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Original Article

Community Section

Repercussions of Consanguinity on Metrical Traits at Different Phases of Growth

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ABSTRACT

Introduction: Consanguinity is associated with increase in the likelihood of receiving two copies of deleterious gene from parents, which brings the hidden recessive disorders. This further increases the risk of neonatal and post neonatal mortality. Some of which may also have negative effect on metrical traits of the children, thereby affecting their development and reducing their cognitive abilities.

Aim: To examine the effect of parental consanguinity on various metrical traits like linear, circumferential and weight measurements among the Muslim males.

Materials and Methods: A cross-sectional study was conducted amongst the Muslim males living in the different river islands of Barpeta district in Assam. The study consisted 1438 males (587 inbred and 851 non inbred). A total of 936 boys (3-18 years) were measured at an interval of one year. The rest (502 adult men) from 19-60 years were in age cohorts of five-years age interval. They were measured for stature, sitting height, lower extremity length, body weight, waist circumference, abdominal circumference and hip circumference. Inbreeding depression on trait was calculated using average coefficient of inbreeding and % of depression in a trait. Wright's path coefficient method was used for the calculation of inbreeding coefficient.

Results: The average coefficient of inbreeding was found to be 0.01637931154. A significant increase in the difference of mean values in all the linear, circumferential and weight measurements has been observed at many ages with the increase in the inbreeding coefficient during childhood and adolescence phase of life. But the difference in mean variance in the adult body parameters between the inbred and non inbred was statistically insignificant at almost all ages ($p>0.05$).

Conclusion: Consanguinity has not affected any of the adult body measurements. A significant positive association between consanguinity and diminution of body measurements found during the growing period needs to be correlated with the other socio-demographic variables because the growing period is always more dependent on environmental variables.

Keywords: Anthropometric measurements, Assam, Inbreeding depression, Males, Phases of life, River islands

INTRODUCTION

Consanguinity is a deeply rooted social trend among one-fifth of the world population mostly residing in the Middle East, West Asia and North Africa, as well as among emigrants from these communities which now residing in North America, Europe and Australia [1,2]. A consanguineous marriage is defined as a union between two individuals who are related as second cousins or closer [3].

There is a long tradition of consanguineous marriage in many communities throughout the world. It is usually associated with demographic features, such as religion, educational level, socio-economic status, geography (including urban/rural community, size of the area, isolation of the population), consanguinity among the parent's marriages and the respondent's attitudes towards consanguinity [4-11]. In populations of North Africa, West Asia and South India, consanguineous marriages are culturally and socially favoured and constitute 20-50% of all marriages, with first cousin unions accounting for almost one-third of all marriages [12,13]. In the Arab world and Middle East, family tradition, maintenance of family structure and property, strengthening of family ties, financial advantage, ease of marital arrangements, better relationships between wife and her in-laws, and enhanced marriage stability and durability are the main reasons of the practise [14].

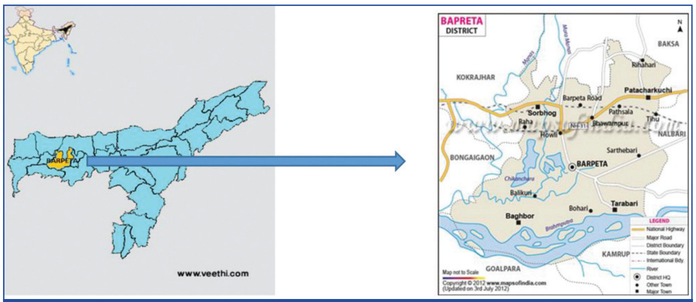
Analysis from the National Family Health Survey (NFHS-4) data has shown the prevalence of consanguineous marriage as 9.9% in India. The Southern region of India with 23% and North-East region with 3.1% being the highest and lowest prevalence [15].

The health implications of consanguineous marriages are rather more important. It not only increases the risk of expression of autosomal recessive conditions in the offspring [16-19] but also makes other morbid conditions more prominent [20,21]. It reduces the genetic variation in any population group; some of which may negatively affect weight and height of children also. Children born into consanguineous unions have lower cognitive scores, lower height-for-age, and a higher likelihood of being severely stunted [1]. From National Family and Health Survey-4 data, the prevalence of childhood stunting was found to be higher among male child (40%) than the female child (38.0%) among ever-married women who have married their blood relatives [22].

The frequency of cousin marriage varies widely across cultural boundaries. It may remain culturally desirable in some communities but the adverse health effects are foremost to be recognised. This consists an increased genetic risk to offspring and a high incidence of congenital pathology in new-borns [18]. There is an absolute lack of study assessing the impact of consanguinity on the metric traits in the entire North Eastern states of India. The present study therefore was an attempt to examine the effect of parental consanguinity on various metrical traits among the Muslims living in the riverine areas of Barpeta district in Assam, India. The metrical traits included were linear measures, circumferential measures and body weight of the children and adults in the different phases of life-childhood, adolescence, adulthood.

MATERIALS AND METHODS

The present cross-sectional study was conducted amongst the Muslims living in the different river islands of Barpeta district in Assam, India. Some of these islands are permanent, some are semi-permanent and some are temporary river islands that can be wiped out by erosion during recurrent floods [Table/Fig-1]. Field work was carried out in the year 2019. Before data collection, a pilot study was conducted and the villagers were briefed about the purpose and nature of the study. Only after taking informed consent, data was collected. The study was conducted with the approval from the Institutional Animal Ethical Committee Gauhati University vide approval no. IAEC/Per/2022/PP-IAEC/2022-09-1.



[Table/Fig-1]: State of Assam showing Barpeta District.
Source: www.veethi.com; www.mapsofIndia.com

Inclusion criteria:

- The male villagers from 3≤ years to ≤70 years who were willing to participate in the study.

Exclusion criteria:

- Anyone who was unwilling to participate.
- Anyone with limited physical activity having medical, surgical, neurological conditions or musculoskeletal disorders.

Sample size calculation: The sample size of the present study was 1438 males which was collected by purposive sampling method. The sample size was calculated with the help of Open Epi open-source software version 3.01, 2006. The sample size falls under 90% confidence interval of the total population with anticipated frequency of 50% and design effect of 1.0. The calculated sample size was 385 out of total Muslim population in Barpeta district, which is 1,198,036 [Census of India, 2011] [23].

The samples were further subdivided into inbred and non inbred. Family pedigrees were drawn to access the consanguinity status and then the subject's inbreeding status was determined. A total of 993 boys from 3-20 years were measured at an interval of one year. Since maturity in linear growth does not cease entirely until maturity is reached, at about 18 years in girls and 20 years in boys [24], therefore adult age categorisation has been done after 20 years onwards. The rest 445 were adult men from >20 to 70 years of age and were grouped in age cohorts of five-year age interval.

