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Age and Secular Factor in Adult Stature in Punjabi Khatri Males and Females of High and Low Socio Economic Groups

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ABSTRACT Age associated changes in adult stature of a cross sectional sample of 268 males and 396 females (age range 18-59 years) of 203 Punjabi Khatri families of high and low socio economic groups were estimated by partial regression coefficient of stature on age, controlling subischial height. The values of ageing estimates indicate unequal developmental plasticity of the two sexes with respect to ageing. Ageing adjusted sex specific means of stature of parents were also compared with the average values of stature of the younger generation males and females. Sons of high as well as low socio economic group have attained significantly higher ($P < 0.01$) mean values of height than fathers while daughters of only high socio economic group are showing a significant increase in stature than their mothers.

A major problem in any analysis of the results of cross-sectional surveys of adult stature involves the ability to partition the variation between different age groups into its secular trend and age associated loss components. The approach to this problem utilizes long bones as a reference, since long bone lengths are affected by secular trend, but not age associated shrinkage, and are highly correlated with stature.

Trotter and Glesser (1951a,b) used tibia length as a reference to investigate secular trend in stature in skeletal material, whereas Hertozog et al. (1969) used radiographically determined tibial length for living subjects. The stature loss obtained in the later study was in good agreement with actual longitudinally derived statural loss values in the same sample. Since radiography is not practicable in field surveys, Himes and Mueller (1977) suggested a simpler approach by taking anthropometrically determined subischial length as a reference. The assumption made regarding long bone lengths may be assimilarly applied to subischial length but for some small changes in subischial length with ageing due to thinning of some articular cartilages in the lower limb and bowed legs or flat feet with ageing (Himes and Mucller, 1977). Himes and Mueller applied this technique to investigate secular trend in adult height in a rural Colombian population. Relethford and Lees (1981) used this technique for western Ireland population.

Though most of the researches on human body changes with ageing have been carried out cross sectionally, some investigations of changes in height with age using multicohort data have also been reported (Gessel, 1977; Miall et al., 1967; Susanne, 1977; Noppa et al., 1980 and Borkan et al., 1983) supporting the view of decline in adult height as the age advances. Unfortunately age associated loss in adult stature assessed for Indian population is available only for rural and urban population groups of Gujarat (Kaur, 1984).

In the present study an attempt has been made to investigate the effects of secular trend and age associated loss of stature in high as well as low socio economic group samples of similar genetic affinity. Developmental plasticity of the two sexes with respect to ageing has also been studied. The parental stature has been adjusted for the estimated rates of statural loss with ageing

and ageing adjusted sex specific means of stature of parents are compared with the average values of stature of the younger generation in order to assess the magnitude of secular trend in stature.

MATERIAL AND METHODS

Data of 268 adult males and 396 adult females of an endogamous caste group *i.e.* Punjabi Khatries of Delhi were drawn from 91 families of high and 112 families of low socio economic group. The subjects were chosen randomly. High socio economic group, included the families of high govt. officials, executives and managers, readers and professors and top class businessmen having monthly income more than Rs. 3,000/- per month. These families were traced through the students stydying in top class public schools and good colleges of Delhi. Low socio economic group families included data of govt. officials of lower ranks such as clerks, public and private workers of different organisations drawing less than Rs. 2,000/-per month. These were traced through the students studying in govt. and municipal corporation schools of Delhi. Information regarding family back ground, number of adult members and children in a family, father's occupation and income was first sought from the Punjabi Khatri students. The addresses of the families which came under the two income categories and comprised adult offspring, were noted down and then those houses were visited for the collection of anthropometric data. Information regarding family back ground, income, occupation, total number of individuals in a family, and style of living was sought from each subject and rechecked. The average per capita per annum income was Rs. 3307/- for low socio economic group sample and Rs. 8220/- for high socio economic group sample. All the data were collected during 1985.

The parents and their adult offspring constitute two generations with different age groups in which there is no overlapping. The two younger age groups (18-29 and 30-39 years), included only the offspring and two older age groups (40-49 and 50-59 years) included only the parents.

Stature and sitting height of each subject were measured to the nearest millimeter following standard techniques of Tanner et al. (1969) using anthropometer rod and subischial length was computed as the difference between standing and sitting height.

