



Secular Trend in Some Anthropometric Measurements of Monpa Boys in Arunachal Pradesh, India: A Comparison of over 3 Decades-Gap Findings

Bhaboklang Sohkhlet

assistant professor, Department of Anthropology, Saint Claret College, Ziro, Arunachal Pradesh. e-mail: bhaboklangs@gmail.com

KEYWORDS

Secular trend,
Anthropometric
measurements, Socio-
economic factors

ABSTRACT

Data on height, sitting height, and body weight of Monpa boys were obtained from two cross-sectional studies whose findings were based on data collected during 1977 and 2014 by Duarah and the present author respectively. The study shows that though the present Monpa population have undergone different transitional stages over the last 3 decades, they show lesser values of height and weight in comparison to that of the general Indian children or other Himalayan populations. Since this report is a first attempt on secular trend of the Monpas, there is a scope for future research in this area and to delve into understanding of the secular trend in growth among the Monpas as well as other Northeastern Indian populations.

Background

The term 'secular trend' is often understood as a trend in the increase of body dimensions (such as height or weight) or a marked tendency to become progressively larger, taller, and heavier; though the concept may imply alternative meanings other than an 'increasing trend'. Changes in body size, fatness, rate of growth, and timing of maturation have been occurring over the past 150 years (Dasgupta & Houspie, 2001). This trend in the increase in height, body weight, and other body dimensions, generally relates to various factors i.e., biological, social, and environmental.

The changing growth patterns among various populations from different developed countries e.g., Germany, England, Poland, Norway, Sweden have been reported in several studies by different scholars (Das, 1993) at different times. Similarly, studies on the secular trend have been reported from developing countries such as Brazil (Ulijaszek, 2001), Iran (Ayatollahi, Pourahmad, & Shayan, 2006), Mexico (Malina et al., 2004), and India (Virani, 2005). Most of these studies often attribute the increasing pattern in height, weight, and other body dimensions to factors such as improvement in nutrition (Hoppa & Garlie, 1998), socio-economic status (Kuh et al., 1991; Padez, 2003), and genetics (Zellner et al., 2003). Therefore, studies on the secular trend in respect of height, weight,

and/or other body dimensions of a population provide an understanding on the nutritional status, health, socio-economic condition, overall living standard, environment, or even genetic status of a population. Surprisingly, there is very little (or not at all) information regarding this trend among the populations of Northeastern India, and more specifically of Arunachal Pradesh.

This paper is, therefore, an attempt to report the secular trends in height, sitting height, weight, and upper-arm circumference of the Monpa boys of Arunachal Pradesh, India. It is also hoped that this study will mirror over the overall health, nutritional, socio-economic status of the people of Northeastern India in general, and Arunachal Pradesh in particular.

Methods

Study population

Arunachal Pradesh, the land of the dawn-lit mountains (Sharma, 2005), is located in Northeastern India between latitude 26° 28' N to 29° 31' N and longitude 91° 30' E to 97° 30' E. It borders the states of Assam and Nagaland to the south, and shares international borders with Bhutan in the west, Myanmar in the east, and People's Republic of China in the north (Figure 1). Geographically, it is comprised of mountainous and sub-mountainous portions of the Himalayan system in its extremity. The state is the largest among the North-East Indian states commonly known as the Seven Sister States, with an area of 83,743 sq km of Indian Territory (Bareh, 2001). Administratively, the state comprises 17 districts, viz., Tawang, West Kameng, East Kameng, Papumpare, Lower Subansiri, Upper Subansiri, Upper Siang, West Siang, East Siang, Upper Dibang Valley, Lower Dibang Valley, Dibang Valley, Lohit, Anjaw, Changlang, Tirap, and Longding districts.

Both studies selected the Monpas of Tawang and West Kameng districts as their subjects. In the West Kameng district, the Monpas inhabit mostly in the Dirang and Kalaktang circles. The Monpas of Kalaktang, Dirang, and Tawang share a common tradition of having migrated from Tibet and Bhutan (Norbu, 2008). They belong to the Tibeto-Mongoloid racial stock (Duarah, 1992) and are Mahayana Buddhists by religion with close cultural and religious affinities to Bhutanese and Tibetans (fig. 1).

