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Body Composition of Two High Altitude Populations—Bodhs and Baltis of Ladakh, Jammu and Kashmir, India

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KEY WORDS Bodhs. Baltis. Body Composition Indices. Ladakh.

ABSTRACT In the present paper, lower extremity length, trunk index, chest index, height index, height-weight ratio, body mass index, ponderal index, surface area and body fat are being reported for two high altitude populations—Bodhs and Baltis of Ladakh division of Jammu and Kashmir. Chest index, trunk index, height index and ponderal index donot show any trend. Height weight ratio, body mass index, surface area and body fat per cent increase continuously at all the yearly intervals during adolescent years.

Body composition of human beings is an important aspect of study as it undergoes adjustmental changes when faced with environmental stresses and change in physical activity pattern. Since changes in body composition are known to occur at high altitudes (Surks et al., 1966; Consolozio et al., 1968; Krzywicki et al., 1969). Various attempts have been made by workers to study body composition of highlanders (Bhardwaj, 1973; Bhardwaj et al., 1974, 1977). These studies deal with body composition of defence personel at high altitude. In the present study an attempt has been made to study body composition of two high altitude populations—Bodhs and Baltis of Ladakh division with special reference to adolescence.

MATERIAL AND METHODS

In the present paper two principal population groups of Ladakh division—Bodhs and Baltis staying in Inner Himalayan zone are being reported. A cross-sectional sample of 1009 males ranging from 8+ to 50 years were collected in 1989. Details of sampling methodologies etc. have been discussed elsewhere (Bhasin and Singh, 1991, 1992). For calculating various indices, ratios etc. the following formulae have been used:

(1) Lower Extremity Length = Height vertex - Sitting height
(2) Trunk Index = Bicristal diameter/Biacromial diameter
(3) Chest Index = Antero-posterior diameter of chest / Transverse diameter of chest
(4) Height Index = Sitting height / Height vertex
(5) Height-Weight Ratio = Weight / Height vertex
(6) Body Mass Index = Weight / Height^2
(7) Ponderal Index = Height / $3\sqrt{\text{Weight}}$
(8) Surface area was computed after DuBois and DuBois (1916) and
(9) Body fat was computed by equations given by Slaughter et al. (1988)

RESULTS AND DISCUSSION

The results of the present study are being presented in table 1.

1. Lower Extremity Length: Lower extremity length continues to increase from 8+ to 18+ years in both the population groups under study. To begin with Baltis have higher lower extremity length. Bodhs takes over in lower extremity length at 10+ years and continue the lead till 17+

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Table 1: Body composition indices of Bodhs and Baltis of Ladakh, Jammu and Kashmir, India

