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Proportional Growth Assessment of Spitian Boys of the Himalayas

S.P. Singh, P. Malhotra, L.S. Sidhu and Prit Pal Singh*

Department of Human Biology, Punjabi University, Patiala 147 002, Punjab, India
**Public College, Samana, Punjab, India*

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ABSTRACT The present cross sectional study on changes in body proportions of different parts during growing years has been conducted on Spitian boys, ranging in age from 5 to 20 years. Anthropometric data for height, weight, biacromial and bicristal diameters and skinfolds at triceps and subscapular was collected on 636 subjects during 1996-1998 from various areas of Spiti valley. The altitudes of different areas from where the data was collected range between 3500 -4200 metres above mean-sea-level. The age trends of proportional body weight in relation to height among Spitian boys expressed as Z-scores have been found to be positive up to 7 years of age and negative thereafter. The major difference between the biacromial and bicristal diameters is that while the relative bicristal diameter keeps on decreasing till the age of 14 years, the relative biacromial diameter stops decreasing at 11 years of age and gains thereafter. This seems to be the reason behind the differential growth of these two measures and the establishment of the masculine body form.

INTRODUCTION

The adults of different populations vary greatly in size. It is a well established fact that Pygmies of the Congo Basin of Western Africa are among the shortest people whereas European and North Americans are among the tallest in the world (Eveleth and Tanner 1990). Interactions between the genetic potential and environmental factors help the individual to achieve the optimal limits set for him. Not only the adult sizes are variable but the bodily shapes also exhibit lot of variations in the world. Norgan (1998) is of the opinion that the shape differences outsmart the size differences among different populations when all of them live under good environmental conditions. Tanner (1964) conducted a study on sportsmen of Rome Olympics and found that the racial differences exist in the body shapes. The typical shape difference encountered in this study was that of leg length which was relatively longer in Africans than in Europeans. This viewpoint was endorsed and supported by Ulijaszek et al. (1998). However, Tanner et al. (1982) explored this problem in greater detail by comparing Japanese children with those of Britain and America. Japanese children investigated during 1957 had smaller leg length than the Europeans, however, after a period of 20 years of living in a similar environment, the differences in leg length of Japanese from those of European simply vanished. If this is true then the concept of genetic differentiation in shape does not seem to be valid. Many investigators have categorically pointed out that the environmental conditions influence the development of body proportions among growing children especially when the environment is not optimal but is stressful (Gurri and Dickinson, 1990; Lohman et al., 1988; Siniarska, 1995; Wolanski, 1979, 1995; Wolanski et al., 1993; Zhang and Huang, 1988). According to Bogin (1999) the socio-economically disadvantaged children show relatively smaller leg lengths than their peer of similar ethnicity and genetic composition. In depth studies are required to disengage the specific contributions of genetic and environmental factors on the development of human body shape. Accordingly, in order to fill the gap in information on the body shape of one of the disadvantaged groups of the North West Himalayas inhabiting the Spiti valley has been investigated for body proportions in case of boys ranging in age from 5 to 20 years.

MATERIAL AND METHODS

The present cross sectional study on changes in body proportions of different body parts during growing years has been conducted on Spitian boys, ranging in age from 5 to 20 years. Anthropometric data for height, weight, biacromial and bicristal diameters and skinfolds at triceps and subscapular was collected on 636 subjects during 1996-1998 from various areas of Spiti valley. The altitudes of different areas from where the data was collected range between 3500-4200 metres above mean-sea-level. The age

of the child was calculated from the date of birth (which was taken from the school registers in case of school going children and from the parents of those children who did not attend the school) and from the date of examination. Yearly age groups were formed so as the mid-point coincided with the whole year figure, e.g., all subjects from 4.500 to 5.499 years were included in 5- year age group, those from 5.500 to 6.499 years in the 6- year age group and so on. The measurements were taken following the techniques of Weiner and Lourie (1969) and Carter and Heath (1990).

The proportionality assessment was done according to the formula given by Ross and Wilson (1974). This is essentially based on the concept of a theoretical reference human known as Phantom. According to Ross and Wilson (1974) "The Phantom is a conceptual unisex, bilaterally symmetrical model derived from reference male and female data". The weight and stature of the phantom is 64.58 kg and 170.18 cm, respectively.

Proportionality assessment is done by adjusting an anthropometric measure to a standard height or size and comparing it with the specified phantom values. The absolute differences are then converted in terms of standard deviation values and are known as z-scores.

This is done as follows:

$Z = 1/s [v (170.18/ h)^{d} – p]$

where Z is the proportionality score

v is a variable

s is the standard deviation of the variable

170.18 is the height of phantom

d is a dimensional constant whose values are

1 for all linear measures,

2 for all areas,

3 for all volumes and masses

p is the mean value of the variable in phantom.