Sampling

For the 1977 survey, the sampling procedure and methods of data collection have been described previously (Duarah, 1992). In the present study, the author purposely selected the Tawang circle as high altitude area (2947 m above sea level), whereas, the Kalaktang (1113 m above sea level) and Dirang (1580 m above sea level) circles were selected as lower altitude areas. At first, the sample design was to select about 10% of the total villages in each circle by using random numbers of the listed villages (Snedecor & Cochran, 1967). The selected villages from the Tawang circle include Lemberdung, Thongleng, Katchanga, Urgeling, Khirmu, and Damgin. Later on, Kongteng, Seru, and Kitpi villages were also included because of the difficulty in getting participants. The selected villages from the Kalaktang circle are Chingi, Rongthangjurpa, Ankalin, Boha, Khungpazong, and Lungdur. For the Dirang circle, five villages, namely, Rama Camp, Sapper Camp, Rungkhung, Kalapahar, and Pangma were randomly selected. Anthropometric data on height, sitting height, body weight, and upper-arm circumference of Monpa boys (9 to 17 years) were collected at different intervals during 2014 following standard techniques (Weiner & Lourie, 1981; Heyward & Wagner, 2004). Anthropometric measurements were taken from the total sample of 219 and 138 boys from lower altitude and high altitude areas respectively.

Data source

For the purpose of comparison, data on height, sitting height, body weight, and upper-arm circumference of Monpa boys were obtained from two cross-sectional studies whose findings were based on data collected during 1977 (by Duarah) and 2014 (present study). Data published by the Indian Academy of Paediatrics (IAP, 2015) were also used to compare the growth pattern of the Monpa boys with Indian standards. Tripathy & Gupta's (2007) reports were used for comparison on the sitting height of Monpa boys with Indian-Tibetan boys, whereas, Weitz et al.'s (2000) report was used to compare the difference in the upper-arm circumference between the Monpas and the Chinese-Tibetan boys.

Statistical analyses

Data were analyzed using SPSS (Version 22.0) for Windows in which the level of significance was set at 5%. Pearson's correlation coefficient (r) was used to test the association between the two variables. Linear regression was used to determine the functional relationship between the variables.

Results

Height, body weight, and sitting height

The age-wise distribution of samples for different anthropometric measurements of Monpa boys (9 to 17 years) belonging to lower and high altitude areas taken during 1977 and 2014 is given in Table 1. The sample size is the same for all the measurements in each study. The means as well as decadal increase in height, body weight, and sitting height for Monpa boys of the lower and high altitude areas are given in Table 2. Overall, the boys of the lower altitude areas are taller and heavier than their counterparts living at a higher altitude across all the ages in both 1977 and 2014 findings. The mean increase (increase per decade) in height over three decades is higher among the lower altitude boys than their high altitude counterparts, except for those 10 and 13 years old (Figure 6). The distance curves for the height (Figure 2) of Monpa boys in comparison with the Indian Academy of Paediatrics (IAP, 2015) growth reference and earlier studies carried out by Duarah in 1977 (Duarah, 1992) shows that the Monpa boys of the lower altitude areas are taller than their high altitude counterparts across ages. The Monpa boys reported in the present study are taller than those reported by Duarah at both lower and high altitudes, though they are far below the 20th percentile of the IAP growth reference. Similarly, in respect of body weight (Figure 3), the lower altitude Monpa boys are heavier than their high altitude counterparts across all ages in both the earlier and present samples. The body weight of Monpa boys (as reported presently) at lower and high altitudes are below the 50th percentile of the IAP growth references (2015) across ages. They are however, heavier than those reported by Duarah (1992) during 1977 for both lower and high altitudes. The increase in weight per decade appears to be more among the high altitude boys (age 10, 11, 13, 14, 17) compared to the lower altitude boys (Figure 7).

When compared the sitting height of Monpa boys with the high altitude Indian Tibetan boys (Tripathy & Gupta, 2007) and those reported by Duarah (Figure 4), the high altitude Monpa boys of the present study show lesser sitting height than their high altitude counterparts as well as than that of the high altitude Tibetan boys. However, both lower and high altitude boys of the present study have greater sitting height than those reported by Duarah (1992). On the other hand, the lower altitude Monpa boys of the present study show greater values in sitting height than the high altitude Tibetan

boys from around 11 till 16 years of age when the latter surpassed the former. The increase in sitting height per decade seems to be higher among the lower altitude boys except in the age 13, 14, and 16, where the high altitude boys show higher increase of the sitting height per decade (Figure 8).

Upper-arm circumference

The distance curves (Figure 5) for the upper arm circumference of Monpa boys in comparison with the high altitude Chinese Tibetan boys (Weitz et al., 2000) and that of the Monpa boys as reported by Duarah show that both the lower and high altitude Monpa boys of the present study have a greater upper arm circumference than the Monpa boys of 1977 at all ages; they also show a bigger arm circumference than the Chinese Tibetan boys up to about 14 years of age. Thereafter, the high altitude Chinese Tibetan boys surpassed the Monpa boys of both lower and high altitudes.