In order to see the age associated trends in linear measurements, mean values and standard deviations of anthropometric data were calculated and compared by age group, sex and socio economic status. Significance of difference for 4 broad age groups *i.e.* 18-29, 30-39, 40-49 and 50-59 were tested using analysis of variance (F statistics). Parent-offspring comparison with respect to these measurements was done by 't' test. Partial correlation and regression coefficients of height on age, linearlly controlling the effect of subischial length have been computed for parents. Sex specific estimates of statural loss due to ageing were obtained for parents of high and low socio economic group as well as for pooled data as partial regression coefficient of height on age, linearlly controlling for the effects of subischial length. This is equivalent to regressing stature on subischial length and then regressing the residual on age (Kleinbaum and Kupper, 1978).

The observed height of parents over 40 years of age was adjusted for the corresponding estimated rate of statural loss with ageing using the following equation of Relethford and Lees (1981) for each individual's height.

Adjusted height=observed height +b (age - 40 years) where b is the rate of statural loss per year due to ageing.

Since many families in the smaple did not have all the four representative members *i.e.* father, mother, son and daughter and the number of sons and daughters measured in different families also varied, therefore, for comparing son's and daughter's mean stature with those of their like-sexed parents, weighted mean of stature of fathers

Table 1: Mother-daughter and father-son comparison of body measurements

Socio Economic group	Measurements (cm)	Mothers		Daughters		Per cent change in daughters	Fathers		Sons		Per cent change in sons
		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
High Socio economic group	Height	153.9	4.6	156.6[3]	4.9	1.8	169.0	4.9	172.2[3]	5.4	1.9
	Sitting height	80.2	2.5	82.0[3]	2.7	2.2	87.3	2.5	88.2	2.6	1.0
	Subischial length	73.8	3.4	74.6	3.5	1.1	81.7	3.8	84.0[2]	4.4	2.8
Low Socio economic group	Height	152.7	4.7	154.3[1]	5.7	1.1	165.6	6.5	170.4[3]	6.1	2.9
	Sitting height	79.1	2.6	80.8	2.9	2.2	85.5	2.9	87.2[2]	3.3	2.0
	Subischial length	73.6	3.5	73.5	4.4	- 0.1	80.1	4.5	83.2	3.8	3.9
Pooled data	Height	153.3	4.7	155.4[3]	5.5	1.4	167.6	5.7	171.5[3]	5.7	2.3
	Sitting height	79.6	2.7	81.4[3]	2.9	2.2	86.6	2.7	87.8[3]	2.9	1.5
	Subischial length	73.6	3.5	74.0	4.1	0.5	81.1	4.2	83.6[3]	4.5	3.2

P values, 1. $P < 0.05$, 2. $P < 0.01$, 3. $P < 0.001$

and mothers were computed. Each parents was entered with each of his/her like sexed offspring. For example if there were three sons with different stature measurements, it was thought apropriate to compare father's stature with all his three sons separately. Therefore, in such cases the father's measurement was entered thrice. This was done to incorporate maximum available information for estimating intergenerational increase in adult height.

Comparison of means of ageing adjusted parental height with means of their like sexed offspring for both the samples is also given.

RESULTS

Mean values and standard deviations of height, sitting height and subischial length of parents and their like sexed offspring are presented in table 1. Comparison of measurements indicates that sons and daughters have attained significantly higher mean values of stature than their like sexed parents. Means and standard deviations of height, sitting height and subischial length by age groups and socio economic status of males and females are presented in table 2. In pooled data as well as in high and low socio economic group samples, the younger age groups of males as well as females show higher mean values for stature, sitting height and subischial length than older age groups.

In high as well as low socio economic group samples, mean sitting height shows decline with the advancement of age in both the sexes (table 2). Estimates of statural loss with ageing in high and low socio economic group as well as pooled data are presented in table 3. Among parents of pooled data average loss of height with increasing age was 0.087 cm/yr in fathers and 0.119 cm/yr ($P < 0.01$) in mothers. Partial regression coefficient of stature on age, controlling subischial height, gave the estimate of statural loss as 0.055 cm/yr for fathers and 0.169 cm/yr for mothers of high socio economic group while for low socio economic group fathers and mothers it was 0.134 cm/yr and 0.068 cm/yr, respectively.

