

## Relationship Between Lung Functions and Body Measurements: A Study Among Gujjars and Tibetans of Jammu and Kashmir, India

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**ABSTRACT** Cross-sectional data on height vertex, body weight and three lung functions FVC, FEV<sub>1.0</sub> and PEF were obtained on 84 Gujjar and 123 Tibetan boys of Jammu and Kashmir in 1989. Height vertex, body weight and lung functions showed continuous increments, though occurrence of 'accelerated growth' varied for different measurements. The lung functions are showing positive correlation with body weight followed by height vertex.

Studies of lung functions of highlanders have shown that they have considerably larger lung volumes than populations of plains (Cotes et al., 1973, 1974). Since existing evidences does not show that level of altitude has significant effect on lung functions (Goldman and Backlace, 1959; Koptzky et al., 1974), it has been suggested that other environmental differences, particularly inhabital activity may be responsible for varied lung size. Positively significant correlations have been reported between lung functions and body weight; height vertex (Jain and Ramiah, 1969; Malik and Singh I.P., 1979; Bhasin and Singh L.P., 1990). In continuation with earlier communication (Bhasin and Singh, L.P., 1990), in the present report; two population groups, Gujjars, (a transhumant group staying in Jammu division) and Tibetans (a refugee community settled in and around Leh, 3500 m) are being reported.

### MATERIAL AND METHODS

For the present study, 84 Gujjar and 123 Tibetan boys ranging from 8+ to 18+ years were studied cross-sectionally from Jammu and Lel districts of Jammu and Kashmir in 1989. Gujjars are a transhumant group, who stay at low altitude areas of Jammu during winter and migrate to higher ranges of Jammu division, Kashmir

valley and even to Ladakh mountains during summer. Tibetans, a refugee community migrated from Tibet and are settled in and around Leh. Small sample size of Gujjars is due to inaccessibility of the transhumant community, while for Tibetans, population size itself is very small. Gujjar boys ranged from 9+ to 18+ years, whereas Tibetan boys ranged from 8+ to 18+ years. For the purpose of analysis the subjects were grouped into yearly age groups. The subjects aged between 8.00 to 8.99 years were grouped into 8+. The individuals selected for the study were normal unrelated subjects at random. The anthropometric measurements and physiological measurements were taken following the techniques described by Weiner and Lourie (1969) and Singh and Bhasin (1989). Lung functions were studied by using Morgan's portable spirometer.

### RESULTS AND DISCUSSION

The result of the present study are being presented in tables 1 and 2. Height vertex increases continuously throughout the adolescent growth phase. The growth in height vertex is faster in Tibetans than Gujjars but as Gujjars are well ahead of Tibetan to begin with, therefore Gujjars remain ahead of Tibetans 8+ through 18+

years Tibetan boys show higher increment than Gujjars growth spurt occurs between 11+ and 12+ years (Table 1). Maximum gain per year corresponding to adolescent in both Gujjars and Tibetans. Body weight increase regularly in Gujjars and Tibetan from 8+ to 15+ years. Gujjars are heavier than Tibetans at 8+ and throughout the period under study till 15+ years. Maximum gain per year is observed between 11+ and 12+ years in Gujjars and a year later in Tibetan boys (Table 2). For both height vertex and body weight, the highest increment occurs between 11+ and 13+ years in Gujjars and Tibetans. From the studies, it has been established that period of accelerated growth varies from individual to individual but every individual growing under normal circumstances must experience the accelerated period of growth between 12 and 17 years of age (Tanner, 1962; Tanner et al., 1966a, 1966b, Miklashevskaya, 1966 and Marshall, 1977).

Table 1: Height vertex (cm) body weight (kg) and lung functions among Gujjars and Tibetan boys of Jammu and Kashmir