Discussion & Conclusion

As far as literature is concerned, this is the first report on the secular trends of the Monpas of Arunachal Pradesh. In this study, the data sources were managed only from two studies whose anthropometric measurements were taken in 1977 and 2014; a span of over three decades with no studies undertaken in between. Therefore, the present attempt may carry certain limitations with regards to the amount of data as well as sampling variations.

The present findings indicate that the secular trend is operational in the Monpa population in the past 3 decades. In each parameters i.e., height, weight, and sitting height, the present samples show an increase trend from 1977 to 2014. Further, the present study suggests that the increase per decade in those parameters is higher among the lower altitude boys except in few age groups. Therefore, on the basis of the present findings, it is obvious that the Monpa population of Arunachal Pradesh is undergoing an increasing trend in body dimensions, the reasons of which may vary.

Earlier studies on secular trends have shown that the increase in height and body weight over generations is strongly related to the improved overall standard of living such as improvement in nutrition (Hoppa & Garlie, 1998), socio-economic status (Kuh et al., 1991; Padez, 2003), and genetics (Zellner et al., 2004; Krawczynski et al., 2003). In the present study, an attempt was made to test the association of some socio-economic factors such as household income and education assuming that these variables have significant positive relationship to other variables such as nutrition and overall standard of living. Using Pearson's coefficient of correlation (r), it was found that household income does not significantly relate to height, body weight, as well as sitting height of the Monpa boys at both altitudes; yet, the education of parents (mother and father) is positively correlated and highly significant for the increase in height and weight of Monpa boys. Similarly, the results of regression indicate that a parent's education affects the growth patterns of the Monpa boys. Thus, without overlooking on the influence of other factors (environment and genetics), the present findings suggest that similar to earlier findings, socio-economic factors play an important role in regulating and improving the growth of the Monpa boys (Fig 9 and Fig. 10).

When compared with the IAP growth standard for Indian children however, it is seen that despite these increases in growth over a three decades gap, the Monpa boys are still below the growth standard of Indian children. Similarly, the lower altitude Monpa boys show greater values in sitting height than

the high altitude Tibetan boys from around 11 till 16 years of age when the latter surpassed the former. Both lower and high altitude Monpa boys (presently reported) have greater upper arm circumference than the Monpa boys as reported by Duarah at all ages, they also show bigger arm-circumference than the Chinese Tibetan boys up to about 14 years of age.

A comparison on the differences in height (Figure 9) and sitting height (Figure 10) of Monpa boys and other high altitude populations shows that the Monpa boys are similar in height to the Sherpas and Indian Tibetans of Ladakh region, but they are about 9 cm shorter than the Andean highlanders of Bolivia. They are also taller than the Chinese Tibetan, Megu of Nepal, and Nuñoa of Peru. Similarly, the Monpa boys show greater sitting height than the Sherpas, but they are by and large similar to the Chileans and Andean highlanders of Bolivia.

Without ignoring the genetic potential on growth, these results therefore, suggest that though the present population shows an increasing trend in the last three decades, yet, there is a potentiality for the same to achieve further in terms of increase height or weight which may be comparable to the general growth pattern of the Indian children or other Himalayan populations. Nevertheless, since the present report is a first attempt, and considering limitations such as limited data and sampling variations, there is a scope for future research in this area and to delve into the understanding of the secular trend in growth among the Monpas as well as other Northeastern populations.

