

A study on adult morphology of high and low altitude Monpas

TiluttomaBaruah

Department of Anthropology, Cotton College, Guwahati

I. INTRODUCTION

Men have been familiar since long with the fact that the conditions of life are usually harder and breathing is more difficult in high altitude areas than in low altitude ones, and that striking functional and morphological differences exist between high and low altitude populations. An appreciable proportion of the world population live permanently at elevations of 3000 m or higher and are exposed to a harsh environment, known as “high altitude”, which in reality comprises a constellation of stresses, namely, hypobaric hypoxia, cold, rugged terrain, high dosage of ultraviolet radiation, iodine deficiency, limited natural resources etc. (Gupta et al. 1989).

Adult body dimensions were subsequently studied at high altitude Bolivia (Mueller et al. 1980, Leatherman et al. 1984), Peru (Monge 1960, Frisancho 1976), Chile (Rothammer and Spielman 1972), Ethiopia (Harrison et al. 1969) and Nepal (Weitz 1973, Sloan and Masali 1978). However, not many reports are available on this line on high altitude Indian populations (Majumder et al. 1986, Singh et al. 1986, Gupta et al. 1989). Moreover, there is no such report in North-East India. Hence, an endeavor has been made in the present study to deal with adult morphology of the Dirang and Tawang Monpa, a low and high altitude population of Arunachal Pradesh.

II. MATERIAL AND METHODS

For the sake of data collection among the Dirang Monpa 146 adult males and 157 adult females were measured. Side by side, among the Tawang Monpa 210 adult males and 262 adult females were measured.

Dirang Monpa: Dirang Monpas are Buddhist by religion, who is one of the sub-groups of Monpa tribe. They inhabit the hilly terrain (1600 m) of West Kameng district of Arunachal Pradesh. This district experiences moderate or heavy rainfall and in the winter it experiences severe cold. Dirang Monpas residing in Dirang town and its surrounding areas were selected for study.

Tawang Monpa: Tawang Monpas are also Buddhist. Like Dirang Monpa they are also one of the sub-groups of the Monpa tribe, who are high altitude (3048 m) people. They inhabit the hilly terrain of Tawang district. This district experiences moderate to heavy rainfall and in the winter it experiences frost and snowfall. For present study Tawang Monpas residing in Tawang town and its surrounding areas were selected.

The investigations were carried out during the months of May and June, 2014 for the Tawang Monpa and during the months of May and June, 2015 for the Dirang Monpa. The anthropometric measurements were taken according to the definition and technique of Martin (1928).

III. RESULTS

Descriptive statistics on anthropometry are set out in Tables 1a and 1b for Dirang and Tawang Monpa males and Tables 2a and 2b for Dirang and Tawang Monpa females respectively. The degree of variation among Dirang Monpa (Tables 1a and 2a) shows that the characters do not represent distinct physical polytypes, which justifies treating the material of the present study as representing a single breeding population. Exceptional case in this respect is weight (males: 16.88 kg; females: 17.83 kg) and upper arm circumference (males: 20.11 cm; females: 22.63 cm). However, such departures from the general trend may be due to sample sizes. Nevertheless, it may be noted that there are some determining differences of variation in greater or lesser order in some measurements. Higher variation is recorded for the biiliac diameter (9.00 cm), chest circumference (8.28 cm) and calf circumference (7.87 cm) in males and for the chest circumference (10.07 cm), calf circumference (9.08

cm) and biiliac diameter (8.70 cm) in females. Side by side, among the Tawang Monpa (Tables 1b and 2b) exceptional case is noticed in weight (18.02 kg) in the males, and weight (19.11 kg) and upper arm circumference (18.02 cm) in females. However, such departures from the general trend may be due to sample sizes. Nevertheless, it may be noted that there are some determining differences of variation in greater or lesser order in some measurements. Higher variation is recorded for the chest circumference (9.31 cm), upper arm circumference (9.66 cm) and calf circumference (9.15 cm) in males and for the chest circumference (10.71 cm), calf circumference (8.98 cm) and biiliac diameter (7.67 cm) in females. Such a variation in these measurements, as explained by Pearson and Davin (1924) is possible due to the spanning of cavities between the space of corresponding measuring landmarks and the varying degrees of thickness of the involved soft tissues of the individuals. However, in a normally distributed sample of a given population, the observed variabilities in different body characters are not unexpected, and on the whole, the Dirang and Tawang Monpa population represented by the present sample is homogenous.

