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GROWTH PROGRESSION AND MATURATIONAL TRENDS AMONG WARLI BOYS: A TRIBAL POPULATION OF MAHARASHTRA, INDIA

ABSTRACT. — The study in physical growth and development confirms the fact that different body segments grow at different rate and time. This trend of growth is not only followed by the normal well-to-do children but even by undernourished and economically backward tribal children, the Warlis also following the similar norms of growth during this age range with certain variations.

Physical growth and development of children is widely recognized as a sensitive index of the health and nutrition of a population and as developing countries with poor nutrition and high infant mortality rates improve their health standards, growth studies become increasingly important in the evaluation of health care (Tanner, 1966). The knowledge of any change in growth pattern which occurs between one decade and the next is valuable evidence about the effectiveness, or othrewise, of status of the community (Marshall, 1977). The growth trends do not show much variation under normal conditions of nutrition but much depends upon the individual's socio-economic statuts. Most researchers have tried to evaluate and enumerate the trends of growth under different living conditions the world over, but the tribal populations have been paid little attention from the standpoint of health and general aspects of bodily development. The present study is devoted to evaluate the trends of growth in a tribal population of India, who not only are undernourished but also belong to the lower socio-economic strata of the society.

Data for the present study have been collected on the "Warlis", a tribal population inhabiting the Kosbad hill area adjacent to the hilly tracts on the western coastline of Thana district of Maharashtra State, India. The total population of this area amounts to 0.884 million including 0.533 million tribals, who mainly subsist on agriculture (Census of India, 1971).

The main tribal groups inhabiting this area are — The Bhils, Warlis, Mahadev Kolis, Gonds, Koknas, Thakurs, Kalkaris, Gamits, Malhar Kolis, Dublas and the Dhodis.

The present study includes the "Warlis" only who have a total population of 0.29 million (Census of India, 1971). They not only lack in education but are also undernourished from the standpoint of health.

MATERIAL AND METHODS

The sample constitutes of 214 male Warli children, in the age range of 8 to 18 years, measured cross-sectionally for the following measurements: stature, body weight, sitting height vertex, trunk height, head and neck length, total upper extremity length, total lower extremity length, biacromial breadth and bi-iliocristal breadth. Standard measurement techniques of Martin and Saller (1959) have been followed with necessary modifications according to I.B.P. handbook No. 9 (Weiner and Lourie, 1969).

Age recording has been done according to Code-2 of I.B.P. (Weiner and Lourie, 1969) in view of the fact that the exact dates of birth were not available but instead the educational institutes record provided the month and year of birth for majority of students as against exact dates of birth for a few children only. Thus, following the Code-2 of I.B.P. the age group 8+ includes all those children who have completed 8 years of age but are less than 9 years. Age group 9+ includes all those children who have completed 9 years of age but are less than 10 years and so on up to age group 18+.

RESULTS

Mean values and standard deviation for the nine measurements under study have been shown in Table 1 alongwith the number of subjects measured per age group from 8+ to 18+. The mean values clearly indicates a rising trend of growth in all the variables with increase in age *(Table 1)*.

The annual increase per year, i.e. the progression of growth, varies for different measures as it is minimum in case of body weight and maximum for stature (Table 2). The highest peak velocity (H.P.V.) occurs between 13+ and 14+ years for seven out of nine variables — stature (107.20 mm), body weight (8.99 kg), sitting height vertex (62.58 mm), trunk height (57.69 mm), total upper extremity lenght (50.99 mm), biacromial breadth (38.63 mm), and bi-iliocristal breadth (27.55 mm). While the total lower extremity length (57.67 mm) and head and neck length (6.94 mm) show the occurence of H.P.V. between 12+ and 13+ years, which is earlier by one year than the rest of the seven variables *(Table 2)*.

There also occurs a second peak velocity for all the variables besides the H.P.V. between 16+ and 17+ years for stature (42.80 mm), body weight (5.72 kg), sitting height vertex (28.69 mm), head and neck length (5.40 mm), total lower extremity length (31.12 mm), while in case of trunk height (18.18 mm), total upper extremity length (24.36 mm), biacromial breadth (17.81 mm) and bi-iliocristal breadth (14.40 mm) it occurs between 15+ and 16+ years, which is earlier by one year than the remaining variables *(Table 2)*.