Study Procedure

The coefficient of inbreeding (F) was calculated for each couple and the mean coefficient of inbreeding (α) estimated for the population. Inbreeding coefficient (F) was calculated applying Wright's path coefficient method [25]. The coefficient of inbreeding (F) is the probability that two alleles at any locus are identical by descent from the common ancestor (s) of two parents. The F values are in the order: double first cousin (F=0.125) >first cousin (F=0.0625) >first cousin once removed (F=0.03125) >second cousin (F=0.0156). First cousin once removed applies to the relation between an individual and the offspring of one of his first cousins [26]. In non consanguineous families, the coefficient of inbreeding is effectively zero (F=0.000). Finally, the subjects were divided into the low and high inbreeding levels, the former below F<0.625 and the latter with F≥0.625.

$$\mathrm{F} = \Sigma\left[\left(\frac{1}{2}\right)^{n+1}(1+F_A)\right]$$

Where,

n is the number of connecting links between the two parents through common ancestors. F_A is the coefficient of inbreeding of the common ancestor A. Inbreeding depression on trait was calculated using average coefficient of inbreeding and % of depression in a trait.

At the population level, the mean level of inbreeding (α) was calculated according to the formula:

$$\alpha = \Sigma \text{ pi } Fi$$

where, Σ is the summation of the proportion of individuals pi in each consanguinity category Fi [25].

The mean or average coefficient of inbreeding (α) provides a measure of the intensity of inbreeding in the population. α represents a measure of the proportion of loci at which the offspring of a consanguineous union is expected to inherit gene copies from both the parents. Higher is the value of (α), higher is the risk of health issues, indicating increased homozygosity for any harmful gene [27].

% Mean depression in trait is calculated as follows:

$$\frac{\bar{x}(\text{Non inbred})-\bar{x}(\text{inbred})\times 100}{\bar{x}(\text{inbred})}$$

The $\bar{x}$ indicates the mean value of the trait [28]

The subjects were measured for stature, sitting height, lower extremity length, body weight, waist circumference, abdominal circumference and hip circumference. Anthropometric measurements were taken up to the nearest 1.00 mm using standard techniques [29]. Stature was measured to the nearest 0.10 cm with an anthropometer. The weight of the children was recorded bare feet to the nearest 0.50 kg with a portable weighing machine. All the circumferential measurements were measured with a constant tension tape to the nearest 0.1 cm. Mean and depression percentage for all the measurements considered was calculated and seen for their differences statistically with the help of student t-test.

Age estimation of all individuals was aided with reference to the important events and birth or school certificates. Technical errors of measurement were found to be within the reference limits [30].

STATISTICAL ANALYSIS

Data was analysed using IBM SPSS Statistics for Windows Software, version 16 (IBM Corp., Armonk, NY, USA). Descriptive statistics and students t-test were used, with a significance level set at 5%.

RESULTS

The total sample of 1438 males from 3-70 years were divided into inbred (587) and outbred (851). Out of 993 boys, 549 were non inbred and 444 are inbred; and of the 445 adult men, 302 are non inbred and 143 are inbred [Table/Fig-2]. The inbred were further subdivided into higher degree of inbreeding (F≥0.0625, 224 males) and lower degree of inbreeding (0.000<F<0.0625, 363 males).

Variables	Outbred	Inbred			Total
		0.000<F<0.0625 (lower degree of in-breeding)	F≥0.0625 (higher degree of in-breeding)	Total inbred	
Boys	549	269	175	444	993
Adults	302	94	49	143	445
Total	851	363	224	587	1438

[Table/Fig-2]: Distribution of total sample size.

The frequency of consanguineous mating among the people are presented in [Table/Fig-3]. The highest frequency of consanguinity was 59.97% of second-cousins, followed by first-cousins which was 27.598%. The average coefficient of inbreeding in the present population was therefore found to be=0.01637931154.

Descriptive statistics of inbreeding on linear, circumferential and body weight measures: The descriptive statistics of the linear measurements, circumferential measurements and body weight of the boys at every age during childhood and adolescent phases

Types of consanguinity	Inbreeding coefficient (F)	Frequency (n) of consanguineous marriages	Percentage (%)
Uncle-niece	0.125	1	0.170
Nephew-aunt	0.125	0	0
Double first-cousin	0.125	61	10.392
First-cousin	0.0625	162	27.598
Half first-cousin	0.0313	1	0.170
First-cousin once removed	0.0313	0	0
Second-cousin	0.0156	352	59.97
Third-cousin	0.0039	10	1.704
Total		587	

[Table/Fig-3]: Frequency of inbreeding among the Muslims of Barpeta.

are presented in [Table/Fig-4-10]. Further depression percentage was calculated at every age category among both the degrees of inbred.

Linear measurements: In all the linear measurements [Table/Fig-4-6], there was a decrease in mean measurements among the inbred against the non inbred children from 3 years till 20 years. The variance in linear measurements among the children between the two levels of parental consanguinity showed insignificant level but the variance between the inbred and non inbred was statistically significant at the level of 5% in various age groups. The percentage decrease in stature among the higher degree inbred was highest at 14 years (5.83%) and was further higher in sitting height (7.89%) at 10 years and in lower extremity length, it was (9.42%) at 7 years.

Body weight: The body weight [Table/Fig-7] of the inbred boys was significantly heavier at the level of 5% and 1% than the non inbred at 3 years (p=0.0464), 7 years (p=0.0411), 10 years (p=0.0079), 13 years (p=0.0320), 15 years (p=0.0054), 18 years (p=0.0472) and 19 years (p=0.0372). A negative correlation exists between the levels of consanguinity and body weight at an insignificant level among the boys of the present study. The percentage depreciation between the two levels of inbreeding was however insignificant at all ages.

Circumferential measurements: The circumferential measurements [Table/Fig-8,10] also showed a depreciation among the inbred in all the measurements under study. The decrease in percentage was statistically insignificant between the two levels of inbred but statistically significant at 5% level between the inbred and non inbred. This decrease was highest in waist circumference at 7 years (3.996%), in abdominal circumference, it was 4.76% at 13 years and in hip circumference, it was 4.49% at 14 years. The depreciation in waist circumference between the inbred and non inbred was significant at 7 years (p=0.0165); in abdominal circumference, it was significant at 7 years (p=0.0103) and 13 years (p=0.0520); in hip circumference, it was at 7 years (p=0.0095), 10 years (p=0.0269) and 14 years (p=0.011).

Adults: Among the adults, the difference between the inbred and the non inbred for all the measurements are presented in cohorts of five years of age interval [Table/Fig-4-10]. In every age cohort, all the measurements showed statistically insignificant difference between the inbred and non inbred at 5% level except in stature between 40-49 years and in waist and hip circumference between 25-29 years of age. The difference in all the body measurements between the two levels of inbred was statistically insignificant at all age cohorts.

