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Parent - Adult Offspring Correlations of Anthropometric Measurements in an Urban Indian Population

Gargi Roy and Raghbir Singh
Department of Anthropology, University of Delhi, Delhi 110 007, India

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ABSTRACT Genetic and environmental influence on anthropometric traits have been studied using intrafamilial correlation and regression analyses on a sample of 85 nuclear Aggarwal families. Highly significant correlation values of midparent-offspring and parent-offspring for body measurements (except upper arm circumference and skinfolds at biceps and triceps) suggest strong genetic component in the expression of these traits. Heritability estimates are found to be higher for linear measurements than for breadth and least for girths and skinfold measurements. Partitioning of phenotypic values show 50% contribution of additive genetic variance (V_A/V_P), 21% of dominance variance (V_D/V_P) and 29% of environmental deviation (V_E/V_P).

The influence of genetic and environmental factors on anthropometric measurements suggest different levels of contribution to their phenotypic expression. This is probably due to difference in different gene pols and environmental contribution to the observed variation in a trait or an interaction between the two. As Wright (1977) has noted, it is useful and imperative to study the heritability of a trait under different environmental conditions and in different ethnic groups, as heritability is a property not only of a trait but is also a function of the population (Falconer, 1960).

Estimates of heritability depend on the magnitude of genetic and environmental components of variance and change in any one of them will affect its coefficient value. It is observed that heritability estimate for the same trait show a wide range of variation relative to the studied population in its specific environment and time (Feldman and Lewontin, 1975). This implies that interpretation of heritability estimates becomes difficult as it may not have a straight forward relationship with the magnitude of genetic determination but provides only a general indication to the degree of resemblance between relatives.

In this study, familial correlations, heritability estimates and variance components of anthropometric measurements among Aggarwals of Delhi are presented so as to understand the magnitude of nature-nurture relationship.

MATERIAL AND METHODS

The data of 85 nuclear Aggarwal families consisting of parents and adult offsprings were selected purposively from a larger collected sample of 225 families; where at least one adult son or one adult daughter met the criteria of being more than 19 years of age. All the individuals in these families were measured for nineteen anthropometric variables *viz*. height, sitting height, height acromion, height dactylion, height iliospinale, middle finger length, body weight, biacromial breadth, bicristal breadth, bitrochanteric breadth, upper arm circumference, wrist circumference, calf circumference, ankle circumference and skinfolds at biceps, triceps, below the scapula, above the iliac crest and at the level of maximum calf girth, following the IBP recommendations (Tanner et al., 1969). Two measurements were estimated : arm length (height acromion - height dactylion) and subischial length (standing height - sitting height) of each subject.

The subjects comprised 73 fathers aged 42 -59 years (mean age 49.4 yrs), 83 mothers aged 37-59 years (mean age 44.8 yrs), 65 sons aged 19-37 years (mean age 23.5 yrs) and 75 daughters aged 19-35 years (mean age 21.7 yrs).

In order to make comparison of these body measurements between the parental and offspring generations more meaningful, weighted means of different anthropometric measurements of fathers and mothers were computed, the weight assigned in each case being equal to the number of sons/daughters measured in the particular family. This was necessary keeping in view that the measurements taken on both parents in many families were lacking and also because the number of sons and daughters studied in different families varied. The means of only those offsprings' measurements were calculated whose like-sexed parents had been included in the sample.

The phenotypic resemblance between two adult generations of parent - offspring would reflect shared genetic component in the expression of a trait. Hence, intrafamilial correlations and regression were computed on age - and - sex standardized scores of body measurements by normalizing the data separately within each age - and-sex group.

Heritability defined as the proportion of total variance of a trait in a particular population due to genetic causes was computed from (i) linear regression of offspring on parent ($2b = h^2$), (ii) linear regression of offspring on midparent ($b = h^2$) and (iii) by Fishers' (1918) method ($2 r_{po} + m_p$) where r_{po} is parent-offspring correlation coefficient and m_p is observed assortative mating.