TABLE 1. *Mean Values and Standard Deviation of Nine Variables of Warli Males from age 8+ to 18+ years*

Age in years	No. of individuals	Height (mm.)		Body weight (kg)		Sitting height (mm)		Trunk height (mm)		Head and Neck lenght (mm)		Total upper Extremity Length (mm)		Total lower Extremity Length (mm)		Biacromial Breadth		Biiliocristal Breadth	
		$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
8+	18	1197.94	73.8	19.52	1.6	620.00	19.3	416.27	18.5	204.00	10.5	519.83	22.2	673.39	25.2	264.05	9.5	184.05	6.5
9+	18	1250.77	35.0	21.66	1.8	644.66	19.5	441.66	20.7	205.00	8.4	550.50	28.4	728.61	29.8	274.53	11.2	194.28	9.5
10+	17	1306.23	54.0	23.26	2.8	662.94	23.7	456.17	22.5	206.76	8.5	564.16	31.8	750.70	31.0	279.00	15.0	200.88	5.9
11+	16	1322.12	28.7	23.50	2.7	663.50	26.4	457.00	20.4	212.75	9.5	585.87	26.4	768.62	22.6	284.81	15.4	201.50	8.7
12+	16	1365.87	28.6	26.47	3.4	686.06	14.5	468.50	14.9	217.56	9.8	602.25	27.5	792.12	28.3	291.62	14.1	208.94	11.2
13+	19	1421.36	52.4	29.07	3.3	712.42	26.2	488.00	30.0	224.52	8.3	622.79	23.8	849.79	30.7	301.84	11.9	215.10	8.6
14+	23	1538.56	48.2	38.06	3.9	775.00	25.9	545.69	24.0	230.01	10.1	673.78	30.8	861.56	32.2	340.47	15.8	242.24	17.8
15+	21	1566.00	34.6	39.50	4.2	783.15	28.6	552.66	28.6	230.47	7.2	683.00	23.8	884.90	32.2	341.19	16.1	243.24	22.9
16+	25	1600.40	38.1	40.08	4.1	801.16	21.3	566.44	26.4	235.60	14.1	707.36	26.6	890.28	29.8	359.00	18.4	257.64	13.7
17+	20	1643.20	42.2	45.80	3.8	829.85	21.4	586.40	20.3	241.00	8.6	726.50	22.9	921.40	13.5	369.40	16.9	266.55	15.8
18+	21	1643.47	39.8	46.00	3.4	830.24	18.4	586.85	19.0	243.38	11.3	727.28	19.8	921.66	19.2	369.66	10.8	267.09	13.3

TABLE 2. *Annual Increments of the Nine Variables Showing Progression of Growth*

Age groups	Height	Body weight	Sitting height	Trunk height	Head and Neck Length	Total Upper Extremity Length	Total Lower Extremity Length	Biacro-mial Breadth	Biiliocris-tal Breadth
8—9	52.83	2.14	26.66	25.29	1.00	30.67	55.22	10.48	10.23
9—10	55.46	1.60	16.28	14.51	1.76	13.66	22.09	4.47	6.60
10—11	15.89	0.24	0.56	0.83	5.99	21.71	17.92	5.81	0.62
11—12	43.75	2.97	22.56	11.50	4.81	16.38	23.58	6.81	7.41
12—13	55.49	2.60	26.36	19.50	6.94	20.54	57.67	10.22	6.16
13—14	117.20	8.99	62.58	57.69	5.49	50.99	11.77	38.63	27.55
14—15	27.44	1.44	8.15	6.97	0.46	9.22	23.34	0.72	1.00
15—16	34.40	0.58	18.01	18.18	5.13	24.36	5.38	17.81	14.80
16—17	42.80	5.72	28.69	15.56	5.40	19.14	31.12	10.40	8.91
17—18	0.27	0.20	0.39	0.45	1.38	0.78	0.26	0.26	0.54

TABLE 3. *Percentage of Growth achieved at each age of its final value taken at 18 years for all the nine variables*

Age groups	Height	Body Weight	Sitting Height	Trunk Height	Head and Neck Length	Total Upper Extremity Length	Total Lower Extremity Length	Biacro-mial Breadth	Biiliocris-tal Breadth
8+	72.89	42.43	74.46	70.91	83.41	71.47	73.06	71.43	68.91
9+	76.15	47.08	77.88	75.24	83.48	75.69	79.05	74.27	72.32
10+	79.48	50.56	79.84	77.73	84.54	77.57	81.45	75.47	75.17
11+	80.44	51.08	79.91	77.87	87.00	80.55	83.39	77.04	75.44
12+	83.11	57.54	82.63	79.83	88.52	82.81	85.94	78.88	77.23
13+	86.48	63.19	85.81	83.15	92.25	85.63	92.20	81.65	80.53
14+	91.61	82.73	90.93	92.98	94.51	92.64	93.47	92.10	90.74
15+	95.28	85.87	94.32	94.34	94.69	93.91	96.01	92.29	91.07
16+	97.38	87.13	96.49	96.52	96.39	97.26	96.59	97.12	96.46
17+	99.98	99.56	99.95	99.92	99.02	99.89	99.97	99.93	99.79

Percentage of growth achieved at each age from 8+ to 17+ years relative to the "final" or "adult" value taken at age 18+, for stature, body weight and other segments of body among the Warli males *(Table 3)* has been calculated to understand the extent of maturity at each age in terms of growth gradients for all the measures.