Table 1a: Biometric data: Dirang Males (n=146)

Sl. No.	Measurements	Range	\bar{x} with S. E.	S. D. with S. E.	C. V. with S. E.
1.	Weight (kg)	48-109	65.18±0.91	11.0±0.64	16.88±0.99
2.	Stature (cm)	135.3-179.0	163.52±0.48	5.83±0.34	3.56±0.21
3.	Sitting height (cm)	67.6-95.6	86.68±0.30	3.60±0.21	4.15±0.24
4.	Biacromial diameter (cm)	31.7-41.9	36.77±0.16	1.91±0.11	5.19±0.30
5.	Biiliac diameter (cm)	22.1-36.0	27.79±0.21	2.50±0.15	9.00±0.53
6.	Head circumference (cm)	52.8-61.0	56.70±0.13	1.62±0.09	2.86±0.17
7.	Chest circumference (cm)	76.5-112.8	90.59±0.62	7.50±0.44	8.28±0.48
8.	Upper arm circumference (cm)	21.4-37.9	27.70±0.46	5.57±0.32	20.11±1.18
9.	Calf circumference (cm)	28.5-42.5	34.67±0.23	2.73±0.16	7.87±0.46

Table 1b: Biometric data: Tawang Males (n=210)

Sl. No.	Measurements	Range	\bar{x} with S. E.	S. D. with S. E.	C. V. with S. E.
1.	Weight (kg)	43-104	67.97±0.84	12.25±0.60	18.02±0.88
2.	Stature (cm)	144.7-183.0	165.59±0.43	6.30±0.31	3.80±0.18
3.	Sitting height (cm)	75.0-96.4	87.32±0.26	3.82±0.19	4.37±0.21
4.	Biacromial diameter (cm)	29.5-44.7	38.04±0.16	2.27±0.11	5.97±0.29
5.	Biiliac diameter (cm)	22.0-35.1	29.55±0.14	2.02±0.10	6.83±0.33
6.	Head circumference (cm)	52.0-62.4	56.46±0.15	2.17±0.11	3.84±0.19
7.	Chest circumference (cm)	74.2-117.3	93.04±0.60	8.66±0.42	9.31±0.45
8.	Upper arm circumference (cm)	21.6-35.5	28.35±0.19	2.74±0.13	9.66±0.47
9.	Calf circumference (cm)	27.9-46.0	34.20±0.22	3.13±0.15	9.15±0.45

Table 2a: Biometric data: Dirang Females (n=157)

Sl. No.	Measurements	Range	\bar{x} with S. E.	S. D. with S. E.	C. V. with S. E.
1.	Weight (kg)	42-97	60.44±0.86	10.78±0.61	17.83±1.01
2.	Stature (cm)	140.0-165.0	153.07±0.39	4.93±0.28	3.22±0.18
3.	Sitting height (cm)	70.0-88.1	81.90±0.27	3.39±0.19	4.14±0.23
4.	Biacromial diameter (cm)	28.7-38.8	33.41±0.16	2.05±0.12	6.13±0.34
5.	Biiliac diameter (cm)	22.5-39.0	28.61±0.20	2.49±0.14	8.70±0.49
6.	Head circumference (cm)	52.7-60.2	56.07±0.13	1.59±0.09	2.83±0.16
7.	Chest circumference (cm)	73.0-120.0	94.33±0.76	9.50±0.54	10.07±0.57
8.	Upper arm circumference (cm)	19.9-36.0	27.44±0.50	6.21±0.35	22.63±1.28
9.	Calf circumference (cm)	26.0-43.5	33.68±0.24	3.06±0.17	9.08±0.51

Table 2b: Biometric data: Tawang Females (n=262)

Sl. No.	Measurements	Range	\bar{x} with S. E.	S. D. with S. E.	C. V. with S. E.
1.	Weight (kg)	39-105	60.59±0.72	11.58±0.51	19.11±0.83
2.	Stature (cm)	140.2-172.2	154.18±0.36	5.81±0.25	3.77±0.16
3.	Sitting height (cm)	54.4-95.0	82.21±0.26	4.15±0.18	5.05±0.22
4.	Biacromial diameter (cm)	29.3-40.6	34.28±0.12	2.03±0.09	5.92±0.26
5.	Biiliac diameter (cm)	23.0-39.0	28.94±0.14	2.22±0.10	7.67±0.33
6.	Head circumference (cm)	50.5-59.1	55.05±0.10	1.64±0.07	2.98±0.13
7.	Chest circumference (cm)	74.0-120.5	90.28±0.60	9.67±0.42	10.71±0.47
8.	Upper arm circumference (cm)	20.5-34.6	27.97±0.31	5.04±0.22	18.02±0.79
9.	Calf circumference (cm)	25.5-44.0	33.29±0.18	2.99±0.13	8.98±0.39

