendelian factor.

Lutz (1908) was the first to study hand clasping in a series of families from Scotland and pointed out probable genetic control of the trait. Freire-Maia and Almeida (1966) suggested that arm folding trait is inherited. Sharma and Vasishta (1976) observed hand clasping and arm folding as least hereditary and most environmental.

The present study results are not depicting the role of heredity in determining length of 2nd toe relative to great toe and iris colour. However, according to Sharma and Vasishta (1976) pattern of iris is very highly hereditary.

According to Chaurasia et al. (1984) handedness is controlled by polygenic mode of inheritance through three autosomal genes. McGee and Cozad (1980) also revealed evidence for familial resemblance and maternal effects. Annett (1978) suggested the inheritance as a complex mechanism and there may be genetic influence toward right but not toward left handedness. According to Kumbhani (1999) right handedness is inherited as an autosomal dominant trait supporting explanation propounded by Rife (1940). The present study results however, show left handedness observing autosomal dominant mode of inheritance in kindreds studied upto three generations in one family whereas in the second pedigree it is sporadic indicating no simple pattern of inheritance for left handedness.

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