References

- Ayatollahi, S. M., Pourahmad, S., & Shayan, Z. (2006). "Trend in physical growth among children in southern Iran, 1988–2003". *Ann. Hum. Biol.*, 33: 510-514
- Bareh, H. M. (2001). *Encyclopedia of Northeast India: 1 Arunachal Pradesh*. New Delhi: Mittal Publications
- Das, B. M. (1993). *Outline of Physical Anthropology*. Kitab Mahal, Allahabad-New Delhi
- Dasgupta, P., & Hauspie, R. (eds.) (2000). *Perspectives in Human Growth, Development and Maturation*. pp. 137-145. Kluwer Academic Publishers
- Duarah, D. K. (1992). *The Monpas of Arunachal Pradesh*. Itanagar: Directorate of Research, Government of Arunachal Pradesh.
- Greksa, L. P. (1986). "Chest Morphology of young Bolivian high-altitude residents of European ancestry". *Human Biology*, 58 (3): 427–443.
- Gupta, R., & Basu, A. (1991). "Altitude and growth among the Sherpas of the Eastern Himalayas". *Am. J. Hum. Biol.*, 3 (1): 1–9.
- Heyward, V. H., & Wagner, D. R. (2004). "Applied Body Composition Assessment" (2nd ed.). *Human Kinetics*
- Hoppa, R. D., & Garlie, T. N. (1998). "Secular changes in the growth of Toronto children during the last century". *Ann. Hum. Biol.*, 25: 553-561
- IAP (Indian Academy of Pediatrics). (2015). "Revised IAP Growth Charts for Height, Weight and Body Mass Index for 5- to 18-year old Indian Children". *Indian Pediatrics*, 52: 47–55.
- Krawczynski, M., Walkowiak, J., & Krzyzaniak, A. (2003). "Secular changes in body height and weight in children and adolescents in Poznan, Poland, between 1880 and 2000". *Acta Paediatr.*, 92: 277-282
- Kuh, D. L., Power, C., & Rodgers B (1991). "Secular trends in social class and sex differences in adult height". *Int. J. Epidemiol.*, 20: 1001-1009
- Malina, R. M., Pena Reyes, M. E., Tan, S. K., Buschang, P. H., Little, B. B., & Koziel, S. (2004). "Secular change in height, sitting height and leg length in rural Oaxaca, southern Mexico: 1968–2000". *Ann. Hum. Biol.*, 31: 615-633
- Norbu, T. (2008). *The Monpas of Tawang: Arunachal Pradesh*. Itanagar: Directorate of Research, Govt. of Arunachal Pradesh
- Padez, C. (2003). "Secular trend in stature in the Portuguese population (1904–2000)". *Ann. Hum. Biol.*, 30: 262-278
- Snedecor, G. W., & Cochran, W. G. (1967). *Statistical Methods* (6th ed.). Iowa: The Iowa State University Press
- Tripathy, V. (2006). *Some Aspects of Human Adaptation: An Anthropological Enquiry on a Migrant High Altitude Population*. Unpublished PhD Thesis. Kolkata: Calcutta University.
- Tripathy, V., & Gupta, R. (2007). "Growth among Tibetans at High and Low Altitudes in India". *Am. J. Hum. Biol.*, 19 (6): 789–800
- Ulijaszek, S. J. (2001). "Increasing body size among adult Cook Islanders between 1966 and 1996". *Ann. Hum.*, 28: 363-373
- Virani, N. (2005). "Growth patterns and secular trends over four decades in the dynamics of height growth of Indian boys and girls in Sri Aurobindo Ashram: a cohort study". *Ann. Hum. Biol.*, 32: 259-282
- Weiner, J. S., & Lourie, J. A. (1981). *Practical Human Biology*. London: Academic Press
- Weitz, C. A., Garruto, R. M., Chin, C. T., & Chuan, J. C. (2004). "Morphological growth and thorax dimensions among Tibetan compared to Han children, adolescents and young adults born and raised at high altitude". *Ann. Hum. Biol.*, 31 (3): 292–310.
- Weitz, C. A., Garruto, R. M., Chin, C. T., Liu, J. I. C., Liu, R. L., & He, X. (2000). "Morphological Growth of Han Boys and Girls Born and Raised Near Sea Level and at High Altitude in Western China". *Am. J. Hum. Biol.*, 12 (5): 665–681
- Zellner, K., Jaeger, U., & Kromeyer-Hauschild, K. (2004). "Height, weight and BMI of schoolchildren in Jena, Germany – are the secular changes levelling off?" *Econ. Hum. Biol.*, 2: 281-294

Tables

Table 1: Age-wise distribution of samples at lower & high altitudes

Age (in years)	Lower Altitude		High Altitude	
	1977	2014	1977	2014
9	39	29	23	22
10	35	30	28	14
11	36	21	18	10
12	36	28	31	12
13	35	16	21	12
14	37	31	20	15
15	35	26	16	16
16	31	20	18	18
17	33	18	15	19
Total	317	219	195	138