Age Years	Bodhs		Baltis	
	Mean	S.D.	Mean	S.D.
1. Lower Extremity Length (cm)				
8+	52.97	4.81	54.18	[illegible]
9+	56.75	5.48	57.24	[illegible]
10+	60.28	4.36	58.63	[illegible]
11+	62.88	3.94	61.02	[illegible]
12+	66.30	4.15	63.36	[illegible]
13+	67.33	4.59	66.08	[illegible]
14+	72.29	5.02	71.31	[illegible]
15+	74.14	4.20	73.95	[illegible]
16+	74.87	4.19	73.84	[illegible]
17+	77.42	4.38	76.40	[illegible]
18+	76.28	4.50	78.86	[illegible]
19+ & ab.	78.23	3.51	79.30	[illegible]
2. Trunk Index				
8+	74.80	6.62	77.41	[illegible]
9+	72.32	6.07	76.56	[illegible]
10+	73.02	6.93	74.42	[illegible]
11+	71.74	6.54	75.27	[illegible]
12+	70.03	6.81	74.38	5.12
13+	71.50	6.17	74.24	5.34
14+	71.42	8.33	75.65	6.50
15+	71.13	6.53	74.26	6.10
16+	73.36	6.73	74.66	5.59
17+	71.42	7.51	73.01	5.34
18+	75.49	5.44	73.68	6.46
19+ & ab.	74.03	7.66	74.80	5.33
3. Chest Index				
8+	73.88	4.15	76.02	4.38
9+	74.27	5.46	76.41	3.13
10+	75.79	4.71	76.06	4.18
11+	74.93	4.62	76.26	4.23
12+	74.44	4.00	77.19	4.27
13+	75.24	3.38	76.83	3.59
14+	75.77	7.41	77.51	4.79
15+	77.09	6.15	77.64	4.61
16+	74.25	3.62	78.07	4.22
17+	73.63	3.60	77.24	3.69
18+	75.34	5.12	76.92	4.50
19+ & ab.	77.04	4.28	75.60	6.06
4. Height Index				
8+	54.95	3.06	54.48	3.62
9+	53.76	1.82	53.77	2.22
10+	53.65	1.60	53.96	1.83
11+	52.66	1.59	52.87	1.45
12+	52.37	1.28	53.28	4.00
13+	52.05	1.47	52.17	1.66
14+	51.91	1.66	51.49	1.54
15+	51.89	1.86	51.95	1.91
16+	52.14	1.65	52.53	1.35
17+	52.15	1.65	51.95	2.26
18+	52.86	2.28	51.67	3.07
19+ & ab.	52.51	1.53	52.35	1.63
5. Height-Weight Ratio (kg/cm)				
8+	17.98	1.81	17.91	2.23
9+	18.58	1.91	18.71	1.73
10+	20.12	2.38	19.30	1.58
11+	21.04	2.75	19.81	1.37
12+	22.17	3.02	21.29	2.75
13+	22.96	2.70	21.70	2.18
14+	25.63	2.81	23.69	2.96
15+	26.56	2.42	25.93	2.76
16+	28.83	2.41	26.52	3.37
17+	31.18	2.26	29.04	3.17
18+	31.40	2.53	29.98	2.26
19+ & ab.	33.73	3.85	32.88	3.42
6. Body Mass Index (kg/m^2)				
8+	15.28	1.29	15.06	1.60
9+	15.16	1.11	15.12	1.02
10+	15.47	1.42	15.17	0.99
11+	15.82	1.65	15.30	1.01
12+	15.87	1.36	15.69	1.42
13+	16.36	1.84	15.73	1.58
14+	17.02	1.26	16.10	1.27
15+	17.22	1.29	16.82	1.28
16+	18.42	1.21	17.00	1.49
17+	19.28	1.36	18.24	1.53
18+	19.40	1.46	18.39	1.61
19+ & ab.	20.48	2.22	18.75	1.93
7. Ponderal Index (cm/kg 1/3)				
8+	43.01	1.41	43.43	1.76
9+	43.71	1.29	43.88	1.21
10+	44.32	1.40	44.26	1.29
11+	44.34	1.48	44.41	1.23
12+	44.98	0.96	44.72	1.25
13+	44.71	1.78	45.03	1.70
14+	45.10	1.14	45.57	1.32
15+	45.32	1.05	45.63	1.19
16+	44.54	1.14	45.66	1.21
17+	44.39	1.29	44.95	1.27
18+	44.31	1.21	45.25	1.58
19+ & ab.	43.83	1.57	44.51	1.41
8. Body Surface Area (m^2)				
8+	0.83	0.07	0.84	0.08
9+	0.88	0.09	0.89	0.08

ab. = above

Age Years	Bodhs Mean	Bodhs S.D.	Baltis Mean	Baltis S.D.
10+	0.98	0.10	0.94	0.08
11+	1.02	0.10	0.96	0.05
12+	1.10	0.12	1.05	0.11
13+	1.13	0.10	1.08	0.08
14+	1.28	0.13	1.21	0.15
15+	1.34	0.09	1.32	0.13
16+	1.41	0.11	1.35	0.16
17+	1.51	0.09	1.44	0.14
18+	1.52	0.08	1.50	0.07
19+ & ab.	1.60	0.10	1.60	0.09
9. Per cent Body Fat				
8+	2.37	1.79	1.33	1.06
9+	2.38	1.79	1.76	1.26
10+	3.00	2.85	1.62	0.97
11+	3.22	2.59	2.12	1.31
12+	3.35	2.71	2.92	1.86
13+	3.19	1.98	2.76	1.64
14+	4.34	1.73	3.45	1.75
15+	4.42	1.81	4.28	1.70
16+	6.46	2.65	4.73	2.19
17+	8.12	2.48	6.59	2.65
18+	6.98	1.99	6.82	1.91
19+ & ab.	9.29	4.74	9.66	5.03

ab. = above

years of age. In the 18+ years' again Baltis show higher lower extremity length than Bodhs. In the age group 19+ and above, Baltis have higher lower extremity length than Bodhs. Maximum per year increment in lower extremity length is shown between 13+ and 14+ years of age in both Bodhs and Baltis.