Age group (years)	Non inbred		Inbred						0.000<F<0.0625×F≥0.0625 (lower degree of inbreeding×higher degree of inbreeding)		F=0.000×F>0.000 (non inbred×inbred)	
	F=0.000		0.000<F<0.0625 (lower degree of inbreeding)			F≥0.0625 (higher degree of inbreeding)						
	n	$\bar{X}$±SD	n	$\bar{X}$±SD	d (%)	n	$\bar{X}$±SD	d (%)	t-values	Probability	t-values	Probability
3-4	34	90.46±5.04	19	90.00±4.05	0.51	9	89.90±3.16	0.62	0.0651	0.9486	0.4487	0.6553
>4-5	26	101.67±5.78	16	98.42±5.50	4.18	7	98.35±3.67	5.23	0.4680	0.9759	2.1798	0.0343*
>5-6	30	106.93±5.16	17	105.79±6.36	1.07	6	105.18±5.35	1.64	0.2094	0.8362	0.9494	0.3469
>6-7	29	111.83±7.44	12	110.79±5.68	0.93	9	109.98±4.13	1.65	0.3612	0.7219	0.7724	0.4437
>7-8	32	118.54±9.44	16	112.67±2.89	4.95	11	112.11±2.39	5.42	0.5293	0.6013	3.2749	0.0018**
>8-9	46	123.64±7.19	17	122.57±7.56	0.87	13	121.76±5.34	1.52	0.3282	0.7452	1.1101	0.2706
>9-10	37	127.61±6.19	18	126.44±6.38	0.92	16	125.99±4.71	1.27	0.2314	0.8184	0.9929	0.3242
>10-11	39	135.66±7.96	17	129.50±5.31	4.54	8	129.16±3.62	4.79	0.1632	0.8718	3.6205	0.0006**
>11-12	31	138.34±9.08	14	135.75±5.25	1.87	7	135.64±4.96	1.95	0.0461	0.9638	1.2068	0.2332
>12-13	32	141.79±12.16	14	136.37±9.66	3.82	13	136.19±8.54	3.95	0.0511	0.9596	1.9895	0.0574*
>13-14	30	150.53±11.40	19	146.61±9.01	2.60	17	146.18±8.83	2.89	0.1443	0.8861	1.6510	0.1036
>14-15	35	157.22±5.73	18	148.53±10.31	5.53	11	148.06±7.34	5.83	0.1318	0.8962	4.8695	0.0001**
>15-16	33	158.91±8.29	16	154.08±5.38	3.04	12	154.00±4.19	3.09	0.0426	0.9663	2.7422	0.0081**
>16-17	20	162.27±4.74	19	156.5±6.68	3.56	13	156.14±4.71	3.78	0.1675	0.8681	0.0714	0.9433
>17-18	29	162.26±6.77	11	157.2±4.02	3.12	08	157.01±3.64	3.24	0.1057	0.9170	3.0085	0.0042**
>18-19	30	161.65±5.36	13	160.00±3.97	1.02	07	159.90±2.47	1.08	0.0602	0.9526	1.2712	0.2098
>19-20	36	162.55±7.96	13	161.83±9.75	0.44	08	160.82±8.95	1.06	0.2375	0.8148	0.5232	0.6029
Adults												
>20-24	57	163.64±6.60	16	162.95±7.29	0.42	09	161.93±8.34	1.04	0.3191	0.7525	0.7158	0.4762
≥25-29	44	163.75±5.68	18	163.15±5.44	0.37	10	162.12±6.50	0.995	0.4480	0.6578	0.7925	0.4307
≥30-34	45	163.86±6.86	12	163.19±4.24	0.41	11	162.15±5.32	1.04	0.5070	0.6080	0.7435	0.4598
≥35-39	47	163.93±5.87	12	163.23±7.07	0.43	07	162.21±4.87	1.05	0.3311	0.7409	0.7546	0.4533
≥40-44	46	163.95±6.80	11	163.45±5.08	0.30	06	162.43±3.29	0.93	0.4405	0.6658	0.5719	0.5695
≥45-49	42	163.97±6.89	12	163.50±3.54	0.29	04	162.69±3.46	0.78	0.3982	0.6965	2.1443	0.0361*
≥50 and above	21	162.59±5.62	13	162.57±5.89	0.01	02	162.56±4.38	0.02	0.0023	0.9982	0.0109	0.9914

[Table/Fig-4]: Mean and Depression Percentage (D) of Stature (cms) in Boys at two levels of Inbreeding in comparison with Non inbred Boys.
*Significant at the level of 5%; **Significant at the level of 1%