Table 1: Mean and SD of body measurements of fathers, sons, mothers and daughters

Measurement	*Fathers* (n = 58)		*Sons* (n = 58)		*Mothers* (n = 73)		*Daughters* (n = 73)	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Height (cm)	164.0	4.74	168.4	5.94	151.6	4.16	154.8	5.01
Sitting height (cm)	85.3	2.82	87.6	3.76	79.9	2.66	81.9	2.88
Height acromion (cm)	135.8	4.02	137.7	5.92	125.5	3.76	126.7	4.25
Height dactylion (cm)	63.2	3.87	63.1	3.73	57.6	2.61	58.3	2.88
Arm length (cm)	72.7	2.98	74.6	3.39	67.9	3.29	68.4	2.72
Height iliospinale (cm)	92.6	3.58	94.6	4.87	86.0	3.49	87.5	3.58
Subischial length (cm)	78.7	3.26	80.9	4.54	71.7	3.53	73.0	3.44
Middle finger length (cm)	8.8	0.55	9.2	0.52	8.4	0.44	8.5	0.46
Body weight (kg)	64.4	9.85	61.7	10.44	61.8	8.80	50.1	7.49
Biacromial breadth (cm)	39.2	1.95	39.8	1.86	35.1	1.95	34.1	1.80
Bicristal breadth (cm)	27.9	1.64	27.7	1.99	28.2	1.67	27.0	1.51
Bitrochanteric breadth (cm)	30.3	1.35	30.0	1.71	30.4	1.59	29.3	1.74
Mid-upper arm circumference (cm)	26.7	2.54	25.5	2.33	28.5	3.00	23.4	2.67
Wrist circumference (cm)	16.2	0.92	15.8	0.91	15.3	0.93	14.4	0.78
Calf circumference (cm)	33.2	2.79	32.6	3.83	33.0	3.76	30.5	2.61
Ankle circumference (cm)	21.1	1.27	21.6	2.35	20.3	1.49	20.0	1.74
Skinfolds								
i) at biceps (mm)	6.0	1.92	4.9	1.96	9.9	3.66	7.0	3.28
ii) at triceps (mm)	9.5	2.94	9.4	4.83	23.0	6.36	15.6	6.51
iii) below the scapula (mm)	19.9	6.65	15.1	7.43	27.4	7.11	17.3	7.38
iv) above iliac crest (mm)	19.2	5.94	15.2	8.75	21.1	6.13	16.1	8.01
v) at calf (mm)	14.5	6.70	16.2	7.90	22.1	9.15	22.0	7.06

Table 2: Intrafamilial correlation coefficient 'r' for different body measurement

