

Heritability Estimates of Height and Weight in Mahishya Caste Population

Arun Raychaudhuri¹, Rohini Ghosh², T.S. Vasulu² and Premananda Bharati²

1. GF3-149, Golmuri, P.O. Agrico, Jamshedpur 831 009, India

2. Anthropology and Human Genetics Unit, Indian Statistical Institute, 203 B.T. Road, Kolkata 700 108, West Bengal, India

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ABSTRACT Intrafamilial relationship and heritability estimates of height and weight were estimated from data on 138 families of Mahishya caste, an agricultural population of Chakpota village in Howrah District, West Bengal. Multiple regression and partial correlation were used to adjust the age and sex influence on height and weight. Intrafamilial correlation suggests greater resemblance of height and weight between father-son and mother-daughter than between other parent-child relationships. Among sibs greater and significant sister-sister and brother-brother correlation was observed possibly suggesting sex influence for height. Heritability estimates were higher for stature (0.62) than for weight (0.54).

INTRODUCTION

The expression of multifactorial traits like height, weight and other morphological traits depend both on genetic and environmental factors. To investigate the relative influence of these in ethnically and environmentally different populations is one of the prime objectives in anthropological genetics. Several studies, especially among twins, families have revealed greater genetic control for height but greater environmental conditions for weight. Some studies have found evidence for maternal inheritance of female height (Boldsen and Taylor 1990) and changes in the heritability components of anthropometric traits due to migration (Livshits and Kobylansky 1984). In India, studies on inheritance of height, weight and other anthropometric traits have been reported in different ethnic communities (Susanne 1977; Kapoor et al. 1985; Byard et al. 1984, 1985; Kaur and Singh 1981, 1983; Rama Devi and Reddy 1982, 1983; Poosha et al. 1984; Sharma et al. 1984; Dasgupta et al. 1997). These studies have revealed differences in heritability estimates and its relative contribution of genetic and environmental influences. The studies are

based on different populations; but comparison of heritability estimates in the same ethnic population albeit living in different regions is of some importance.

Such studies can help to detect the consistency in the heritability estimates in space and time and to detect the differences due to population structure or in assessing the changes in environmental influences. The present study reports the estimates of heritability and family resemblance in height and weight in one such rural community, Mahishya living near an urban center and compared with another study among same caste population of another area.

MATERIALS AND METHODS

The data on height and weight forms part of a detailed study (1985-87) on the nutritional anthropometry among the Mahishya caste population of Chakpota village in Amta Block, Howrah District, West Bengal. For the study data on height (cm) and weight (kg) from 138 families consisting of a total of 276 children (147 sons and 129 daughters) were considered for the estimation of heritability. For the purpose of uniformity, we have considered the parents and the two eldest children, and other children were not considered for this study. The age of adult individuals range from 30 to 69 years among fathers (mean 51.9, sd 10.94) and 28 to 65 years among mothers (mean 42.7, sd 8.5). In case of offspring, the age ranges from 5 to 41 years among sons (mean 20.2, sd 9.7) and 5 to 35 years among daughters (mean 17.2, sd 6.8). The data were collected by one of us (PB).

The Mahishya is one of the largest caste populations living for several generations mostly in southern parts of West Bengal, India. Though their prime occupation is agriculture and cultivates paddy, cereals and vegetables in their small

landholdings of about 2 to 3 acres, but some are engaged in business, service, teaching and government organizations. There has been change in their life style in the recent past due to developments in agriculture, communication, education and health aspects. This has influenced their food habits and living conditions, the results of which have been reported earlier in series of papers (Bharati 1981, 1983, 1989; Mazumder et al. 1985; Basu et al. 1986). The average family size of the village is 6.52. The average educational level of the families is at the primary standard, though some are graduates and a few are highly educated. The families who depend on government service are more exposed to urban influence than others. Overall the economic level of the families is more or less uniform. The Mahishya mainly take cereals, pulses and vegetables daily and also take non-vegetarian food (fish, egg etc.) if not daily, but at least a couple of times a week.

Age is one of the confounding variables of height and weight for estimating heritability and so we regressed out the effect of age from height and weight (for both parents and offspring) by multiple regression (third degree polynomial). Then we studied the residuals and tried to see the correlation between parents and offspring. Interclass product moment correlation between parents and offspring and intraclass correlation between sibling pairs were calculated according to Fisher (1958). Coefficient of heritability, which

was equal to the regression of the offspring on mid-parent (Falconer 1960) were also estimated for height and weight from the intrafamilial correlation. Descriptive statistics, especially range, average and variability of height and weight were calculated for fathers, mothers, sons and daughters of the Mahishya caste. The average height and weight of fathers (161.4, 50.1) and mothers (148.7, 42.3) is higher than the sons (150.6, 40.7) and daughters (140.5, 35.2). The results show greater variability in height and weight in case of sons (21.2, 15.2) and daughters (17.3, 12.5) than among fathers (6.9, 8.6) and mothers (4.9, 7.0).

RESULTS

Intrafamilial correlations and the estimates of coefficient of heritability based on the age-adjusted data set are shown in Table 1. Most of the correlations are statistically significant ($p < 0.05$). The father-mother correlation is not significantly different from zero for height and thus suggests no indication of assortative mating. All parent-daughter correlations are high and significant and it appears that mothers height do not significantly affect sons height. Of the sibling correlations for height, sister-sister combinations show the highest values followed by brother-sister combination and brother-brother correlation. But for weight, only mother-sister combination is significant. The coefficient of heritability, estimated

Table 1: Intrafamilial correlation coefficients and estimates of heritability among Mahshiya caste of Chakpota village in Howrah District and from Diamond Harbour in South 24 Parganas (Dasgupta et al. 1997).