Age group (years)	Non inbred F=0.000		Inbred 0.0000<F<0.0625 (lower degree of inbreeding)			Inbred F≥0.0625 (higher degree of inbreeding)			0.000<F<0.0625×F≥0.0625 (lower degree of inbreeding×higher degree of inbreeding)		F=0.000×F>0.000 (non inbred×inbred)	
	n	$\bar{X}$±SD	n	$\bar{X}$±SD	d (%)	n	$\bar{X}$±SD	d (%)	t-values	Probability	t-values	Probability
3-4	34	52.78±3.14	19	52.33±2.86	0.85	9	52.30±2.35	0.92	0.0273	0.9784	0.6187	0.5385
>4-5	26	56.01±2.44	16	53.50±2.86	4.48	7	53.45±2.10	4.57	0.0414	0.9674	3.5946	0.0008**
>5-6	30	58.24±2.18	17	58.19±5.15	0.09	6	58.09±4.15	0.26	0.0427	0.9663	0.1040	0.9176
>6-7	29	61.15±3.44	12	59.07±2.09	3.40	9	59.00±1.40	3.52	0.0867	0.9318	2.5871	0.0128*
>7-8	32	63.67±4.31	16	60.70±1.86	4.66	11	60.11±1.01	5.59	0.9558	0.3483	4.5917	0.0001**
>8-9	46	67.35±4.57	17	67.33±6.15	0.03	13	67.14±5.88	0.31	0.0854	0.9325	0.0904	0.9282
>9-10	37	68.68±3.75	18	67.44±4.02	1.81	16	67.29±3.13	2.02	0.1203	0.9050	1.5026	0.1375
>10-11	39	73.12±4.81	17	67.80±1.64	7.28	8	67.35±1.93	7.89	0.6055	0.5508	5.5065	0.0001**
>11-12	31	73.33±5.32	14	70.23±2.25	4.23	7	70.16±2.14	4.32	0.0682	0.9463	2.5463	0.0140**
>12-13	32	76.35±5.61	14	73.87±4.36	3.25	13	73.57±4.12	3.64	0.2109	0.8347	2.0002	0.0502*
>13-14	30	80.14±4.46	19	75.00±3.16	6.41	17	74.94±3.09	6.49	0.0575	0.9545	5.5168	0.0001**
>14-15	35	82.82±4.35	18	78.20±6.20	5.58	11	78.05±5.37	5.76	0.0664	0.9476	3.6975	0.0005**
>15-16	33	82.65±4.94	16	82.00±3.32	0.79	12	81.94±2.43	0.86	0.0528	0.9583	0.6413	0.5238
>16-17	20	83.15±3.75	19	82.70±5.13	0.54	13	82.57±3.54	0.70	0.0792	0.9374	0.4337	0.6664
>17-18	29	83.68±4.24	11	83.50±2.01	0.22	08	83.48±1.90	0.24	0.0219	0.9828	0.1825	0.8560
>18-19	30	84.42±3.11	13	84.28±0.71	0.17	07	84.06±0.33	0.43	0.7690	0.4518	0.3550	0.7241
>19-20	26	85.15±4.42	13	85.00±3.18	0.18	08	84.99±2.64	0.19	0.0074	0.9941	0.1248	0.9012
Adults												
>20-24	57	86.21±3.79	16	85.38±0.95	0.96	09	85.36±1.26	0.99	0.0449	0.9645	1.0846	0.2814
≥25-29	44	86.43±2.72	18	85.50±0.68	1.08	10	85.52±0.76	1.05	0.0716	0.9435	1.7471	0.0850
≥30-34	45	86.54±4.96	12	85.64±1.06	1.04	11	85.61±0.82	1.07	0.0754	0.9406	0.8689	0.3881
≥35-39	47	86.58±3.82	12	85.66±1.06	1.06	07	85.63±1.23	1.10	0.0562	0.9559	1.0380	0.3032
≥40-44	46	86.59±4.43	11	85.69±0.85	1.04	06	85.67±0.87	1.06	0.0460	0.9639	0.8370	0.4058
≥45-49	42	86.75±3.79	12	85.70±0.71	1.21	04	85.68±0.43	1.23	0.0525	0.9589	1.1080	0.2726
≥50 and above	31	85.54±3.11	13	85.33±6.11	0.25	02	85.32±2.56	0.26	0.0022	0.9983	0.1882	0.8516

[Table/Fig-5]: Mean and Depression Percentage (D) of Sitting Height (cms) in Boys at two levels of Inbreeding in comparison with Non inbred Boys.
*Significant at the level of 5%; **Significant at the level of 1%

Age group (years)	Non inbred F=0.000		Inbred 0.000<F<0.0625 (lower degree of inbreeding)			Inbred F≥0.0625 (higher degree of inbreeding)			0.000<F<0.0625×F≥0.0625 (lower degree of inbreeding×higher degree of inbreeding)		F=0.000×F>0.000 (non inbred×inbred)	
	n	$\bar{X}$±SD	n	$\bar{X}$±SD	d (%)	n	$\bar{X}$±SD	d (%)	t-values	Probability	t-values	Probability
3-4	34	39.39±3.15	19	38.33±2.75	2.69	9	38.12±2.04	3.22	0.2033	0.8405	1.6021	0.1144
>4-5	26	46.52±4.45	16	43.92±4.85	5.59	7	43.57±3.49	6.34	0.1715	0.8655	2.3640	0.0216*
>5-6	30	49.71±3.15	17	47.00±4.41	5.45	6	46.69±3.74	6.08	0.1532	0.8797	2.8818	0.0058**
>6-7	29	51.03±5.21	12	49.14±4.61	3.70	9	48.98±3.48	4.02	0.0870	0.9316	1.4440	0.1552
>7-8	32	54.34±6.74	16	50.30±2.93	7.43	11	49.22±2.89	9.42	0.9462	0.3531	3.2791	0.0018**
>8-9	46	58.57±5.93	17	56.75±3.70	3.11	13	56.62±3.12	3.33	0.1019	0.9196	1.5729	0.1200
>9-10	37	59.14±3.69	18	58.46±2.02	1.15	16	58.03±1.63	1.88	0.6774	0.5030	0.2085	1.2697
>10-11	39	63.62±4.35	17	61.90±4.95	2.70	8	61.81±3.37	2.85	0.0464	0.9634	1.6060	0.1134
>11-12	31	65.70±4.98	14	63.50±3.50	3.35	7	63.42±2.57	3.47	0.0534	0.9580	1.5105	0.1372
>12-13	32	69.27±5.69	14	67.98±5.19	1.86	13	67.11±3.32	3.12	0.5142	0.6116	1.2937	0.2010
>13-14	30	73.11±5.70	19	69.63±6.02	4.76	17	69.17±5.52	5.39	0.2380	0.8133	2.6153	0.0111**
>14-15	35	73.81±3.28	18	70.58±4.53	4.38	11	70.45±3.31	4.55	0.0824	0.9349	3.6565	0.0005**
>15-16	33	77.63±6.33	16	72.30±3.88	6.87	12	72.28±2.16	6.89	0.0160	0.9873	4.0833	0.0001**
>16-17	20	77.84±5.06	19	75.80±5.32	2.62	13	75.72±4.27	2.72	0.0451	0.9643	1.6993	0.0942
>17-18	29	77.91±4.74	11	76.02±4.76	2.43	08	75.96±3.44	2.81	0.0303	0.9762	1.4455	0.1551
>18-19	30	78.03±5.53	13	77.15±6.01	1.13	07	77.02±4.07	1.29	0.0510	0.9599	0.6096	0.5450
>19-20	26	78.10±5.77	13	77.55±7.42	0.70	08	77.54±4.83	0.72	0.0034	0.9973	0.3160	0.7535
Adults												
>20-24	57	78.35±4.89	16	77.57±3.68	0.996	09	77.55±3.49	1.02	0.0133	0.9895	0.4319	0.6670
≥25-29	44	78.56±5.38	18	77.69±4.37	1.11	10	77.67±4.75	1.13	0.0113	0.9911	0.7167	0.4760
≥30-34	45	78.72±4.18	12	77.80±2.12	1.17	11	77.78±3.21	1.19	0.0178	0.9860	0.9688	0.3362
≥35-39	47	78.77±5.71	12	77.84±4.95	1.18	07	77.82±2.49	1.21	0.0099	0.9922	0.6614	0.5107
≥40-44	46	78.87±4.18	11	77.91±3.04	1.22	06	77.89±3.38	1.24	0.0125	0.9902	0.9015	0.3709
≥45-49	42	78.89±5.84	12	77.93±2.83	1.22	04	77.92±2.09	1.23	0.0064	0.9950	0.6337	0.5289
≥50 and above	31	76.85±3.88	13	74.77±2.47	2.71	02	74.76±2.83	2.72	0.0053	0.9959	1.8706	0.0681