Measurement	*Husband-wife (n = 71)*	*Father-son (n = 58)*	*Father-daughter (n = 61)*	*Mother-son (n = 64)*	*Mother-daughter (n = 73)*	*Father-offspring (n = 119)*	*Mother-offspring (n = 137)*	*Parent-offspring (n = 256)*	*Sibling (n = 71)*
Height	[illegible]	0.41^{2}	0.15	0.54^{3}	0.20	0.28^{2}	0.37^{3}	0.33^{3}	0.26^{1}
Sitting height	[illegible]	0.20	0.27^{1}	0.31^{1}	0.35^{2}	0.24^{2}	0.33^{3}	0.29^{3}	0.25^{1}
Height acromion	[illegible]	0.38^{2}	0.20	0.41^{3}	0.27^{1}	0.29^{2}	0.34^{3}	0.32^{3}	0.33^{2}
Height dactylion	[illegible]	0.37^{2}	0.30^{2}	0.08	0.27^{1}	0.34^{3}	0.18^{1}	0.26^{3}	0.12
Arm length	[illegible]	0.22	0.36^{2}	0.52^{2}	0.34^{2}	0.29^{2}	0.43^{3}	0.37^{3}	0.17
Height iliospinale	[illegible]	0.24	0.23	0.48^{3}	0.24^{1}	0.23^{1}	0.36^{3}	0.30^{3}	0.20
Subischial length	[illegible]	0.33^{1}	0.28^{1}	0.48^{3}	0.19	0.31^{3}	0.33^{3}	0.32^{3}	0.26^{1}
Middle finger length	[illegible]	0.19	0.33^{2}	0.49^{3}	0.45^{3}	0.26^{2}	0.47^{3}	0.38^{3}	0.31^{2}
Body Weight	[illegible]	0.20	0.24	0.01	0.27^{1}	0.22^{1}	0.15	0.18^{2}	0.34^{2}
Biacromial breadth	[illegible]	0.49^{3}	0.51^{3}	0.22	0.53^{3}	0.51^{3}	0.40^{3}	0.45^{3}	0.46^{3}
Bicristal breadth	[illegible]	0.39^{2}	0.15	0.20	0.04	0.27^{2}	0.12	0.19^{2}	0.24^{1}
Bitrochanteric breadth	[illegible]	0.19	0.20	0.14	0.07	0.20^{1}	0.10	0.15^{1}	0.29^{1}
Mid upper arm circumference	0.25^{1}	-0.01	0.32^{1}	-0.01	0.17	0.16	0.09	0.12	0.29^{1}
Wrist circumference	[illegible]	0.52^{3}	0.32^{1}	0.3[illegible]^{2}	0.29^{1}	0.42^{3}	0.32^{3}	0.37^{3}	0.45^{3}
Calf circumference	0.14	0.11	0.25	0.01	0.34^{2}	0.18	0.19^{1}	0.19^{2}	0.26^{1}
Ankle circumference	0.15	0.10	0.11	0.43	0.18	0.10	0.30^{3}	0.21^{2}	0.26^{1}
Skinfolds									
i) at biceps	-0.20	-0.10	0.07	0.03	0.30^{1}	0.01	0.18^{1}	0.10	0.19
ii) at triceps	0.14	-0.06	0.04	-0.09	0.04	-0.01	-0.02	-0.02	0.50^{3}
iii) below the scapula	-0.07	0.18	0.23	0.03	0.33^{2}	0.21^{1}	0.19^{1}	0.20^{2}	0.33^{2}
iv) above iliac crest	-0.04	0.13	0.15	-0.05	0.28^{1}	0.14	0.13	0.13^{1}	0.27^{1}
v) at calf	0.15	0.55^{3}	0.05	0.17	0.30	0.31^{3}	0.24^{2}	0.27^{3}	0.55^{3}

P values : - 1. $p < 0.05$; 2. $p < 0.01$; 3. $p < 0.001$

The phenotypic value (P) of an individual consists of two parts, a genotypic value (G) determined by the individuals' genetic constitution and an environmental deviation (E) which may be either positive or negative. The genotypic value (G) further consists of additive genetic effect (A) and dominance (D).

Since P=G+E or P = A + D + E it follows that $V_P = V_A + V_D + V_E$ where V's represent the variances associated with each source (Falconer, 1960). This partitioning of the total variance indicates the importance of the genotype in determining the phenotype. Different variance components were extracted from the sample parent-offspring and sibling correlation values.

Fishers' Z - transformation test (1970) was used for evaluating the significant differences between correlation values.

RESULTS

Means and standard deviation of 21 anthropometric measurements are listed in table 1. Both sexes of filial generation show significantly higher mean values for height, sitting height, height iliospinale and subischial length than their like-sexed parents, whereas soft-tissue related measurements are significantly higher in the parental generation.

Table 2 shows the intrafamilial correlation coefficient for body measurements. Levels of assortative mating for body size estimated from spouses correlation show low and non-significant values except for arm length, subischial length, biacromial breadth, bicristal breadth, upper arm circumference, wrist circumference and skinfolds at biceps and triceps. The correlation values of body measurements in parent-offspring are significantly lower than the theoretical value of 0.5, except biacromial breadth, thus indicating presence of larger component of environmental variation in them. Comparison of correlation coefficient between father-offspring and mother-offspring show none of the anthropometric measurements to be significantly different from zero. Sibling correlation for bony measurements are lower than corresponding parent-offspring correlation values, but higher for body weight, circumferences and skinfolds at different sites.

Parent-offspring regression coefficients presented in tables 1 and 2.

Table 3 show the same direction and variability as parent - offspring correlations.

Midparent - offspring correlations and regressions listed in table 4 differ among different body measurements indicating a varying degree of hereditary control over the phenotypic expression of these traits. Midparent - son correlations are significantly higher for height and subischial length than midparent - daughter correlations.