Age years	Gujjars			Tibetans		
	N	Mean	S.D.	N	Mean	S.D.
<b>Height Vertex (cm)</b>						
8 +	-	-	-	12	125.60	4.04
9 +	06	138.71	6.20	15	127.99	4.64
10 +	09	136.95	6.33	11	128.26	5.40
11 +	08	141.18	8.63	10	132.56	7.43
12 +	14	150.02	8.17	10	137.94	7.24
13 +	10	153.70	5.19	11	145.10	8.34
14 +	09	156.70	6.27	07	139.92	9.49
15 +	08	165.92	10.57	13	154.84	7.50
16 +	10	168.15	4.94	20	160.28	6.89
17 +	04	168.25	4.40	09	161.42	4.21
18 +	06	164.91	1.81	05	159.04	4.80
<b>Body Weight (kg)</b>						
8 +	-	-	-	12	23.50	2.57
9 +	06	28.41	3.77	15	25.16	3.08
10 +	09	27.38	3.47	11	24.77	3.09
11 +	08	30.87	5.43	10	27.80	4.70
12 +	14	35.53	6.14	10	30.70	4.83
13 +	10	38.75	5.08	11	34.40	4.99
14 +	09	42.94	4.55	07	32.64	1.86
15 +	08	48.50	8.35	13	44.96	6.26

16 +	10	51.45	4.83	20	48.50	6.17
17 +	04	51.37	4.57	09	50.55	6.25
18 +	06	48.83	0.81	05	47.00	4.12
<b>Forced Vital Capacity (FVC lit)</b>						
8 +	-	-	-	06	1.64	0.36
9 +	06	1.83	0.51	05	1.13	0.25
10 +	09	1.71	0.31	02	1.60	0.11
11 +	08	2.00	0.51	07	1.44	0.32
12 +	14	2.15	0.44	09	2.02	0.62
13 +	10	2.37	0.61	10	2.08	0.54
14 +	09	2.44	0.54	06	1.91	0.44
15 +	08	2.72	0.52	10	2.46	0.63
16 +	10	3.08	0.71	16	2.92	0.95
17 +	04	3.24	0.26	09	3.25	0.57
18 +	06	3.65	0.24	09	3.35	0.93

<b>Forced Expiratory Volume: (FEV<sub>1.0</sub> lit)</b>						
8 +	-	-	-	06	1.44	0.43
9 +	06	1.90	0.37	05	1.20	0.36
10 +	09	1.41	0.28	02	1.59	0.11
11 +	08	1.83	0.39	07	1.43	0.32
12 +	14	1.89	0.38	09	1.76	0.40
13 +	10	2.10	0.50	10	1.83	0.51
14 +	09	2.10	0.40	06	1.85	0.44
15 +	08	2.52	0.52	10	2.41	0.63
16 +	10	2.85	0.56	16	2.68	0.65
17 +	04	2.97	0.29	09	3.06	0.50
18 +	06	3.43	0.57	04	3.16	0.78

<b>Peak Expiratory Flow (ml)</b>						
8 +	-	-	-	06	138.33	50.11
9 +	06	197.50	42.06	05	117.60	32.33
10 +	09	192.66	45.34	02	210.00	33.94
11 +	08	181.12	34.52	07	187.00	57.59
12 +	14	226.21	85.41	10	201.40	60.40
13 +	10	219.00	65.34	09	170.66	60.40
14 +	09	235.22	73.47	06	208.00	95.77
15 +	08	274.87	130.60	10	297.10	108.28
16 +	10	355.10	111.15	16	308.12	74.82
17 +	04	274.00	45.34	09	351.33	99.91
18 +	06	404.33	31.88	04	330.50	86.35

Like height vertex and body weight, lung functions also increase during the period 8+ to 18+ years. In both Gujjars and Tibetans, forced vital capacity (FVC) increase during the period under study. Gujjars are ahead of Tibetans at all yearly intervals, but the gap narrows down as the age increases. Tibetan boys develop more forced vital capacity than Gujjars in the corresponding period showing that total gain is higher in Tibetans than

Table 2: Co-efficient of Correlation between height vertex, body weight and lung functions among Gujjar and Tibetan boys of Jammu and Kashmir