Table 2: Means of height, body weight, and sitting height in 1977 & 2014

Age (in years)	Lower Altitude			High Altitude		
	1977	2014	Increase/decade	1977	2014	Increase/decade
Height(cm)						
9	117.89	128.48	3.53	119.52	127.84	2.77
10	122.83	130.99	2.72	121.45	130.25	2.93
11	127.45	133.71	2.09	125.57	131.18	1.87
12	130.03	140.59	3.52	131.53	132.78	0.42
13	140.38	145.82	1.81	134.53	143.61	3.03
14	141.72	150.18	2.82	144.85	145.07	0.07
15	147.92	158.35	3.48	144.90	154.73	3.28
16	152.91	160.53	2.54	152.64	156.30	1.22
17	156.97	164.13	2.39	156.18	161.93	1.92
Weight (kg)						
9	21.38	28.78	2.47	21.96	27.55	1.86
10	24.17	28.93	1.59	23.50	30.20	2.23
11	27.04	30.71	1.22	24.44	30.33	1.96
12	27.70	37.82	3.37	29.03	31.00	0.66
13	34.56	38.50	1.31	30.24	37.75	2.50
14	36.57	45.48	2.97	36.30	45.40	3.03
15	39.92	51.69	3.92	40.00	50.00	3.33
16	43.50	53.85	3.45	42.28	51.00	2.91
17	48.53	54.17	1.88	45.43	52.78	2.45
Sitting height (cm)						
9	64.17	68.57	1.47	65.31	66.60	0.43
10	65.82	69.51	1.23	66.44	67.70	0.42
11	67.28	72.88	1.87	67.48	70.10	0.87
12	69.47	76.30	2.28	69.87	71.68	0.60
13	73.37	78.87	1.83	71.30	77.38	2.03
14	76.72	82.64	1.97	75.40	81.66	2.09
15	78.06	85.23	2.39	77.39	82.18	1.60
16	80.68	84.97	1.43	78.21	83.53	1.77
17	83.04	87.07	1.34	81.55	83.85	0.77

Table 3: Pearson's correlation (r) for factors affecting height/weight/sitting height on Monpa boys 2014 samples

Variable	Anthropometric measures		
	Height	Weight	Sitting height
Household income	0.022	0.058	0.081
Father's Education	0.508**	0.452**	0.418**
Mother's education	0.136*	0.136*	0.140*

* Correlation is significant at the 0.05 level; ** Correlation is significant at the 0.01 level

Table 4: Factors affecting height/weight/sitting height on Monpa boys 2014 samples

Variable	Anthropometric measures					
	Height		Weight		Sitting height	
	Regression coefficient	F ratio	Regression coefficient	F ratio	Regression coefficient	F ratio
Father's Education	5.99	109.32	4.41	81.01	2.86	66.57
Mother's education	1.24	5.58	1.02	5.54	0.74	5.94