Adjusted height of each parent was weighted to the number of like sexed offspring studied in a particular family. The weighted means of ageing adjusted height of parents are presented

Table 2: Means and standard deviations of anthropometric measurements by age group and socio economic status of males and females

Measurement (cm.)	Socio economic status	Age group 18-29 n	mean	S D	30-39 n	mean	S D	40-49 n	mean	S D	50-59 n	mean	S D	F ratio between mean of age groups
MALES Height	A	72	172.2	5.0	4	172.9	8.5	28	169.6	4.7	31	167.8	51	df 3, 131 5.19[3]
	B	67	170.5	5.6	4	170.8	5.7	35	165.6	6.3	27	165.9	6.3	df 3, 129 6.65[3]
	C	139	171.3	5.3	8	171.9	6.1	63	167.4	5.7	58	166.9	5.7	df 3, 264 11.19[3]
Sitting height	A	72	88.2	2.6	4	88.5	5.8	28	87.0	2.4	31	86.9	2.2	df 3, 131 2.31
	B	67	87.6	3.1	4	90.2	5.2	35	85.5	3.0	27	85.2	2.6	df 3, 129 4.35[2]
	C	139	88.0	2.9	8	89.3	5.5	63	86.2	2.8	58	86.1	2.4	df 3, 264 8.92[3]
Subischial length	A	72	83.8	4.3	4	84.4	4.0	28	82.6	3.2	31	80.9	4.2	df 3, 131 3.87[2]
	B	67	82.8	4.4	4	80.6	0.7	35	80.1	4.3	27	80.8	4.8	df 3, 129 3.92[2]
	C	139	83.3	4.3	8	82.5	2.9	63	81.2	2.4	58	80.8	4.5	df 3, 264 5.94[3]
FEMALES Height	A	105	156.8	5.0	7	153.8	4.0	57	153.7	4.3	11	153.9	5.5	df 3, 176 5.55[3]
	B	126	154.5	5.6	17	151.8	4.9	60	152.6	5.0	13	152.6	4.0	df 3, 212 2.53
	C	231	155.6	5.3	24	152.4	4.6	117	153.1	4.6	24	153.2	4.7	df 3, 392 7.78[3]
Sitting height	A	105	82.0	2.7	7	80.8	1.8	57	80.4	2.3	11	78.4	2.2	df 3, 176 8.71[3]
	B	126	81.0	2.9	17	78.9	1.8	60	79.3	2.9	13	78.6	1.9	df 3, 212 6.51[3]
	C	231	81.4	2.8	24	79.5	1.8	117	79.9	2.6	24	78.5	2.0	df 3, 392 5.7[2]
Subischial length	A	105	74.8	3.6	7	73.0	3.8	57	73.2	3.4	11	75.5	4.4	df 3, 176 2.95
	B	126	73.6	4.4	17	72.9	4.1	60	73.1	3.4	13	73.9	3.2	df 3, 212 0.22
	C	231	74.2	4.0	24	72.9	4.0	117	73.2	3.4	24	74.7	3.8	df 3, 392 2.33

A: High socio economic group B: Low socio economic group, C: Pooled data
P Values, 2. P < 0.01, 3. P < 0.001

in table 4 for high and low socio economic groups. Comparison of means of ageing adjusted parental heights with the mean of their like sexed offspring (table 4) shows that sons of high as well as low socio economic group have attained significantly higher ($P < 0.01$) mean values for height than fathers providing evidence of a positive secular trend towards increase in height of males of younger generation. Dauthters of high socio economic group also show higher ($P < 0.01$) mean value of height as compared to their mothers, while low socio economic group mother-daughter comparison does not yield statistically significant difference.