Table 5 shows the estimates of heritability (h^2) of body measurements observed in the sample and expected in panmictic conditions (ho^2). The pattern of inheritance of different anthropometric measurements differ in the levels of genetic contribution, highest being for longitudinal measurements followed by transverse and

Table 3: Parent - offspring regression coefficients b ± s.e of b of body measurements

Measurement	*Father son (n = 58)* b	s.e of b	*Father daughter (n = 61)* b	s.e of b	*Mother son (n = 64)* b	s.e of b	*Mother daughter (n = 73)* b	s.e of b	*Father offspring (n = 119)* b	s.e of b	*Mother offspring (n = 137)* b	s.e of b	*Parent offspring (n = 256)* b	s.e of b
Height	0.51	0.15	0.13	0.12	0.68	0.13	0.24	0.14	0.32	0.10	0.45	0.09	0.39	0.07
Sitting height	0.26	0.17	0.24	0.11	0.42	0.16	0.38	0.12	0.25	0.09	0.40	0.09	0.33	0.07
Height acromion	0.57	0.18	0.17	0.10	0.58	0.16	0.31	0.13	0.36	0.11	0.44	0.10	0.40	0.07
Height dactylion	0.35	0.11	0.22	0.09	0.12	0.18	0.30	0.13	0.28	0.07	0.22	0.10	0.25	0.06
Arm length	0.25	0.15	0.32	0.11	0.57	0.12	0.28	0.09	0.29	0.09	0.42	0.08	0.36	0.06
Height iliospinale	0.32	0.18	0.17	0.09	0.52	0.12	0.25	0.11	0.24	0.09	0.38	0.08	0.31	0.06
Subischial length	0.46	0.18	0.24	0.10	0.60	0.14	0.18	0.11	0.35	0.09	0.38	0.09	0.37	0.07
Middle finger length	0.19	0.13	0.34	0.12	0.50	0.11	0.47	0.11	0.27	0.09	0.48	0.08	0.38	0.06
Body weight	0.21	0.13	0.15	0.07	0.01	0.12	0.23	0.09	0.18	0.07	0.13	0.07	0.15	0.05
Biacromial breadht	0.47	0.11	0.49	0.11	0.20	0.11	0.48	0.09	0.48	0.07	0.35	0.07	0.41	0.05
Bicristal breadth	0.47	0.15	0.13	0.11	0.18	0.12	0.04	0.11	0.30	0.10	0.11	0.08	0.20	0.06
Bitrochanteric breadth	0.21	0.15	0.19	0.13	0.14	0.12	0.08	0.13	0.20	0.09	0.11	0.09	0.15	0.06
Mid-upperarm circumference	-0.01	0.12	0.30	0.12	-0.01	0.13	0.16	0.10	0.15	0.09	0.08	0.08	0.11	0.06
Wrist circumference	0.51	0.11	0.24	0.09	0.38	0.13	0.24	0.09	0.37	0.07	0.31	0.08	0.34	0.05
Calf circumference	0.15	0.18	0.18	0.09	0.01	0.13	0.24	0.07	0.17	0.09	0.13	0.06	0.15	0.05
Ankle circumference	0.19	0.25	0.14	0.16	0.68	0.18	0.21	0.13	0.16	0.15	0.43	0.12	0.30	0.09
Skinfolds:														
i) at biceps	-0.09	0.14	0.06	0.13	0.02	0.07	0.27	0.10	0.01	0.09	0.15	0.07	0.08	0.09
ii) at triceps	-0.09	0.22	0.05	0.16	-0.06	0.09	0.04	0.12	-0.01	0.17	-0.01	0.04	-0.01	0.03
iii) below the scapula	0.19	0.14	0.25	0.13	0.03	0.11	0.35	0.12	0.22	0.09	0.20	0.09	0.21	0.06
iv) above iliac	0.19	0.19	0.17	0.14	0.05	0.15	0.37	0.15	0.19	0.12	0.17	0.11	0.18	0.09
v) at calf crest	0.65	0.13	0.04	0.11	0.16	0.11	0.23	0.08	0.34	0.09	0.20	0.07	0.27	0.06

Table 4: Midparent - offspring correlation coefficients 'r' and regression coefficients 'b' of body measurements