Images

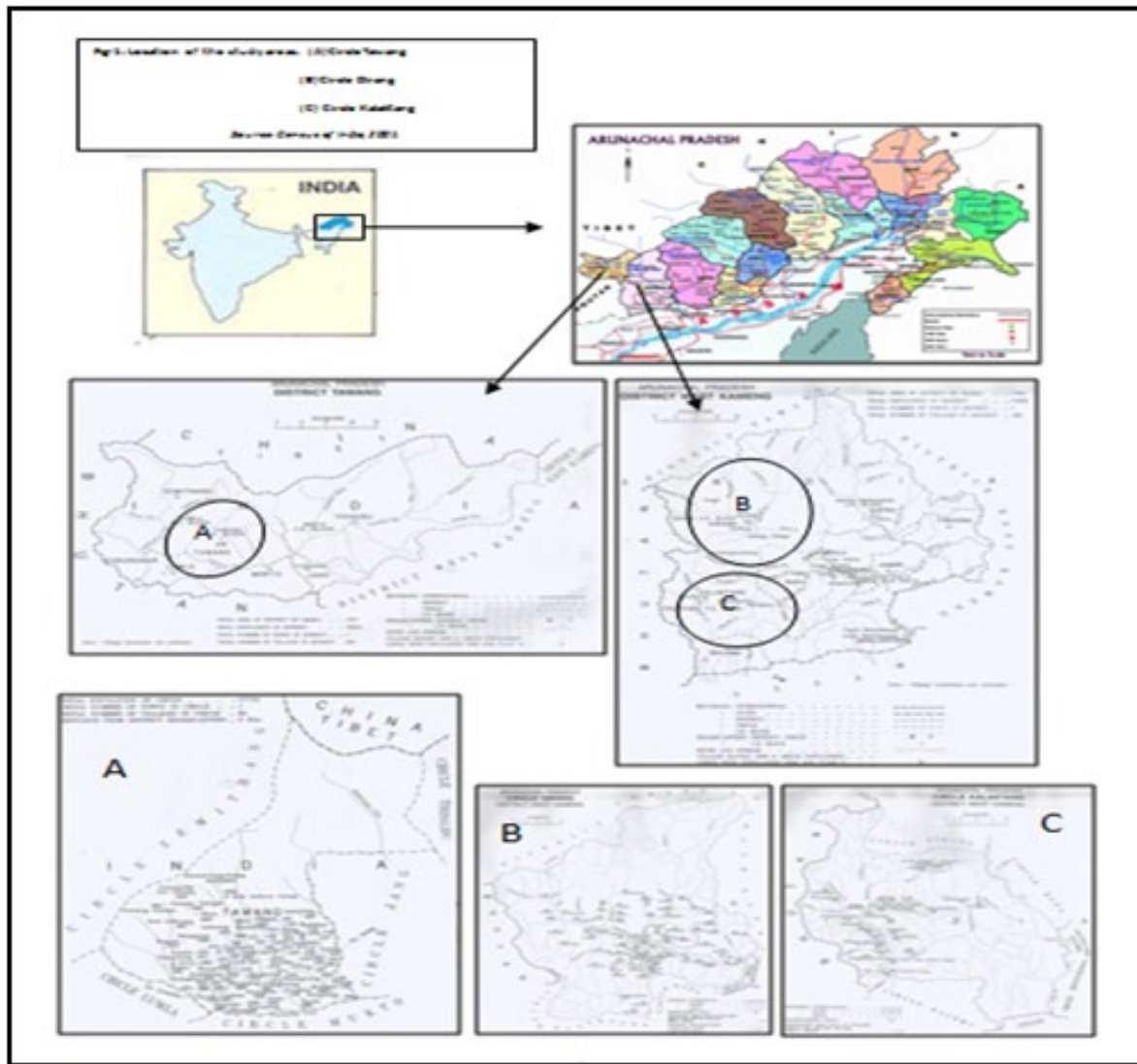


Figure 1: Location of the study area

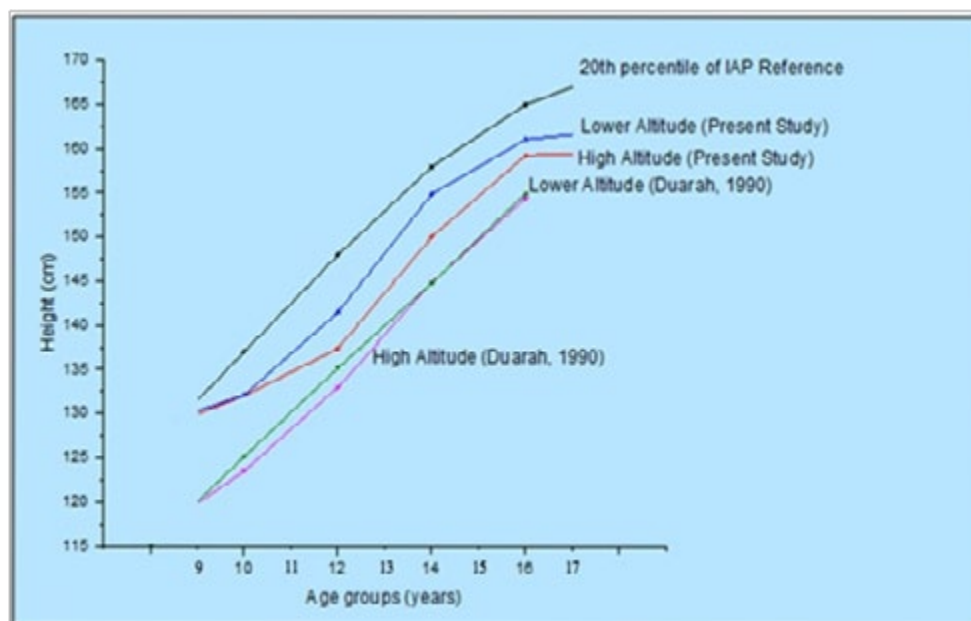


Figure 2: Height of Monpa boys in comparison with IAP reference and earlier studies

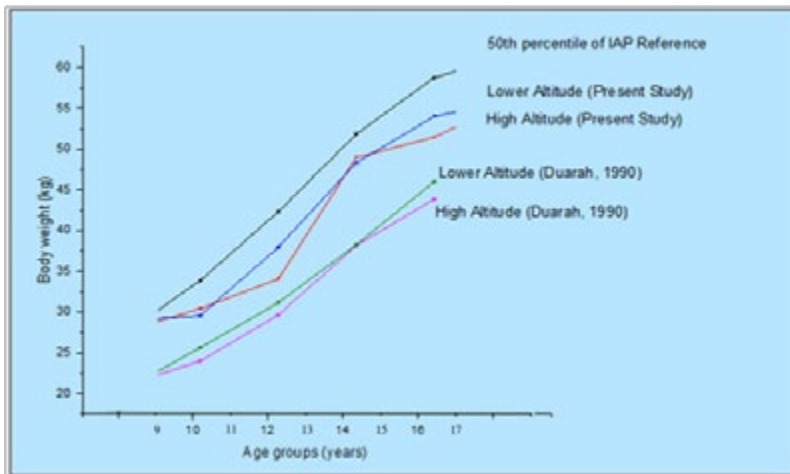


Figure 3: Weight of Monpa boys in comparison with IAP reference and earlier studies.