A percent frequency of different types of stature is shown in Tables 3a and 3b for the Dirang and Tawang males respectively. More than 31 per cent of the Dirang Monpa males (Table 3a) possess below medium stature. Short (21.23 %) stature occurred in moderate per cent. Medium (17.12 %) and above medium (14.38 %) stature also occurred in moderate per cent among them. However, a considerable percent (12.33) of the males have tall stature. On the other hand, Tawang Monpa males (Table 3b) have medium and tall stature in equal percent (21.9 %) followed by above medium (20.95 %) stature. Below medium (19.53 %) and short (12.86 %) stature also occurred in moderate per cent in this section of population.

Table 3a: Percent frequencies of different types of stature*: Dirang Males

Class (in cm)	No.	Per cent
Very short (130.0-149.9)	5	3.43
Short (150.0-159.9)	31	21.23
Below medium (160.0-163.9)	46	31.51
Medium (164.0-166.9)	25	17.12
Above medium (167.0-169.9)	21	14.38
Tall (170.0-179.9)	18	12.33
Total	146	100.00

*According to Martin (1928: cf. Singh and Bhasin, 1989)

Table 3b: Per cent frequencies of different types of stature*: Tawang Males

Class (in cm)	No.	Per cent
Very short (130.0-149.9)	6	2.86
Short (150.0-159.9)	27	12.86
Below medium (160.0-163.9)	41	19.53
Medium (164.0-166.9)	46	21.90
Above medium (167.0-169.9)	44	20.95
Tall (170.0-179.9)	46	21.90
Total	210	100.00

*According to Martin (1928: cf. Singh and Bhasin, 1989)

Majority of the Dirang females (Table 4a) are represented by below medium (28.66 %) and medium (25.48 %) stature. However, short (17.2 %), above medium (14.65 %) and tall (12.74 %) stature also occurred in moderate per cent among them. On the other hand, majority of the Tawang females (Table 4b) are represented by below medium stature (25.95 %), followed by tall (22.52 %) and medium (21.37 %) stature. However, short stature (17.56 %) also occurred in moderate per cent among the females. Percent frequencies of different types of stature are shown in Figure 1 and 2 for Dirang and Tawang Monpa for both the sexes.