[Table/Fig-6]: Mean and Depression Percentage (D) of Lower Extremity Length (cms) in Boys at two levels of Inbreeding in comparison with Non inbred Boys.
*Significant at the level of 5%; **Significant at the level of 1%

Age group (years)	Non inbred F=0.000		Inbred 0.00<F<0.0625 (lower degree of inbreeding)			Inbred F≥0.0625 (higher degree of inbreeding)			0.000<F<0.0625×F≥0.0625 (lower degree of inbreeding×higher degree of inbreeding)		F=0.000×F>0.000 (non inbred×inbred)	
	n	$\bar{X}$±SD	n	$\bar{X}$±SD	d (%)	n	$\bar{X}$±SD	d (%)	t-values	Probability	t-values	Probability
3-4	34	12.33±1.91	19	11.43±1.58	7.30	9	11.41±1.49	7.46	0.0318	0.9749	2.0339	0.0464*
>4-5	26	14.50±2.57	16	14.23±2.35	1.86	7	14.20±2.17	2.07	0.0288	0.9773	0.4232	0.6738
>5-6	30	15.67±2.38	17	15.57±3.21	0.64	6	15.52±2.51	0.96	0.0344	0.9729	0.1667	0.8683
>6-7	29	16.62±3.10	12	15.96±1.66	3.97	9	15.91±1.20	4.27	0.0764	0.9399	0.9339	0.3550
>7-8	32	18.91±3.24	16	17.50±1.38	7.46	11	17.43±1.92	7.83	0.1105	0.9129	2.0901	0.0411*
>8-9	46	20.96±3.83	17	19.71±4.68	5.96	13	19.68±2.53	6.11	0.0208	0.9835	1.4336	0.1559
>9-10	37	22.91±3.33	18	21.75±2.66	5.06	16	21.68±2.06	5.37	0.0850	0.9328	1.7233	0.0893
>10-11	39	27.34±6.29	17	24.00±2.15	12.22	8	23.60±1.22	13.68	0.4871	0.6308	2.7440	0.0079**
>11-12	31	28.13±4.70	14	26.25±5.85	6.68	7	26.18±3.58	6.93	0.0289	0.9773	1.4354	0.1574
>12-13	32	30.94±7.51	14	29.21±5.69	5.59	13	29.04±4.10	6.14	0.0884	0.9302	1.0736	0.2875
>13-14	30	36.67±8.50	19	33.00±5.85	10.01	17	32.82±4.77	10.50	0.1004	0.9206	2.1918	0.0320*
>14-15	35	41.00±5.05	18	38.63±6.00	5.78	11	38.58±5.34	5.90	0.0227	0.9821	1.7827	0.0795
>15-16	33	43.83±6.10	16	40.00±7.38	8.74	12	39.11±3.24	10.77	0.3892	0.7003	2.8892	0.0054**
>16-17	20	45.20±9.55	19	44.89±7.57	0.69	13	44.72±3.02	1.06	0.0766	0.9395	0.1896	0.8504
>17-18	29	47.31±6.56	11	46.50±6.45	1.71	08	46.16±3.10	2.43	0.1372	0.8925	0.5602	0.5781
>18-19	30	49.50±6.28	13	46.00±8.66	7.07	07	45.96±2.35	7.15	0.0119	0.9907	2.0367	0.0472*
>19-20	26	51.65±5.83	13	47.95±6.93	7.16	08	47.91±5.07	7.24	0.0141	0.9889	2.1468	0.0372*
Adults												
>20-24	57	54.46±7.14	16	52.44±9.32	3.71	09	52.41±6.94	3.76	0.0084	0.9934	1.1358	0.2594
≥25-29	44	55.21±9.13	18	53.34±9.40	3.39	10	53.31±7.56	3.44	0.0086	0.9932	0.8753	0.3844
≥30-34	45	56.46±11.54	12	53.49±5.41	5.26	11	53.44±4.98	5.35	0.0230	0.9819	1.1796	0.2424
≥35-39	47	56.70±9.56	12	53.50±9.19	5.64	07	53.45±5.85	5.73	0.0129	0.9899	1.3112	0.1945
≥40-44	46	56.80±10.74	11	53.59±5.26	5.65	06	53.55±6.79	5.72	0.0136	0.9894	1.1698	0.2466
≥45-49	42	56.84±12.62	12	53.70±4.95	5.72	04	53.67±4.65	5.58	0.0106	0.9917	0.9677	0.3374
≥50 and above	31	53.32±10.40	13	51.33±10.12	3.73	02	51.30±7.29	3.79	0.0040	0.9969	0.6427	0.5237

[Table/Fig-7]: Mean and Depression Percentage (D) of Body Weight (Kg) in Boys at two levels of Inbreeding in comparison with Non inbred Boys.
*Significant at the level of 5%; **Significant at the level of 1%