DISCUSSION

It is obvious yet essential in understanding growth, to recognize that for different segments of body, maturity comes at different points. As a general phenomenon the rates of growth not only vary from one child to another but also within one individual child as well. This variation is attributed to the fact that growth and differentiation do not take place at the same rate and time in constituent components of the body. Thus, we often observe that the overall increase in stature is more due to the increase in the size of trunk segment than in leg segment or head and neck segment during adolescence (Tanner, 1962; Nath 1972, 1975). This differential trend in the segmental growth is mainly responsible for early and late occurrence of adolescent growth spurt. The highest peak velocity (H.P.V.) in different segments may occur during the same period of time on one hand while on the other different segments may show variation of time in the occurrence of H.P.V.

Analysis of the present results reveal that stature, body weight, sitting height vertex, trunk height (trunk segment), total upper extremity length (arm segment) biacromial breadth (upper transverse border of trunk segment) and bi-iliocristal breadth (lower transverse border of the trunk segment), attain H.P.V. between 13+ and 14+ years, whereas head and neck length (head and neck segment) and total lower extremity length (leg segment) attain H.P.V. between 12+ an 13+ years, which is earlier by one year in comparison to the other seven variables. The early occurrence of H.P.V. in case of leg segment and head and neck segment suggests an early maturity in contrast to trunk segment and stature as a whole. Confirming the fact that the spurt in stature (between 13+ and 14+ years) is more due to increase in rate of growth of trunk segment at the same period than to the leg segment with increased growth rate during the preceeding age group (12+ to 13+) (Tanner, 1962, 1964; Nath, 1971, 1972; Marshall, 1977; Smart & Smart, 1972).

Though the leg segment mature earlier, showing early occurrence of H.P.V. over stature and trunk segment, yet it is more close to the adult value at age 17+ (99.97 percent) in comparison to the trunk segment (99.92 percent) and sitting height vertex (99.95 percent). Head and neck segment, which attains 99.02 percent of adult value at age 17+, seems to mature at the slowest rate despite the fact that at age 8 it has already achieved 83.41 percent of growth.

It may be derived that the increase in stature beyond age 17+ is more dependent upon the increase in head and neck segment than to the trunk and leg segments as they require only 0.08 percent and 0.03 percent of growth respectively to reach the "final" or "adult" value in contrast to head and neck segment which requires 0.92 percent of growth at age 17+ to reach "adult" or "final" value *(Table 3)*.

The occurrence of second peak velocity (S.P.V.) or a postadolescent spurt in case of all the nine variables under study is perhaps due to the fact that the Warli boys, as they hail from a tribal set up, are lacking many resources and represent the lower socio-economic strata of the society. Inadequacy in their nutritional intake causes poorer health status. However, they do not suffer from any major disease, but their general pattern of growth and development does get affected causing a bimodality in the velocity curves (represented by a post-adolescent spurt). The cross-sectional nature of data does not seem to be solely responsible for this discrepancy in the patterns of the velocity curve as bimodality is not alone caused by the cross-sectional nature of data. Nath (1972) reported normal uni-

modal velocity curves among Jat boys of Meerut, U.P. (India) belonging to a somewhat similar socio-economic strata of society as that of the Warlis, with certain discrepancies in their nutritional intake. The increased sample size per age group could have provided us some alternative situation but collection of larger sample size was not possible.

Sitting height vertex, which is constituted of trunk segment (trunk height) and head and neck segments, attains H.P.V. between 13+ and 14+ years alongwith stature, body weight, upper extremity length (arm segment), biacromial breadth and bi-iliocristal breadth. But among the two constituent segments of sitting height vertex, head and neck segment attains H.P.V. a year earlier, i.e. between 12+ and 13+ years, along with the lower extremity length (leg segment), while the trunk segment attains H.P.V. along with sitting height vertex a year later than the head and neck segment. This discrimination in attainment of H.P.V. in the two constituent segments highlights the fact that the rate of head and neck segment in growth of total stature is more during the period of pre-adolescence along with the leg segment while the spurt in stature is more due to the increase in trunk segment than to the leg segment or head and neck segment.