2. *Trunk Index:* Trunk index does not show any regular trend in both Bodhs and Baltis from 8+ to 18+ years of age. Bodhs show maximum value of trunk index at 18+ years and minimum trunk index at 12+ years, whereas for Baltis maximum and minimum values of trunk index have been observed at 8+ and 17+ years respectively. For age group 19+ and above, Baltis show higher trunk index than Bodhs (Table 1).

3. *Chest Index:* Chest index does not show any regular trend during the adolescent years. For Bodhs, maximum value of chest index has been observed at 15+ years and minimum at 17+ years, whereas in Baltis maximum and minimum values of trunk index have been observed at 16+ and 18+ years respectively. For age group 19+ and above, Bodhs show higher chest index than Baltis. In general Baltis show higher chest index as compared to Bodhs.

4. *Height Index:* Like trunk index and chest index height index too does not show any regular trend in any of population groups. Maximum value of height index has been observed at 8+ and minimum value at 15+ years for Bodhs and at 8+ and 14+ years for Baltis. For age group 19+ and above, Bodhs show higher height index than Baltis.

5. *Height-weight Ratio:* Height-weight ratio increases regularly from 8+ to 18+ years in both Bodhs and Baltis of Ladakh division. Bodhs show higher height-weight ratio at 8+ and continuous to do so till 18+ years, thus showing higher increment in height-weight ratio than their Baltis counterparts. For age group 19+ and above also Bodhs show higher height-weight ratio than Balti adults.

6. *Body Mass Index:* Like height-weight ratio body mass index also shows continues increase in body mass index from 8+ to 18+ years of age in both Bodhs and Baltis. Bodhs show higher increase in body mass index as compared to Baltis during adolescent years. Body mass index increases from 15.28 to 19.40 and from 15.06 to 18.38 in Bodhs and Baltis respectively. For age group 19+ and above also, Bodhs show higher value of body mass index than their Balti counterparts (Table 1).

7. *Ponderal Index:* Unlike height-weight ratio, and body mass index, no regular trend has been observed in ponderal index. Bodhs show maximum and minimum value of ponderal index at 15+ and 8+ years in both Bodhs and Baltis. For age group 19+ and above, Baltis show higher ponderal index than Bodhs (Table 1).

8. *Body Surface Area:* Body surface area increases regularly in both Bodhs and Baltis from 8+ to 18+ years. In general Bodhs have higher body surface area though for some age groups Baltis show higher body surface area. In the age group 19+ and above both Bodhs and Baltis show same body surface area. No marked increase corresponding to adolecent growth spurt has been observed in Bodhs and Baltis of Ladakh division (Table 1).

9. Percent Body Fat: Percent body fat increases regularly with few exception from 8+ to 18+ years in both Bodhs and Baltis of Ladakh division. Bodhs show more body fat as compared to Baltis. Percent body fat increases from 2.37 to 6.98 and 1.33 to 6.82 in Bodhs and Baltis respectively. In age group 19+ and above however Baltis show higher body fat as compared to Bodh adults (Table 1).

Bhasin and Singh (1992) reported that in general Baltis are taller than Bodhs for height vertex and sitting height so accordingly Baltis have higher lower extremity length as compared to Bodhs. Bodhs and Baltis show higher 'lower extremity length' as compared to Tibetans of Jammu and Kashmir whereas Gujjars, and Dogras show higher lower extremity length as compared to Bodhs and Baltis (Bhasin and Singh, 1991).

For height index, chest index and trunk index more or less constant values have been observed, suggesting similar growth patterns in various body parts. Similar findings have been reported by Malina (1974).

Norgan and Jones (1990) reported that body mass index (BMI) of less than 16 kg/m^2 has been proposed as cut-off point for severe chronic energy deficiency. According to this cut off Bodhs and Baltis are undernourished even by standard of developing countries. Baltis have lower nutritional standard as compared to Bodhs which are comparatively better-off than Baltis.

Whereas bones remain relatively constant and total protein can also be altered by disease etc., body fat remains most variable of major constituents of body. Quantity of fat depends upon simple every day experience—difference between energy output and calorie input because of its variability fat commands special interest in studies of body composition. During adolescent years, Gujjars, Dogras and Tibetans have higher body fat percentage as compared to Bodhs and Baltis of Ladakh division. In the age group 19+ and above, also Bodhs and Baltis show lower body fat per cent as compared to other population groups of the state.

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