Age group (years)	Non inbred F=0.000		Inbred 0.00<F<0.0625 (lower degree of inbreeding)			Inbred F≥0.0625 (higher degree of inbreeding)			0.000<F<0.0625×F≥0.0625 (lower degree of inbreeding×higher degree of inbreeding)		F=0.000×F>0.000 (non inbred×inbred)	
	n	$\bar{X}$±SD	n	$\bar{X}$±SD	d (%)	n	$\bar{X}$±SD	d (%)	t-values	Probability	t-values	Probability
3-4	34	49.61±3.64	19	49.22±3.02	0.79	9	49.21±1.36	0.81	0.0094	0.9926	0.4972	0.6208
>4-5	26	50.65±2.88	16	50.58±1.36	0.14	7	50.51±2.48	0.28	0.0880	0.9307	0.1974	0.8444
>5-6	30	51.60±2.65	17	51.57±3.10	0.06	6	51.46±2.57	0.27	0.0777	0.9388	0.1056	0.9163
>6-7	29	52.00±3.53	12	51.96±2.85	0.08	9	51.89±2.11	0.21	0.0619	0.9513	0.0779	0.9382
>7-8	32	53.30±3.22	16	51.33±2.58	3.70	11	51.17±3.65	3.996	0.1338	0.8946	2.4710	0.0165*
>8-9	46	54.10±3.18	17	53.86±4.10	0.44	13	53.84±3.58	0.48	0.0140	0.9890	0.3085	0.7586
>9-10	37	55.80±4.03	18	55.44±2.80	0.645	16	55.41±4.22	0.70	0.0247	0.9805	0.4109	0.6824
>10-11	39	58.43±5.60	17	56.14±2.61	3.92	8	56.10±4.76	3.99	0.0274	0.9784	1.8219	0.0733
>11-12	31	58.89±3.54	14	58.75±6.40	0.24	7	58.72±4.02	0.29	0.0113	0.9911	0.1238	0.9020
>12-13	32	59.67±4.83	14	59.00±5.76	1.12	13	58.9±5.34	1.29	0.0467	0.9631	0.5328	0.5962
>13-14	30	63.07±6.02	19	62.44±2.92	1.09	17	62.33±5.45	1.17	0.0766	0.9394	0.5392	0.5916
>14-15	35	64.72±3.41	18	63.38±4.63	2.07	11	63.32±4.66	2.16	0.0338	0.9733	1.3580	0.1794
>15-16	33	65.17±4.41	16	64.42±4.18	1.15	12	64.41±3.24	1.17	0.0069	0.9946	0.7112	0.4798
>16-17	20	67.48±8.13	19	65.82±7.01	2.46	13	65.80±2.56	2.49	0.0098	0.9922	0.9341	0.3548
>17-18	29	67.72±5.22	11	66.16±6.03	2.30	08	66.14±3.94	2.33	0.0082	0.9936	1.0367	0.3053
>18-19	30	69.33±4.47	13	67.67±6.11	2.39	07	67.65±3.44	2.42	0.0079	0.9938	1.2589	0.2141
>19-20	26	71.23±5.36	13	68.00±4.36	4.53	08	67.95±3.98	4.60	0.0263	0.9793	2.2759	0.0277*
Adults												
>20-24	57	75.47±6.80	16	73.97±5.77	1.99	09	72.94±4.79	3.35	0.4536	0.6543	1.3129	0.1930
≥25-29	44	80.69±7.12	18	75.38±6.59	7.04	10	74.31±5.87	7.91	0.4272	0.6727	3.5575	0.0007**
≥30-34	45	82.60±10.51	12	80.50±3.54	2.54	11	78.04±4.21	7.94	1.5214	0.1431	1.4648	0.1477
≥35-39	47	82.59±9.76	12	81.52±7.07	1.30	07	80.49±4.87	2.54	0.3394	0.7385	0.0415	0.9670
≥40-44	46	82.23±9.29	11	81.50±6.06	0.89	06	81.48±5.98	0.91	0.0065	0.9949	0.3045	0.7618
≥45-49	42	82.11±10.93	12	81.40±6.12	0.86	04	81.39±5.99	0.88	0.0028	0.9978	0.2343	0.8156
≥50 and above	31	80.39±9.76	13	80.33±10.21	0.07	02	80.30±6.58	0.11	0.0040	0.9969	0.0238	0.9811

[Table/Fig-8]: Mean and Depression Percentage (D) of Waist Circumference (cms) in Boys at two levels of Inbreeding in comparison with Non inbred Boys.
*Significant at the level of 5%; **Significant at the level of 1%

Age group (years)	Non inbred F=0.000		Inbred 0.00<F<0.0625 (lower degree of inbreeding)			F≥0.0625 (higher degree of inbreeding)			0.000<F<0.0625×F≥0.0625 (lower degree of inbreeding×higher degree of inbreeding)		F=0.000×F>0.000 (non inbred×inbred)	
	n	$\bar{X}$±SD	n	$\bar{X}$±SD	d (%)	n	$\bar{X}$±SD	d (%)	t-values	Probability	t-values	Probability
3-4	34	50.25±3.68	19	50.11±2.98	0.28	9	50.10±2.43	0.30	0.0088	0.9931	0.1673	0.8677
>4-5	26	52.15±3.30	16	51.83±2.48	0.61	7	51.82±2.10	0.63	0.0093	0.9927	0.3893	0.6988
>5-6	30	52.85±2.30	17	52.57±3.19	0.53	6	52.55±2.48	0.57	0.0139	0.9891	0.4108	0.6829
>6-7	29	53.52±3.63	12	53.29±3.35	0.43	9	53.27±2.22	0.47	0.0155	0.9878	0.2534	0.8011
>7-8	32	54.81±3.58	16	52.67±2.34	3.90	11	52.66±2.39	3.92	0.0108	0.9915	2.6524	0.0103**
>8-9	46	56.29±3.34	17	55.79±3.60	0.89	13	55.76±3.44	0.94	0.0231	0.9818	0.6370	0.5261
>9-10	37	57.78±3.81	18	57.63±3.84	0.26	16	57.62±3.59	0.28	0.0078	0.9938	0.1676	0.8674
>10-11	39	60.57±6.14	17	59.64±3.75	1.54	8	59.61±3.98	1.58	0.0183	0.9855	0.6877	0.4942
>11-12	31	60.53±3.51	14	60.25±5.97	0.46	7	60.21±4.56	0.53	0.0155	0.9878	0.2902	0.7729
>12-13	32	62.02±4.95	14	61.57±6.16	0.73	13	61.52±4.96	0.81	0.0231	0.9817	0.3528	0.7256
>13-14	30	66.37±6.75	19	63.52±3.31	4.75	17	63.21±5.32	4.76	0.2124	0.8331	1.9804	0.0520*
>14-15	35	68.00±3.82	18	66.38±6.48	2.38	11	66.36±3.28	2.41	0.0095	0.9925	1.6014	0.1144
>15-16	33	68.15±4.41	16	67.45±3.09	1.32	12	67.24±2.35	1.34	0.1963	0.8459	0.7179	0.4757
>16-17	20	72.55±8.59	19	71.11±5.10	3.36	13	71.10±3.56	2.14	0.0061	0.9952	0.8021	0.4263
>17-18	29	73.38±5.33	11	73.02±4.12	2.94	08	72.59±4.98	1.08	0.2059	0.8393	0.3832	0.7033
>18-19	30	73.58±5.00	13	73.33±4.73	3.06	07	73.22±4.37	0.49	0.0509	0.9600	0.2152	0.8304
>19-20	26	73.79±5.80	13	73.57±2.75	0.30	08	73.45±3.65	0.46	0.0858	0.9325	0.1980	0.8440
Adults												
>20-24	57	76.39±7.41	16	74.13±6.03	2.96	09	74.07±4.86	3.04	0.0255	0.9799	1.5055	0.1361
≥25-29	44	82.38±7.73	18	80.50±6.68	2.28	10	78.18±5.76	5.10	0.9225	0.3648	1.7501	0.0845
≥30-34	45	84.91±11.06	12	81.58±5.12	3.92	11	80.56±4.99	5.12	0.4831	0.6341	1.5784	0.1192
≥35-39	47	85.67±9.45	12	84.50±6.36	1.37	07	84.31±5.20	1.59	0.0668	0.9475	0.5403	0.5909
≥40-44	46	85.86±10.02	11	85.25±5.87	0.71	06	85.08±4.87	0.91	0.0603	0.9527	0.2691	0.7888
≥45-49	42	85.94±10.79	12	85.90±6.83	0.05	04	85.14±5.43	0.93	0.2008	0.8437	0.1464	0.8841
≥50 and above	31	85.65±10.25	13	85.33±10.12	0.37	02	85.05±7.43	0.70	0.0371	0.9710	0.1491	0.8821