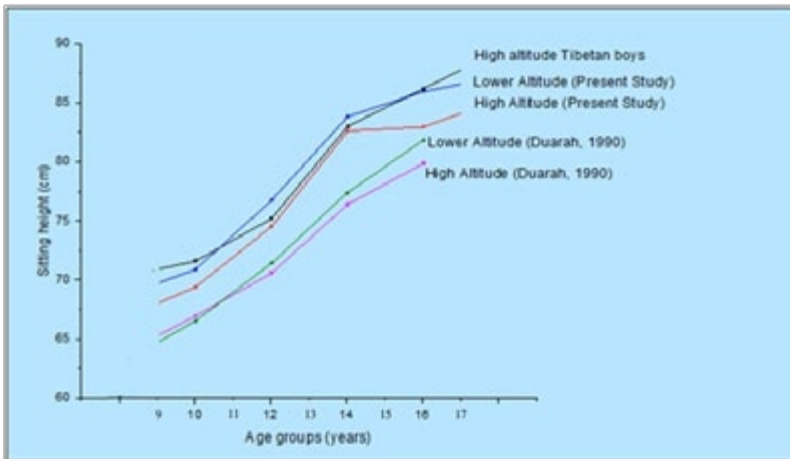


Figure 4: Sitting height of Monpa boys in comparison with earlier studies.

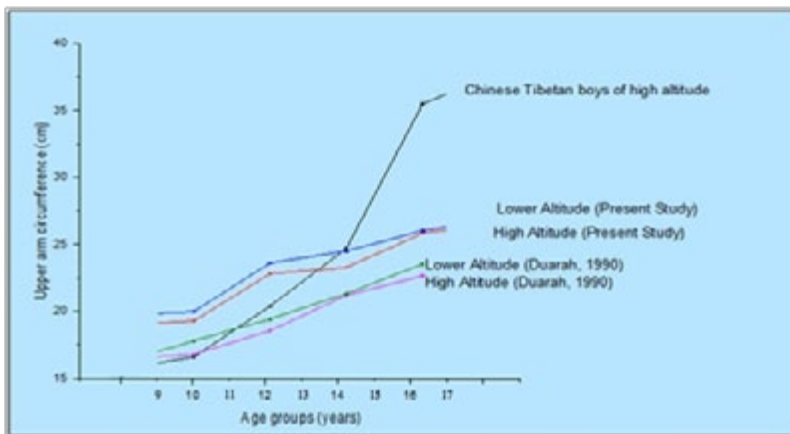


Figure 5: Upper-arm circumference of Monpa boys in comparison with earlier studies.