Measurement	*Midparent-son (n = 57)*			*Midparent-daughter (n = 59)*			*Midparent-offspring (n = 116)*		
	r	*b*	*s.e of b*	*r*	*b*	*s.e of b*	*r*	*b*	*s.e of b*
Height	0.60^{3}	0.96	0.17	0.25^{1}	0.34	0.20	0.44^{3}	0.69	0.13
Sitting height	0.34^{2}	0.59	0.22	0.43^{3}	0.59	0.16	0.39^{3}	0.62	0.13
Height acromion	0.55^{3}	1.07	0.22	0.31^{1}	0.42	0.16	0.43^{3}	0.74	0.14
Height dactylion	0.33^{1}	0.53	0.21	0.37^{2}	0.46	0.15	0.36^{3}	0.51	0.12
Arm length	0.46^{3}	0.60	0.15	0.40^{2}	0.41	0.12	0.42^{3}	0.49	0.09
Height iliospinale	0.48^{3}	0.79	0.19	0.29^{1}	0.34	0.15	0.39^{3}	0.56	0.12
Subischial length	0.57^{3}	0.98	0.19	0.25^{1}	0.30	0.15	0.43^{3}	0.63	0.12
Middle finger length	0.55^{3}	0.80	0.16	0.53^{3}	0.65	0.13	0.54^{3}	0.71	0.10
Body weight	0.12	0.17	0.19	0.34^{2}	0.29	0.11	0.24^{2}	0.28	0.10
Biacromial breadth	0.41^{3}	0.46	0.13	0.64^{3}	0.71	0.11	0.54^{3}	0.58	0.09
Bicristal breadth	0.35^{2}	0.43	0.15	0.09	0.11	0.15	0.23^{1}	0.28	0.11
Bitrochanteric breadth	0.21	0.29	0.18	0.13	0.18	0.18	0.18	0.25	0.12
Mid-upper arm circumference	0.03	0.02	0.12	0.27^{1}	0.28	0.13	0.15	0.15	0.08
Wrist circumference	0.51^{3}	0.62	0.13	0.37^{2}	0.36	0.12	0.45^{3}	0.48	0.09
Calf circumference	0.04	0.06	0.19	0.38^{2}	0.33	0.10	0.22^{1}	0.26	0.11
Ankle circumference	0.35^{2}	0.84	0.31	0.16	0.26	0.22	0.25^{2}	0.50	0.18
Skinfolds									
i) at biceps	0.02	0.02	0.14	0.20	0.22	0.14	0.11	0.12	0.10
ii) at triceps	0.09	0.11	0.17	0.04	0.05	0.17	0.05	0.06	0.12
iii) below the scapula	0.13	0.20	0.19	0.36^{2}	0.47	0.16	0.25^{2}	0.35	0.13
iv) above iliac crest	0.07	0.13	0.25	0.22	0.36	0.22	0.22^{1}	0.16	0.07
v) at calf	0.43^{3}	0.55	0.16	0.20	0.22	0.14	0.31^{3}	0.36	0.11

P values : 1. $p < 0.05$; 2. $p < 0.01$; 3. $p < 0.001$

Table 5: Heritability estimates (h^2) of body measurements

Measurement	*h^2 from Parent-offspring regression*	*h^2 from Midparent-offspring regression*	*h^2 calculated by Fishers' method*	*Mean h^2*	*h^2_o*
Height	0.78	0.69	0.67	0.71	0.74
Sitting height	0.66	0.62	0.57	0.62	0.65
Height acromion	0.80	0.74	0.59	0.71	0.72
Height dactylion	0.50	0.51	0.54	0.52	0.52
Arm length	0.72	0.49	0.54	0.58	0.47
Height iliospinale	0.62	0.56	0.55	0.58	0.62
Subischial length	0.74	0.63	0.54	0.64	0.60
Middle finger length	0.76	0.71	0.70	0.72	0.69
Body weight	0.30	0.28	0.36	0.31	0.30
Biacromial breadth	0.82	0.58	0.67	0.69	0.55
Bicristal breadth	0.40	0.28	0.29	0.32	0.28
Bitrochanteric breadth	0.30	0.25	0.30	0.28	0.30
Mid-upper arm circumference	0.22	0.15	0.19	0.19	0.17
Wrist circumference	0.68	0.48	0.59	0.58	0.50
Calf circumference	0.30	0.26	0.33	0.30	0.25
Ankle circumference	0.60	0.50	0.37	0.49	0.51
Skinfolds:					
i) at biceps	0.16	0.12	0.25	0.18	0.21
ii) at triceps	-0.02	0.06	-0.04	0.00	-0.02
iii) below the scapula	0.42	0.35	0.43	0.40	0.44
iv) above iliac crest	0.36	0.16	0.27	0.26	0.38
v) at calf	0.54	0.36	0.47	0.46	0.45