[Table/Fig-9]: Mean and Depression Percentage (D) of Abdominal Circumference (cms) in Boys at two levels of Inbreeding in comparison with Non inbred Boys.
*Significant at the level of 5% ; **Significant at the level of 1%

Age group (years)	Non inbred F=0.000		Inbred 0.00<F<0.0625 (lower degree of inbreeding)			F≥0.0625 (higher degree of inbreeding)			0.000<F<0.0625×F≥0.0625 (lower degree of inbreeding×higher degree of inbreeding)		F=0.000×F>0.000 (non inbred×inbred)	
	n	$\bar{X}$±SD	n	$\bar{X}$±SD	d (%)	n	$\bar{X}$±SD	d (%)	t-values	Probability	t-values	Probability
3-4	34	50.07±3.73	19	49.72±4.07	0.70	9	49.71±3.46	0.72	0.0063	0.9950	0.3659	0.7157
>4-5	26	53.85±3.71	16	53.08±3.38	1.43	7	53.07±3.54	1.45	0.0064	0.9949	0.7482	0.4581
>5-6	30	54.62±3.00	17	53.64±3.73	1.790	6	53.62±3.65	1.83	0.0113	0.9911	1.0775	0.2863
>6-7	29	55.41±4.16	12	54.92±3.35	0.88	9	54.90±2.38	0.92	0.0152	0.9880	0.4745	0.6373
>7-8	32	57.55±3.87	16	55.25±2.09	3.997	11	55.22±2.78	4.05	0.0320	0.9747	2.6823	0.0095**
>8-9	46	59.28±3.77	17	58.57±3.78	1.20	13	58.55±3.66	1.23	0.0146	0.9885	0.8180	0.4160
>9-10	37	61.23±4.59	18	59.75±2.38	2.42	16	59.71±2.86	2.48	0.0445	0.9648	1.6711	0.0992
>10-11	39	65.02±6.60	17	61.86±2.91	4.86	8	61.85±2.56	4.88	0.0083	0.9934	2.2668	0.0269*
>11-12	31	65.39±4.92	14	62.75±4.27	4.04	7	62.71±4.64	4.10	0.0197	0.9845	1.9850	0.0526*
>12-13	32	65.94±6.31	14	65.93±6.01	0.02	13	65.91±4.87	0.05	0.0095	0.9925	0.0129	0.9897
>13-14	30	70.72±7.23	19	67.78±6.20	4.16	17	67.75±5.76	4.20	0.0150	0.9881	1.8147	0.0743
>14-15	35	73.92±3.60	18	70.63±6.76	4.45	11	70.60±5.89	4.49	0.0122	0.9904	2.6178	0.011**
>15-16	33	74.09±5.71	16	71.83±7.31	2.92	12	71.81±6.21	3.08	0.0076	0.9940	1.4221	0.1603
>16-17	20	77.43±8.03	19	74.56±6.15	3.71	13	74.54±6.35	3.73	0.0089	0.9929	1.4475	0.1540
>17-18	29	78.48±5.26	11	75.43±5.11	3.89	08	75.41±5.88	3.91	0.0079	0.9938	1.9360	0.0590
>18-19	30	79.50±5.08	13	76.33±6.66	3.99	07	76.32±5.97	4.00	0.0033	0.9974	1.9596	0.0559
>19-20	26	79.92±5.99	13	76.67±8.50	4.07	08	76.43±5.98	4.37	0.0696	0.9452	1.7470	0.0875
Adults												
>20-24	57	82.24±6.28	16	80.19±6.35	2.49	09	79.99±4.67	2.74	0.0825	0.9350	1.4792	0.1430
≥25-29	44	86.26±6.47	18	82.25±5.31	4.65	10	82.03±5.29	4.90	0.1052	0.9170	2.8190	0.0063**
≥30-34	45	88.10±6.06	12	86.50±5.71	1.82	11	86.09±4.85	2.28	0.1847	0.8552	1.2083	0.2312
≥35-39	47	88.33±5.99	12	86.00±4.41	2.64	07	85.67±4.51	3.01	0.1561	0.8778	1.6349	0.1070
≥40-44	46	88.65±6.43	11	87.12±5.22	1.73	06	87.01±5.90	1.85	0.0397	0.9688	0.9299	0.3561
≥45-49	42	88.79±6.14	12	87.15±5.71	1.85	04	87.02±4.85	1.99	0.0407	0.9681	0.9771	0.3327
≥50 and above	31	87.48±8.38	13	85.33±5.77	2.46	02	85.17±4.67	2.64	0.0370	0.9710	0.9428	0.3509

[Table/Fig-10]: Mean and Depression Percentage (D) of Hip Circumference (cms) in Boys at two levels of Inbreeding in comparison with Non inbred Boys.
*Significant at the level of 5%; **Significant at the level of 1%

DISCUSSION

The mean coefficient of inbreeding estimates the risk of expression of recessive genes. The more biologically related the parents are, the greater the coefficient of inbreeding. The mean coefficient of inbreeding in the present population was higher (0.01637931154) than the inbreeding coefficient found in the entire North-Eastern states [Table/Fig-11] [15,31-34]. This is a matter of concern for the population. The highest reported from any part of India could be seen in Aligarh as 0.0538 [Table/Fig-11]. The table lays out status of the mean coefficient of inbreeding in the present population against some states of India and some countries outside India. Aligarh city shows the highest coefficient followed by the present population.

Region	States	Mean coefficient of Inbreeding (α)	Source
Northeast	Assam (Barpeta District)	0.01637931154	Present study, 2022
Northeast	Arunachal Pradesh Assam Manipur Meghalaya Mizoram Nagaland Tripura Sikkim	0.0021 0.0005 0.0007 0.0019 0.0003 0.0009 0.0001 0.0006	NFHS- 4; 2015-16 [15]
North	Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajasthan, Uttarakhand	0.0030	NFHS- 4; 2015-16 [15]
Central	Chattisgarh, Madhya Pradesh, Uttar Pradesh	0.0040	NFHS- 4; 2015-16 [15]
East	Bihar, Jharkhand, Odisha, West Bengal	0.0023	NFHS- 4; 2015-16 [15]
West	Goa, Gujarat, Maharashtra	0.0059	NFHS- 4; 2015-16 [15]
South	Andhra Pradesh, Telangana, Karnataka, Kerela, Tamil Nadu	0.0153	NFHS- 4; 2015-16 [15]
North	Aligarh City	0.0538	Khan SY (2019) [31]
Pakistan	Okara District	0.0356	Nawaz A et al., (2021) [32]
Saudi Arabia	Dammam City, Eastern Province	0.0312	Abdulkareem AA and Ballal SG, (1998) [33]
Turkey	Turkey	≥0.0156	Kars ME et al., (2021) [34]

[Table/Fig-11]: Mean coefficients of inbreeding (α) by states and countries [15,31-34].