RESULTS

The age trends of proportional body weight in relation to height among Spitian boys expressed as Z-scores have been found to be positive up to 7 years of age (Table 1). Thereafter, these scores are negative. It suggests that the weight proportional to height is relatively much more up to 7 years of age. The boys keep on becoming relatively thinner and at age 15, they have the least relative body mass. From 15 years onwards, Spitian boys again start putting on more relative weight but are nowhere near their value in the early years of life. Thus the proportional body weight presents a picture which is very different from that of absolute body weight which keeps on increasing with advancing age.

Table 1: Z-values of body mass of Spitian males.

Age	*Number*	*Mean*	*S.D.*	*S.E.M.*
5	37	0.88	0.78	0.19
6	37	0.93	0.65	0.11
7	40	0.25	1.10	0.17
8	40	-0.03	0.73	0.11
9	36	-0.24	0.64	0.11
10	36	-0.26	0.98	0.16
11	46	-0.80	0.62	0.09
12	70	-0.79	0.60	0.07
13	37	-0.88	0.65	0.11
14	33	-0.96	0.72	0.12
15	38	-1.03	0.69	0.11
16	45	-0.79	0.37	0.35
17	40	-0.68	0.52	0.08
18	38	-0.99	0.83	0.13
19	33	-0.53	0.67	0.12
20	30	-0.46	0.94	0.17

The proportional chest circumference is positive during 5 and 8 years of age and thereafter it is negative (Table 2). The trend of z-scores indicate decreasing values up to 14 years of age and thereafter these scores witness an increase. It may be inferred that 14 year old boys possess the least chest circumference in proportion to height as compared to those at all other ages. It is during late adolescence that they start growing in the chest circumference very fast.

The biacromial diameter relative to height shows negative z-scores up to 18 years of age.

Table 2: Z-value of chest circumference of Spitian males.

Age	*Number*	*Mean*	*S.D.*	*S.E.M.*
5	37	0.19	0.74	0.12
6	37	0.09	0.64	0.10
7	40	-0.68	0.76	0.12
8	40	-0.75	0.67	0.11
9	36	-1.00	0.79	0.13
10	36	-1.12	0.77	0.13
11	46	-1.56	0.95	0.14
12	70	-1.53	1.33	0.16
13	37	-1.63	1.02	0.17
14	33	-1.75	0.66	0.11
15	38	-1.34	0.85	0.14
16	45	-1.24	1.62	0.24
17	40	-1.32	1.20	0.19
18	38	-0.83	1.05	0.17
19	33	-0.37	0.97	0.17
20	30	-0.08	0.85	0.16

Only during 19 and 20 years, these become positive (Table 3). By and large the relative shoulder width becomes narrower and narrower from 5 to 11 years of age. A trend of its relative becomes apparent during and after the adolescence. The Spitian boys gain a lot in shoulder width especially during late adolescence. The proportional bicristal diameter also presents

Table 3: Z-value of biacromial diameter of Spitian males.

Age	*Number*	*Mean*	*S.D.*	*S.E.M.*
5	37	-0.88	0.85	0.14
6	37	-0.73	0.92	0.15
7	40	-1.14	1.46	0.23
8	40	-0.95	1.26	0.20
9	36	-1.09	1.26	0.21
10	36	-0.89	1.30	0.22
11	46	-1.24	1.01	0.15
12	70	-1.03	1.03	0.12
13	37	-0.57	1.09	0.18
14	33	-1.11	1.50	0.26
15	38	-0.85	1.10	0.18
16	45	-0.60	1.67	0.25
17	40	-0.75	1.20	0.19
18	38	-0.39	1.41	0.23
19	33	1.01	2.39	0.42
20	30	1.78	1.96	0.36

a similar picture to that of the biacromial diameter (Table 4). The major difference between the two is that while the relative bicristal diameter keeps on decreasing till the age of 14 years, the relative biacromial diameter stops decreasing at 11 years of age and gains thereafter. This seems to be the reason behind the differential growth of these two measures and the establishment of masculine body form.

Table 4: Z-value of bicristal diameter of Spitian males.