Relationship	Present Study			South 24 Parganas#		
	<i>n</i>	<i>Stature</i>	<i>Weight</i>	<i>n</i>	<i>Stature</i>	<i>Weight</i>
Father – Mother	138	0.080	0.166*	110	-0.074	0.235*
Father – Son	147	0.452*	0.248*	187	0.170*	0.175*
Mother – Son	147	0.094	0.204*	187	0.345**	0.257**
Father – Daughter	129	0.295*	0.196*	133	0.272**	0.288**
Mother – Daughter	129	0.443*	0.344*	133	0.337**	0.309**
Father – 1 st Son	111	0.260*	0.326*			
Mother – 1 st Son	111	-0.050	0.199*			
Father – 1 st Daughter	102	0.162	0.198*			
Mother – 1 st Daughter	102	0.384*	0.207*			
Brother – Brother	36	0.368*	0.226	220	0.143**	0.120
Brother – Sister	45	0.386*	0.378*	380	0.265**	0.082
Sister – Sister	27	0.489*	0.276	154	0.481**	0.351**
Sib – Sib				754	0.285**	0.144**
Father – Child	138	0.128	0.060	320	0.212**	0.222**
Mother – Child	138	-0.040	0.020	320	0.341**	0.277**
Parent – Child				640	0.277**	0.250**
Heritability	138	0.622	0.542	320	0.603	0.405

* Significant at 5% level.

** Significant at 1% level.

as the regression of offspring on midparent value, shows that approximately 62% and 54% of the variances of stature and weight are under genetic control. Overall, stature shows higher intrafamilial correlation and heritability than weight, a common general finding suggesting greater genetic influence of stature and greater environmental effect on weight.

The results of the present study has been compared with the heritability estimates obtained by Dasgupta et al. (1997) from the same caste population (Mahishya) but from a different sample from South 24 Parganas district, about 100 km away (towards south) from Chokpota village (Table 1). Both the studies show similar correlation values for both height and weight in case of spouse. However, they show differences in father-son, mother-daughter, brother-brother and brother-sister combinations for both height and weight. In case of height the two studies show differences in mother-son correlation and in case of weight they differ in father-daughter and father-child correlation. The heritability estimate for height (0.6) is almost same for both the studies, but the weight shows higher heritability estimates (0.54) in the Mahishya from Chakpota village (present study) than from the (Mahishya) sample from Diamond Harbor (0.40).

DISCUSSION

In general the results show greater mother-daughter correlation than father-daughter correlations, possibly suggesting maternal effect for the characters as was observed in other studies (Rao et al. 1975; Boldsen et al. 1990). However, the asymmetry of parent-offspring correlation for height do not support the X-linked inheritance. In case of father-mother correlation, the lower values obtained for height and significant values for weight is in agreement with other findings among Indian populations (Kaur and Singh 1981; Kapoor et al. 1985; Byard et al. 1985). The poor correlation between father and mother suggest random mating (or) no preference for height, whereas for weight it can be explained as due to the common intrafamilial food habits. Similar results of inter-spouse correlation have been reported by other studies in diverse populations of India (Kaur and Singh 1981; Byard et al. 1985; Dasgupta et al. 1997).

The correlation among sibs is an important

indicator of genetic mechanism of a trait. According to Mathur and Jenkins (1963) if correlation among sisters is greater than among brothers and between brother-sister correlation, then it suggests sex linkage. i.e., $r(\text{sis-sis}) > r(\text{br-br}) > r(\text{br-sis})$. However, according to Wright (1977) the sex influence of a trait is expected to follow the inequality, viz., $r(\text{sis-sis}) > r(\text{br-sis}) > r(\text{br-br})$. The results obtained supports Wright's formulation, especially for height, and females show higher heritability estimates. Theoretically in a random mating population, sibling correlation should be 0.5 for an autosomal nondominant trait, which is under polygenic inheritance. Since the result of the study is far below the expected value, it can be inferred that the environmental influence is predominant for both the traits. The study also shows greater sib-sib correlation than parent-child correlation. This is expected in case it is a dominant trait, where the expected value is greater than 0.5.

Though Mahishya belong to an endogamous caste, but due to dispersion and settlement in their pursuit for survival in different regions during decades in the past, they now represent several local regional breeding populations and are exposed to a variety of environmental differences. In case if there is no significant change in population structure of the caste: especially admixture, kin-migration etc., (which are expected to lead to significant changes in genetic structure and genetic composition) then the genetic component of heritability for the morphological traits can be assumed to be same between the samples. The observational data do not indicate differences in the endogamy status between the two samples. Therefore any differences in heritability estimates are attributed to the influence of environmental differences and the errors due to sampling, methodology are least and insignificant. The similar spouse correlation implies similar mating structure or preferences for the two traits. However the differences in parent-child correlation between the two samples is attributable to wide environmental differences. The asymmetry in sibling correlation between the two samples is a significant finding. This is because, when compared to their sisters, boys are more influenced to the changing food habits, exposure to outside contact etc., due to education, communication and other facilities. Such external environmental influences are least among sis-

ters, who tend to remain at home and village.

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