soft-tissue related measurements. Positive assortative mating will cause an augmentation of heritability (h^2) whereas genetically less assortative mating will tend to yield greater within family hereditary variance in the offspring. A comparison of h^2 with ho^2 shows former phenomenon affecting the heritability of arm length, biacromial breadth and bicristal breadth.

Partitioning of phenotypic variance of linear, transverse, girth and skinfold measurements (illustrated in Fig. 1) show gradual decrease in the contribution of additive genetic variance, thus indicating a greater genetic heritability of bony measurements than soft-tissue measurements.

Figure 2 illustrates the partitioning of phenotypic variance of anthropometric measurements, which indicate 50% contribution of additive factors (V_A/V_P), 21% due to dominance (V_D/V_P) and 29% of environmental deviation (V_E/V_P).

DISCUSSION

The sons and daughters show significantly higher mean height than those of fathers and mothers. The corresponding increments in the younger adult generation of sons and daughters are 4.4 cm and 3.2 cm respectively. It is observed that the two components of height, *viz.* sitting height and subischial length contribute equitably (1.4%, 1.3%) to the increased height of adult sons but not so among the girls (1.3% and 0.8% respectively). The above observations suggest the possibility of occurrence of secular trend towards increase in mean height within younger generation of boys and girls. This observation gets further strengthened on finding significantly higher mean values of sitting height and subischial length in the offsprings, as these form major components of the total height of the individual.

The degree of assortative mating is expressed as the correlation between phenotypic values of the mated individuals. An assessment in the level of assortative mating is important because it affects the magnitude of parent - offspring and sibling correlations and thereupon the heritability of a trait. Very low and non-significant husband - wife correlation for height suggests absence of assortative mating for height. Significant marital correlations for few adiposity related measurements possibly reflect increasing similarity of spouses due to environmental covariation.

The strength of correlation estimates in the familial transmission of anthropometric measurements suggest that longitudinal bony measurements are more genetically determined as compared to soft-tissue related measurements. This finding is in agreement with earlier observations made on growing offsprings (Mueller and Titcomb, 1977) and adult offsprings reported by Susanne (1977) and Kaur and Singh (1981). Low and non-significant midparent - offspring correlation for upper arm circumference, biceps and triceps skinfolds indicate low genetic transmission of these traits and therefore, anthropometric evaluation of the adiposity related measurements of the upper limb may become useful as indicators of the nutritional state of an individual. Maternal influence is found to be slightly stronger than paternal influence for most of the body measurements, but the differences do not reach statistical significance, thereby suggesting the contributive role played by both the parents in shaping the traits of their offspring. Sibling correlations for body weight, girths and skinfolds exceed those of corresponding parent-offspring correlations, suggesting the presence of relatively homogeneous environment within siblings which probably affect measurements easily influenced by nutrition and environment.

Heritability estimated by the three methods are similar in magnitude but for little variation; h^2 estimated from midparent-offspring regression gives estimate of the proportion of the phenotypic variance due to additive genetic variance. Mean heritability (h^2) and that calculated for a theoretical panmictic Aggarwal population (ho^2) range between - 2% to 74% for the traits. The value of mean (h^2) are lower than corresponding (ho^2) and the decreasing order of (ho^2) do not correspond with the decreasing order of (h^2) for the anthropometric measurements; however the correlation between (h^2) and (ho^2) remains high. Higher heritability of wrist circum-