Table 4a: Per cent frequencies of different types of stature*: Dirang Females

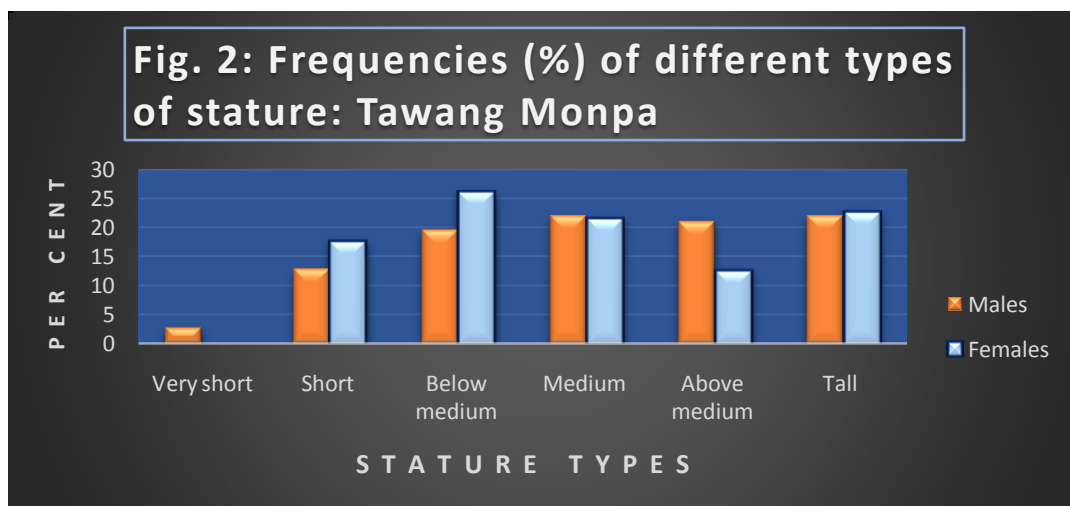
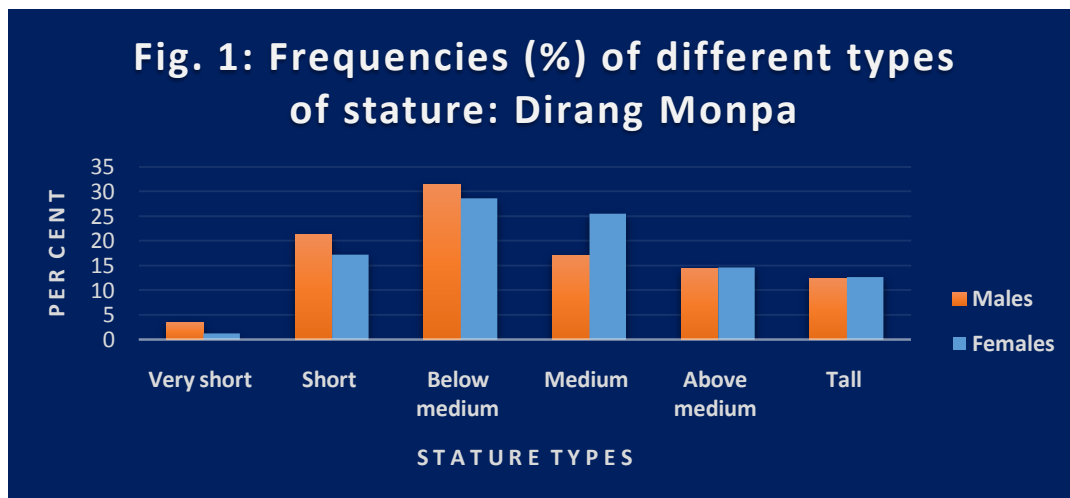
Class (in cm)	No.	Per cent
Very short (121.0-139.9)	2	1.27
Short (140.0-148.9)	27	17.20
Below medium (149.0-152.9)	45	28.66
Medium (153.0-155.9)	40	25.48
Above medium (156.0-158.9)	23	14.65
Tall (159.0-167.9)	20	12.74
Total	157	100.00

*According to Martin (1928: cf. Singh and Bhasin, 1989)

Table 4b: Per cent frequencies of different types of stature*: Tawang Females (n=262)

Class (in cm)	No.	Per cent
Very short (121.0-139.9)	-	-
Short (140.0-148.9)	46	17.56
Below medium (149.0-152.9)	68	25.95
Medium (153.0-155.9)	56	21.37
Above medium (156.0-158.9)	33	12.60
Tall (159.0-167.9)	59	22.52
Total	262	100.00

*According to Martin (1928: cf. Singh and Bhasin, 1989)



Mean, S.D. and C.V. of waist circumference, hip circumference and waist-hip ratio are presented in Tables 5a and 5b for the Dirang and Tawang males respectively. It is found that there are considerable differences in terms of all these anthropometric variables in two populations. Means of waist circumference, hip circumference and waist-hip ratio are all considerably higher among Tawang than that of Dirang Monpa.

males. However, in case of females (Tables 6a and 6b) a reverse trend is perceptible. It is found that means of waist circumference, hip circumference and waist-hip ratio all are considerably higher among Dirang than that of Tawang Monpa females.

Table 5a: Waist - hip ratio: Dirang males

Measurements	Range	\bar{x} with S. E.	S. D. with S. E.	C. V. with S. E.
Waist circumference (cm)	68.50-110.0	86.78±0.68	8.25±0.48	9.51±0.56
Hip circumference (cm)	77.90-109.2	92.01±0.55	6.63±0.39	7.21±0.42
Waist -hip ratio	0.88-1.01	0.94±0.00	0.02±1.17	2.13±0.12

Table 5b: Waist - hip ratio: Tawang males

Measurements	Range	\bar{x} with S. E.	S. D. with S. E.	C. V. with S. E.
Waist circumference (cm)	69.0-114.8	90.24±0.61	8.88±0.43	9.84±0.48
Hip circumference (cm)	78.2-114.9	93.45±0.47	6.76±0.33	7.23±0.35
Waist -hip ratio	0.78-1.20	0.97±5.52	0.07±0.01	7.22±0.31