The second peak velocity for sitting height vertex occurs between 16+ and 17+ years while the two constituent segments again show a reverse discrimination, i.e. trunk segment attains second peak velocity earlier by a year, i.e. between 15 and 16 years than the sitting height vertex whereas the head and neck segment attains it a year after trunk segment along with the sitting height vertex. This situation is reverse of what is observed during the occurrence of H.P.V. This substantiates the fact that excepting head and neck segment, the other two constituent segments of stature, i.e. the trunk and the leg, have attained their adult growth percentage at age 17+ while the head and neck segment is yet to achieve 0.98 percent of growth at this age in contrast to 0.08 percent and 0.03 percent in case of trunk and leg segments respectively. It may be deduced from this analysis that the increase in stature beyond the age of 17 is mainly due to the increase in the head and neck segment.

The two transverse breadths of the trunk segment, i.e. the biacromial breadth and the bi-iliocristal breadth, show the occurrence of adolescent spurt (H.P.V.) between 13+ and 14+ years along with other linear measures among Warli boys, except the head and neck segment and the leg segment *(Table 2)*. The occurrence of second peak velocity for both of these variables is registered between 15+ and 16+ years. This phenomenon of occurrence of second peak velocity is simultaneously recorded between 15+ and 16+ years for the height of trunk segment and arm segment. It would be interesting to note here that all the variables related to the trunk segment show the occurrence of adolescent spurt (H.P.V.) and the second peak velocity (post adolescent spurt) at the same time indicating the fact that the different parts of the trunk segment follows a similar pattern in attainment of adolescent spurt despite the observed differential rates of growth at different age levels. Sitting height vertex on the other hand shows the occurrence of second peak velocity a year after the variables of trunk and arm segments simply because of the fact that sitting height vertex is composed of two successive segments, i.e. head and neck segment, and trunk segment, and the delay in occurrence of second peak velocity is because of the head and neck segment mainly, which attains second peak velocity a year after between 16+ and 17+ years along with the leg segment, stature and body weight.

The maturational direction of the constituent segments of stature among the Warli boys follows a cephalo-caudal gradient of growth at age 8+ where the head and neck segment achieves 83.41 percent of growth as compared to the trunk segment (70.91 percent) and leg segment (73.06 percent). But on assessing the trunk and leg segments at the same age, a reverse gradient of maturation seems to be operative, i.e. leg segment achieving 73.06 percent of growth is ahead of the trunk segment (70.91 percent) at age 8+. This reverse situation of the maturation has been referred to as caudo-cephalic gradient of growth (Nath, 1975). Thus, it may be elucidated here that cephalo-caudal gradient is operative between head and neck segment and trunk segment but trunk — leg gradient is reverse, i.e. caudo-cephalic at age 8+ within the stature. This clearly indicates a differential trend of growth within the constituent segments of stature.

Further, it is observed that the trunk — leg maturity gradient follows caudo-cephalic direction of maturation of each age from 8+ to 17+ years while head and neck — trunk gradient follows a cephalo-caudal direction upto age 15+ whereafter caudo-cephalic gradient is operative up to age 17+ *(Table 3)*.

The arm — leg maturity gradient also follows a caudo-cephalic maturational direction indicating an advanced maturity of leg segment at each age from 8+ to 17+ over the arm segment. While considering sitting height vertex (as combination of head and neck and trunk segments) — leg gradient a mixed direction of maturation is observed, as at age 8+ the maturation follows cephalo-caudal progression but from age 9+ onward till 17+ the maturational direction follows a reverse progression, i.e. caudo-cephalic. The emergence of this mixed trend, due to the head and neck component of sitting height vertex, is indicative of advanced maturity of leg segment over the sitting height vertex from age 9+ onwards.

The two transverse dimensions of trunk, i.e. biacromial breadth and bi-iliocristal breadth, show that biacromial breadth is more advanced in maturity at each age over the bi-iliocristal breadth. This advanced maturity of biacromial breadth indicates a cephalo-caudal progression at each age between the transverse measures of trunk segment.

Observations on percentage of growth achieved between 8+ and 17+ years elucidate the fact that body weight shows maximum increase amounting to 57.13 percent, while the increase in other measures does not exceed beyond 31 percent — bi-iliocristal breadth (30.88 percent), trunk height (29.01 percent), biacromial breadth (28.50 percent), upper extremity length (28.42 percent), lower extremity length (28.42 percent), lower extremity length (26.91 percent), stature (27.09 percent), sitting height vertex (25.49 percent). The head and neck segment shows minimum increase of only 15.16 percent within this age range. This variation in the percentage of growth achieved by different segments, once again, confirms the basic fact of growth trends that different segments grow at different rate at time. This trend of growth is not only followed by the normal well-to-do children but even by undernourished and economically backward tribal children, the Warlis, also following the similar norms of growth during this age range with certain variations.

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