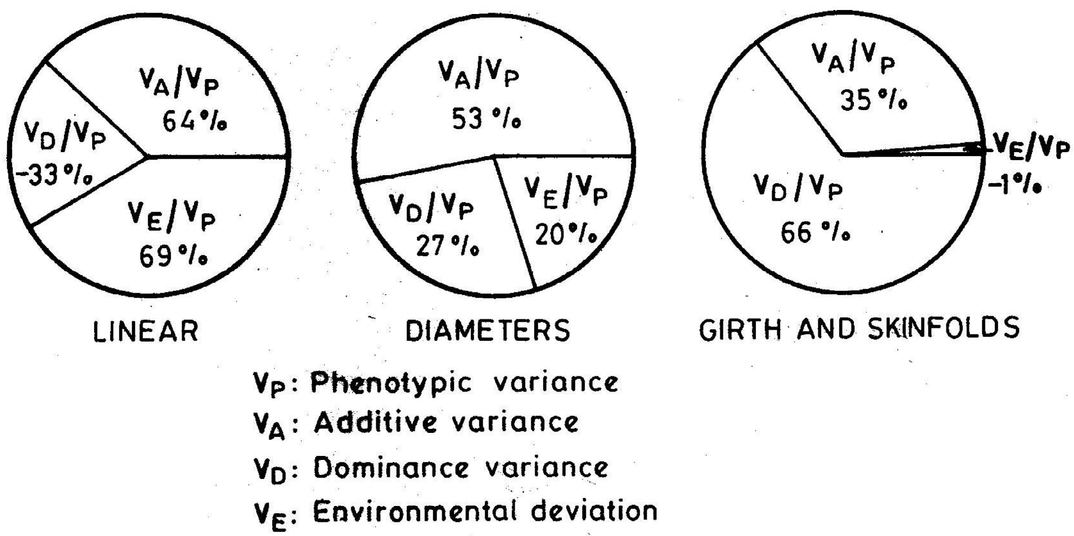
V_A/V_P 64%
V_D/V_P -33%
V_E/V_P 69%
V_A/V_P 53%
V_D/V_P 27%
V_E/V_P 20%
V_A/V_P 35%
V_E/V_P -1%
V_D/V_P 66%
LINEAR
DIAMETERS
GIRTH AND SKINFOLDS
V_P: Phenotypic variance
V_A: Additive variance
V_D: Dominance variance
V_E: Environmental deviation

Fig. 1

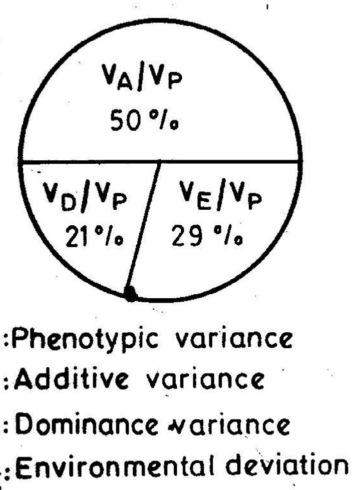
V_A/V_P 50%
V_D/V_P 21%
V_E/V_P 29%
V_P:Phenotypic variance
V_A:Additive variance
V_D:Dominance variance
V_E:Environmental deviation

Fig. 2

ference related to upper arm circumference and ankle circumference related to calf circumference indicates a greater genetic influence of the osseous tissues in relation to adipose tissues.

The partitioning of the phenotypic variance into its components estimate the relative importance of the various determinants of the phenotype in relation to heredity versus environment. It is observed that even though the genetic factors seem to play a major part in the determination of body size traits (64%, 53%) and 35 in linear, diameters and girths and skinfolds respectively), dominance and environmental deviation also play an important role in determining the phenotype of an individual.

On comparing the results of the present study with those reported in the literature, (Susanne, 1975, 1977; Kaur and Singh, 1981, 1983; Paganine Hill et al., 1981; Devor et al, 1986) it can be concluded that even though the absolute correlation values are found lower, the pattern in heritability of body measurement is more or less similar *i.e.* highest in linear measurements, least in skinfolds and intermediate in circumferential and transverse measurements. Absence of assortative mating, increased environmental variance between generations and low parent-offspring environmental covariance ar some of the factors affecting the correlation values of body measurements in the population.

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