Table 3: Statural loss with ageing in high and low socio economic groups as well as pooled data

Socio economic group		*Partial correlation coefficient 'r' of height on age controlling subischial length*	*Partial regression coefficient 'b' of height on age controlling subischial length*
High socio economic group	Father (n = 59)	- 0.090	- 0.055
	Mother (n = 76)	- 0.214[1]	- 0.169[1]
Low socio economic group	Father (n = 63)	- 0.200	- 0.134
	Mother (n = 85)	- 0.126	- 0.068
Pooled data	Father (n = 122)	- 0.131	- 0.087
	Mother (n = 161)	- 0.225[2]	- 0.119[2]

P values, 1. $P < 0.05$, 2. $P < 0.01$

Table 4: Comparison of ageing adjusted height (cm) of parents with height (cm) of like sexed offspring

Socio economic group	*Ageing adjusted height (cm) of mothers*			*Height (cm) of daughters*			*Increment in offspring height*	*Ageing adjusted height (cm) of fathers*			*Height (cm) of sons*			*Increment in offspring height (cm)*
	n	*mean*	*SD*	*n*	*mean*	*SD*		*n*	*mean*	*SD*	*n*	*mean*	*SD*	
High socio economic group	96	154.7	4.7	96	156.6[2]	5.0	1.9	59	169.5	4.8	59	172.2[2]	5.3	2.7
Low socio economic group	113	153.0	4.6	113	154.3	5.6	1.3	47	166.8	6.5	47	170.4[2]	6.1	3.6
Pooled data	209	153.8	4.6	209	155.4[3]	5.4	1.6	106	168.4	5.6	106	171.5[3]	5.6	3.1

P values, 2. p. < 0.01, 3. $P < 0.001$

DISCUSSION

Age associated statural loss of parents of high and low socio economic group calculated by partial regression of height on age, controlling subischial height suggests that decline in height due to ageing in males is higher in low socio economic group than high socio economic group sample. This has strengthened the fact that males tend to respond more drastically to environmental adversities than females. Similar conclusions can be drawn when secular increase in height is taken into consideration. Differences noted among males and females in the present study, together with the variation observed among other studies (Table 5) suggest that environmental factors play an important role in ageing process. Greater effects of ageing on height of males of low socio economic group than females supports the observations reported earlier in the literature on rural subjects (Himes and Mueller, 1977; and Relethford and Lees, 1981). The reported differences between rural and urban populations are related to environmental factors and these socio economic differences are probably related to nutritional differences. The values of ageing estimates indicate unequal developmental plasticity of the two sexes with respect to ageing.

Significantly higher adult height of sons as compared to their fathers in high as well as low socio economic group and daughters over their mothers only in high socio-economic group is due to a greater environmental component as both the samples have similar genetic determination. This may be attributed to greater success in fulfilling genetic growth potential in males as compared to females. In other words it suggests that daughters have not been able to reap the advantage of improved living conditions during growth to the extent as shown by sons. These results are in line with the observations of earlier studies reported in the literature dealing with sexual dimorphism and secular trends in height (Tanner, 1962; Tobias, 1962; Tobias, 1975; Acheson and Fowler, 1964; Stini, 1969; Irena, 1975; Bielicki and Charzewski, 1977 and Hall, 1978).

Table 5: Reported estimates in literature of statural loss with ageing based on partial regression of height on age controlling subischial length

Authors	*Population*	*Ageing estimates cm/yr*	
		Males	*Females*
Trotter and Glesser (1951 a)	Skeletal material	0.060[2]+	
Himes and Mueller (1977)	Rural Columbia	0.125[3]	0.030
Relethford and Lees (1981)	Rural Western Ireland	0.096[3]	0.043
Kaur D.P. (1984)	Rural (Gujrat)	0.068	0.026
	Urban(Gujarat)	0.154[3]	0.172
Present Study	High Socio-economic group	0.055	0.169[1]
	Low Socio-economic group	0.134	0.068
	Pooled data	0.087	0.119[2]

+ average estimate of males and females
P values, 1. $P < 0.05$, 2. $P < 0.01$, 3. $P < 0.001$

The magnitude of increase in females' height in the younger generation is statistically non significant and less marked in low socio economic group. These results substantiate the fact that sons, in our society are still being looked after in a better way than the daughters. This tendency may be more obvious in familes of low socio economic group as they have limited resources to spend on the diet of their offspring. Moreover, the sons are given more time to relax while, the daughters, on the other hand live under various restrains besides getting inferior diet.

The findings of the present study also indicate that the younger generation in both the socio economic groups has enjoyed better living conditions which have increased their height.

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