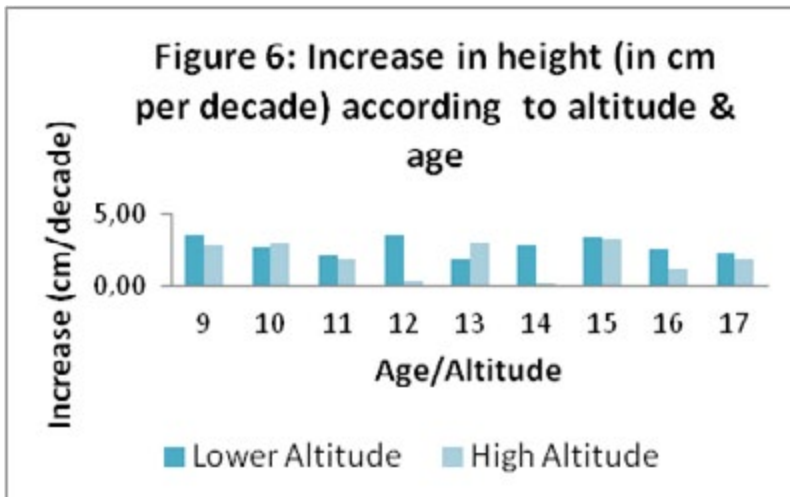


Figure 6: Increase in height (in cm per decade) according to altitude & age

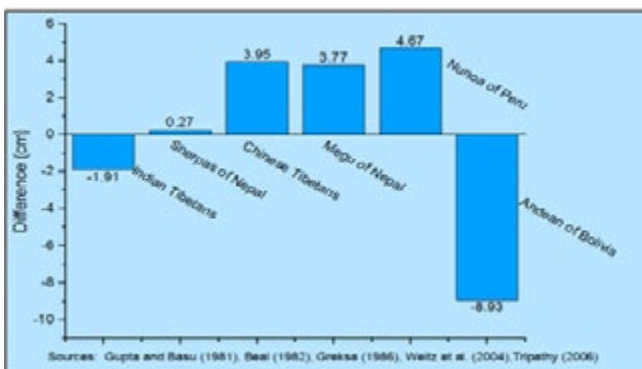
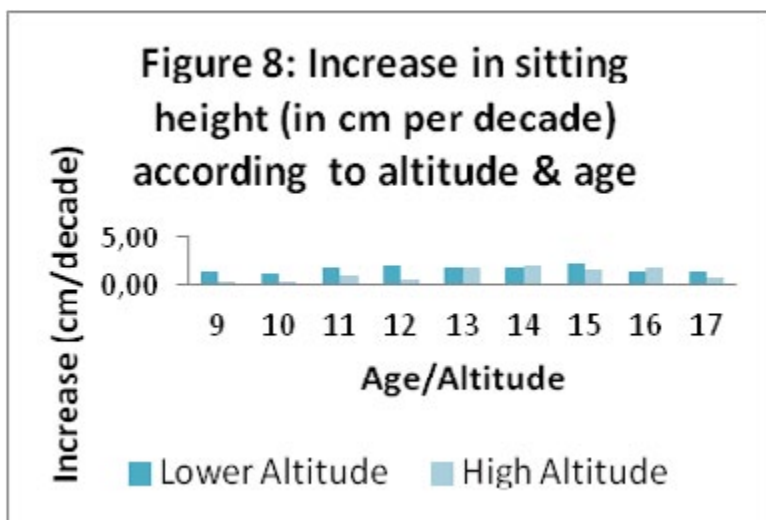
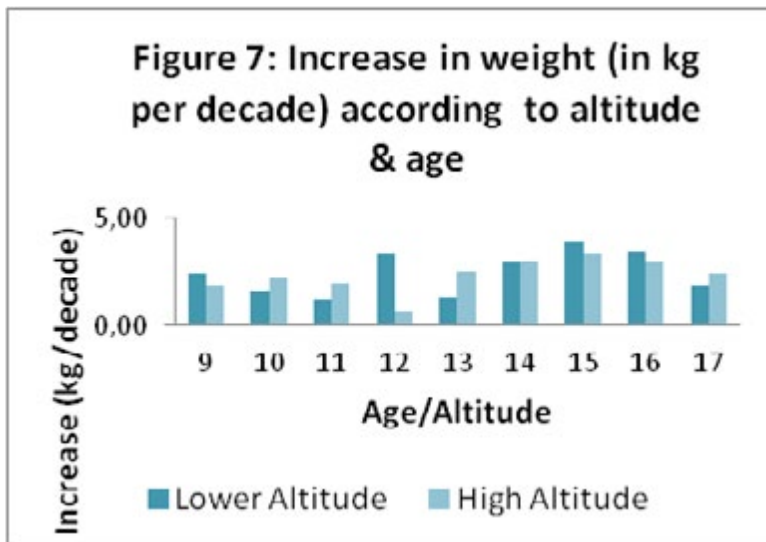


Figure 9: Differences in height of Monpa Boys and other high altitude populations

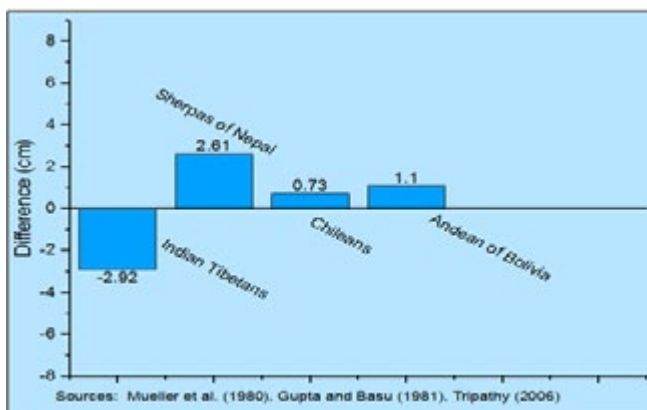


Figure 10: Differences in sitting height of Monpa Boys and other high altitude populations