Age	*Number*	*Mean*	*S.D.*	*S.E.M.*
5	37	-0.78	1.03	0.17
6	37	-0.68	1.06	0.17
7	40	-1.08	1.02	0.16
8	40	-1.20	1.00	0.16
9	36	-0.99	1.11	0.18
10	36	-1.09	1.07	0.18
11	46	-1.55	1.23	0.18
12	70	-1.28	1.49	0.18
13	37	-1.61	1.01	0.17
14	33	-1.87	1.00	0.17
15	38	-1.85	0.95	0.15
16	45	-1.71	1.65	0.25
17	40	-1.74	0.98	0.16
18	38	-1.12	1.21	0.20
19	33	1.44	2.80	0.49
20	30	1.52	2.60	0.47

The proportional z-scores of triceps and sub scapular skin folds are shown in Tables 5 and 6, respectively. The age trends in proportional triceps skin fold indicate a decreasing trend almost throughout the period under study. It means that triceps skinfold thickness decreases relative to height with the advancing age. On the other hand, the relative sub scapular skinfold thickness decreases only up to around 9 years and remains stable thereafter without witnessing any perceptible change.

Table 5: Z-value of triceps skinfold of Spitian males.

Age	*Number*	*Mean*	*S.D.*	*S.E.M.*
5	37	-0.56	0.63	0.10
6	37	-0.61	0.53	0.09
7	40	-1.25	0.47	0.07
8	40	-1.30	0.50	0.08
9	36	-1.40	0.44	0.07
10	36	-1.33	0.59	0.10
11	46	-1.60	0.63	0.09
12	70	-1.55	0.54	0.06
13	37	-1.46	0.65	0.11
14	33	-1.77	0.53	0.09
15	38	-1.88	0.34	0.06
16	45	-1.96	0.48	0.08
17	40	-1.97	0.30	0.05
18	38	-1.99	0.31	0.05
19	33	-1.96	0.42	0.07
20	30	-2.01	0.28	0.05

Table 6: Z-value of sub-scapular skinfold of Spitian males.

Age	*Number*	*Mean*	*S.D.*	*S.E.M.*
5	37	-1.48	0.49	0.08
6	37	-1.63	0.44	0.07
7	40	-1.95	0.26	0.04
8	40	-1.99	0.28	0.04
9	36	-2.09	0.23	0.04
10	36	-2.11	0.32	0.05
11	46	-2.05	0.30	0.04
12	70	-2.05	0.44	0.05
13	37	-2.03	0.21	0.03
14	33	-2.08	0.29	0.05
15	38	-2.13	0.24	0.04
16	45	-2.11	0.19	0.03
17	40	-1.98	0.29	0.05
18	38	-1.97	0.34	0.06
19	33	-1.94	0.42	0.07
20	30	-1.96	0.47	0.09

DISCUSSION

Age changes in body proportions of Spitian boys of the present study have indicated that while the absolute size increases with the advancing age, the body proportions don't. Relative body mass in these boys decreases up to 15 years and then increases. This can be explained in terms of differential rates of growth of body weight and height. A decreasing ratio of body weight to height up to 15 years would suggest a relative faster tempo of growth in height

than in weight. The situation reverses somewhat after 15 years when the rate of increase in height slows down but in case of weight picks up and goes on. In the case of biacromial and bicristal diameters, the major difference is that while the relative bicristal diameter keeps on decreasing till the age of 14 years, the relative biacromial diameter stops decreasing at 11 years of age and gains thereafter. This seems to be the reason behind the differential growth of these two measures and the establishment of the masculine body form. Thus boys keep on growing in shoulder width even during late adolescence. It may be noted that 14 year old boys possess the least chest circumference in proportion to height as compared to those at all other ages. It is during late adolescence that they start growing in the chest circumference very fast.

It may be concluded that proportional body weight, shoulder width and chest circumferences have a tendency to keep on growing even during the late adolescence years. Perhaps the stressful conditions of high altitude delay the development of these variables. In general, delayed and mild adolescent growth spurt has earlier been reported from almost all high altitude zones of the world (Basu and Gupta, 1984; Bhasin and Singh, 1992; Clegg et al., 1972; Frisancho and Baker, 1970; Malik and Singh, 1978, 1979; Singh, 1989).

The origin of the differences in body proportion is very controversial. Earlier studies in literature indicate population differences in bodily shape of different races and these differences have been attributed to genetic factors (Tanner, 1964; Eveleth and Tanner, 1990). However, there have been numerous other environmental factors which could not be controlled in these studies and they may also be responsible in establishing these differences. The children who are disadvantaged socio-economically show relatively smaller leg lengths than their peer of similar ethnicity and genetic composition (Bogin, 1993, 1999; Bogin and Loucky, 1997). In depth investigations on body proportions of a large array of human populations by Bogin and Kapell (2002) "indicate a role for genetic and environmental interactions in the regulation of the growth of human body segments". The question of differences in body shape among different populations is generating a lot of interest and needs further probing. The present study would provide useful data on body proportions of Spitian boys who live in those environments which exert numerous stresses including hypoxia and nutritional inadequacies.

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