Rudan I et al., has estimated the population attributable risk as 23-48% of the incidence of the disorders showing an inbreeding effect. The global impact of inbreeding being one billion people globally show rates of consanguineous marriages greater than 20% [35]. In health terms, parental consanguinity would be expected to influence the disease profile in India from a predominantly communicable to a non communicable disease [36].

In the study by Figueira BBD and Segre CAM, significant differences between the inbred and non inbred in weight, height, head, chest and mid-arm circumference have been reported in case of foetal growth, new born children, preschool and school children and the adolescents [37]. In the present study, during the childhood and adolescent phase, an increase in the difference of mean values at a significant level ($p<0.05$) was found at many ages in the linear, circumferential and weight measurements with the increase in the inbreeding coefficient.

Height measurement is a widely used indicator of chronic growth retardation. The results in the present study suggest that inbreeding has a significant negative effect on stature, sitting height and lower extremity length. A significant association between consanguineous marriages and child stunting was also found when the results of propensity score matching also showed that child stunting was significantly higher in consanguineous marriages compared to non consanguineous marriage in India [1]. Child stunting was found to be higher in the male child than female child under the age of five-years in India [38]. If women in consanguineous union were not married to their blood relatives, the childhood stunting was found to decrease by 0.001 [0.1%] [21]. Child stunting was also reported to be higher in rural areas among the poorest quintiles of those mothers who married their blood relatives [22].

A highly significant inverse association has also been found between height and genome-wide homozygosity which is equivalent to a height reduction of up to 3 cm in the offspring of first cousins compared with the offspring of unrelated individuals, an effect which remained after controlling for the effects of socio-economic status. In Libya, parental consanguinity was found to be a significant factor associated with stunting of the children in bivariate analysis [39]. This disappeared in multivariate analysis indicating that it was a confounding variable.

A significant diminution between the inbred and non inbred in trunk length and leg length could be observed during childhood as well as adolescent phase of growth at many age categories in the present study. Leg length of infant (under 5 years) was found to be sensitive to socio-economic circumstances and diet, whilst trunk length was sensitive to serious illness and possibly to chronic emotional disturbance [40]. The socio-economic circumstances in the present study therefore becomes important to be correlated with the inbreeding outcomes.

Previous literature conducted on consanguinity either lack socio-demographic variables, such as maternal age and birth intervals, mother's education, economic conditions, or the nutritional status of mother and children has not been taken in to account [21,22,37,39,40]. The need for comprehensive and more balanced investigations into all aspects of consanguineous marriage is required. The relationship may be specific for each studied population and highly dependent on the cultural context.

A significant diminution at many age groups is also found in the present study boys in their linear, circumferential and weight measurements. Diminutions in weight, height, chest girth, calf girth, head girth, head length (except head breadth) was also found in Visakhapatnam, Andhra Pradesh among the new born babies. But this decrease ceased to exist after a gap of 20 years, thus opining that the population has already undergone the process of inbreeding in the earlier generations [41]. A slight inbreeding depression was also found in stature, sitting height, head length, head circumference, chest girth and calf girth among the Sheikh Sunni Muslim boys of old Delhi between the ages 11 and 16 years [42,43]. Greater inbreeding depression in adolescent period was also noticed rather than in earlier age groups in both the sexes [44].

Blood-relationship alone does not affect multifactorial traits, although anthropometric values were found to be slightly less among the children from first-cousin couples, but the differences were insignificant [45]. A negative correlation exists between the levels of consanguinity and body weight at an insignificant level among the boys of the present study. Consanguinity was identified as a risk factor for underweight among the children in rural Sindh [46], among infants of Moroccan Jewish community in Jerusalem [47] and infants with low birth weight in Jordan [48]. Children who were underweight were found to be 1.5 times more likely to have consanguineous parents than normal children [49]. In South India, the measurements of weight, length, head circumference and triceps and subscapular skinfold thickness was found to be smaller among the uncle-niece groups than those of the first cousin group which further was smaller than the non consanguineous groups [50].

The circumferential measurements of waist circumference, abdominal circumference and hip circumference are also found to be affected in the present study. Significant depreciation between the inbred and non inbred at many ages are found. Depreciation found is whether because of malnutrition arising out of consanguinity needs to be studied. Consanguinity has been regarded as an infamous predictor of malnutrition, however, there are relatively fewer studies examining this relationship in the context of India. In the present study, it has been found that people from lower economic strata choose consanguinity to escape dowry payment during marriage by the bride's family and *meher* (bride price) from the groom's family. Therefore, correlating the metric traits with the economic variables is more important as this has a direct effect on their nutritional status.

The significant positive association between consanguinity and diminution of body measurements during the growing phases in the present study needs to be correlated with the other socio-demographic variables because the growing period is always more dependent on environmental variables [51].

The body parameters among the adult males did not show any statistically significant difference between the inbred and non inbred in all age categories. Stature is a classical and highly heritable complex trait which is influenced by both genetic and non-genetic factors, with 80%-90% of variation explained by genetic factors [52]. The association between low childhood Socio-Economic Status (SES) and reduced adult stature is well established, with the likely mechanism being poor nutrition during childhood [53], although shared genetic factors cannot be excluded [54]. In the present study, the genetic factors probably are the determining factor behind the similar body measurements (linear, circumferential and body weight) among the inbred and non inbred adults. Consanguinity has not affected their body parameters.

Among the major populations so far studied, the highest rates of consanguineous marriage have been associated with low socio-economic status, illiteracy, young age at marriage, low education of mother, low occupation of husband, and rural residence. All these factors are also associated directly with the nutritional intake of the people. Adequate nutrition is essential for proper growth and physical development from conception to adulthood to ensure optimal working capacity, normal reproductive performance and adequacy of immune mechanism which provides resistance to infections [55]. So the influence of the environmental causes and effects on the depreciation in body measurements among the inbred boys in the present study needs to be corroborated by further research.

Limitation(s)

A comparative study between the sexes would have provided an insight into the effect of environmental variations arising out of any cultural factors. Since consanguinity is highly influenced by illiteracy, mother's age at marriage, parental occupation, socio-economic conditions and place of residence (rural or urban), any form of inequality if maintained between the sexes will surely be reflected in their anthropometry. But the space constraint in research articles do not allow to cover every detail.

CONCLUSION(S)

Significant positive association is found between consanguinity and diminution of body measurements in the growing phases. This needs to be correlated with other socio-demographic variables because the growing period is always more dependent on environmental factors. However, consanguinity did not affected any of the linear, circumferential or weight measurements among the adult males. Studies can be done in future to find any environmental causes behind the depreciation of the metric traits among the inbred during the growing period.

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