Table 6a: Waist - hip ratio: Dirang females

Measurements	Range	\bar{x} with S. E.	S. D. with S. E.	C. V. with S. E.
Waist circumference (cm)	67.5-114.2	91.51±0.82	10.34±0.58	11.30±0.64
Hip circumference (cm)	79.5-119.5	95.12±0.61	7.62±0.43	8.01±0.45
Waist -hip ratio	0.85-0.96	0.96±0.00	0.04±0.00	4.17±0.23

Table 6b: Waist - hip ratio: Tawang females

Measurements	Range	\bar{x} with S. E.	S. D. with S. E.	C. V. with S. E.
Waist circumference (cm)	68.0-100.2	84.89±0.38	6.19±0.27	7.29±0.32
Hip circumference (cm)	77.0-114.0	93.75±0.44	7.09±0.31	7.56±0.33
Waist -hip ratio	0.65-1.08	0.91±4.94	0.08±0.01	8.79±0.38

Tables 7a and 7b show the distribution of Dirang and Tawang males according to central obesity indicated by waist-hip ratio. It is found that according to waist-hip ratio centrally obese males (61.90%) are more frequent among the Tawang than that of the Dirang males (36.99%). A more or less same trend is perceptible in case of Dirang and Tawang Monpa females also (Tables 8a and 8b). Centrally obese females are much higher among the Tawang (79.01%) than that of the Dirang Monpa females (58.60%).

Table 7a: Central obesity according to waist-hip ratio: Dirang males

Level of obesity	No.	Per cent
Normal: <0.95	92	63.01
Centrally obese: >0.95	54	36.99
Total	146	100.00

Table 7b: Central obesity according to waist-hip ratio: Tawang males

Level of obesity	No.	Per cent
Normal: <0.95	80	38.10
Centrally obese: >0.95	130	61.90
Total	210	100.00

Table 8a: Central obesity according to waist-hip ratio: Dirang females

Level of obesity	No.	Per cent
Normal: <0.85	65	41.40
Centrally obese: >0.85	92	58.60
Total	157	100.00

Table 8b: Central obesity according to waist-hip ratio: Tawang females

Level of obesity	No.	Per cent
Normal: <0.85	55	20.99
Centrally obese: >0.85	207	79.01
Total	262	100.00

IV. DISCUSSION

Since long, man has been cognizant of the fact that the conditions of life are usually harder and breathing is more difficult in high altitude areas than in the low altitude ones, and that striking functional and morphological differences exist between high and low altitude populations. Multidisciplinary studies on high altitude human biology began as part of the International Biological Programme/Human Adaptability panel on indigenous high altitude populations of the Andes, Simien, Tien Shan-Pamirs and the Himalaya (Gupta et al. 1989).

Rothhammer and Spielman (1972) studied anthropometric variations among high and low altitude Aymara of Chile and found anthropometric distance to closely correspond altitude difference; the high altitude groups had smaller body size and body mass compared to low altitude ones. It is generally suggested that thoracic size was related to respiratory function (Frisancho 1969), but Hoff (1974) failed to find any convincing evidence of altitude effects of adult thoracic size (cf. Gupta et al. 1989).

Dirang and Tawang Monpa are the sub-groups of Monpa tribe. Tawang Monpa inhabit at high altitude, the hilly terrain of the Tawang district of Arunachal Pradesh. It is found from the present study that mean of body weight, stature and chest circumference all are higher among the high altitude Tawang Monpa males than that of the low altitude Monpa males. Side by side, body weight and stature both are higher among the females of Tawang Monpa than their counterpart is. However, mean of chest circumference is higher among the low altitude Dirang Monpa females than that of the high altitude Tawang Monpa females.

It appears from the classification of stature that below medium and short stature both are higher among the Dirang Monpa males than that of the Tawang Monpa males. But, in case of medium and tall stature a reverse trend is perceptible. Among the females below medium and medium stature are higher among the Dirang Monpa. While, short and tall stature females are higher among the Tawang Monpa females than their counterpart is. It is also found that centrally obese individuals are much higher among the high altitude Tawang Monpa (males: 61.90; females: 79.01) than the low altitude Dirang Monpa (males: 36.99; females: 58.60). Thus in fine, it can be said that findings of the present study is more or less indicative of altitudinal stresses on biological traits in highlander Tawang Monpa.

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