Age years	FVC	FEV <sub>1.0</sub>	PEF	FVC	FEV <sub>1.0</sub>	PEF
<b>Height Vertex and Lung Functions</b>						
8 +				-0.38	-0.57	-0.74
9 +	0.78	0.87	0.79	-0.22	0.17	0.03
10 +	0.73	0.86	0.33	1.00	1.00	1.00
11 +	0.95 <sup>2</sup>	0.99 <sup>2</sup>	0.39	0.36	0.35	0.64
12 +	0.66 <sup>1</sup>	0.71 <sup>1</sup>	0.32	0.36	-0.06	-0.20
13 +	0.90 <sup>2</sup>	0.77 <sup>1</sup>	0.44	0.70	0.59	0.58
14 +	0.47	0.68	0.34	0.01	0.16	0.37
15 +	0.77	0.67	0.45	0.48	0.48	0.56
16 +	0.19	-0.04	0.00	0.51	0.48	0.26
17 +	0.50	-0.01	-0.79	0.46	0.64	0.55
18 +	0.42	-0.90 <sup>2</sup>	0.38 <sup>1</sup>	0.65	0.74	0.23
<b>Body Weight and Lung Functions</b>						
8 +				-0.51	-0.09	0.01
9 +	0.81	0.33	0.51	-0.37	0.26	0.10
10 +	0.91 <sup>2</sup>	0.71	0.32	1.00	1.00	1.00
11 +	0.93 <sup>2</sup>	0.85	0.34	0.23	0.22	0.69
12 +	0.73 <sup>1</sup>	0.80 <sup>2</sup>	0.66 <sup>1</sup>	0.64	0.42	0.02
13 +	0.92 <sup>2</sup>	0.79 <sup>1</sup>	0.43	0.70	0.51	0.56
14 +	0.71	0.41	0.74	-0.34	-0.26	-0.25
15 +	0.95 <sup>2</sup>	0.82 <sup>1</sup>	0.45	0.36	0.35	0.44
16 +	0.48	0.45	0.42	0.49	0.49	0.10
17 +	0.63	0.54	-0.06	0.17	0.34	0.48
18 +	0.12	-0.47	0.58	0.95	0.96	0.78

Significant 1. P > 0.01 2. P > 0.001

Gujjars (Table 1). In Forced Expiratory Volume also, Gujjar show higher value than Tibetan boys at all yearly intervals. Total attained volume is slightly higher in Gujjar than Tibetan boys (Table 1).

Peak Expiratory Flow (PEF) increase continuously in Gujjars and Tibetans. For PEF, Gujjar boys are mostly ahead of Tibetan boys but at some yearly intervals Tibetan boys are comparable with their counterpart Gujjar boys of corresponding age.

For height vertex and body weight as well as for the lung functions at some yearly intervals, some deviations from normal trends have been observed. These fluctuations may be due to small sample size and cross-sectional nature of study.

Earlier reports show that in populations from plains as well as altitudes, lung functions are significantly correlated with height vertex, body weight and age (Jain and Ramiah, 1969; Malik and Singh, 1979, Bhasin and Singh, 1990). For both Gujjars and Tibetans lung functions show mostly positive correlation with height vertex and body weight (Table 2). It has been observed that lung functions show higher values of correlation with body weight than height vertex. Similar findings has been reported for Ladakhi Bods, Gaddis of Himachal Pradesh and Dogra population groups of Jammu (Malik and Singh, I.P., 1979; Singh, I.P. and Bhasin, 1983; Bhasin and Singh, 1990).

As the two populations under study come from two different altitudes, it becomes relevant to establish the differences with adjoining population groups: Gujjars show higher stature than Dogra Rajputs and Scheduled Castes whereas Dogra Brahmans are taller than Gujjars. For body weight, Gujjars are heavier than Dogra Brahmans, Rajputs and Scheduled Castes of the same region. Tibetans show higher body weight than Bods of Leh, but lesser body weight as compared to Bods of Kulu, who stay at 1500-2000m, whereas both Tibetans and Bods of Leh stay in and around Leh (3514 metres). For height vertex also Tibetans of Leh are taller than Leh Bods and Kulu Bods of high and middle altitudes. For Forced Vital Capacity, Gujjars show higher values than Dogra Brahmans, Rajputs and Scheduled Castes. Same trends has been observed for FEV<sub>1.0</sub> and PEF at most of the age groups. Tibetans of Leh show higher value of forced vital capacity than Bods of Leh and Kulu to begin with, but at later stage, Bods pick up 'more momentum' and finally show higher values of FVC than their Tibetan counterparts. For Forced Expiratory Volume, Tibetans of Leh show lesser value at corresponding age than Bods of Leh and Kulu, occupying high and mid altitudes. Similar trend has been observed for Bharmour Brahmans, Bharmour Rajputs, Kangra Brahmans, Kangra Rajputs (Singh, R., 1979).

Several studies emphasized that respiratory

functions are mainly governed by environmental stresses like high level habitual activity rather than altitude, genetic or industrial pollution factors (Cotes et al., 1973; Jones et al., 1977 and Anderson et al., 1978). Gujjars show higher values than the other populations of the area, this may be due to the transhumant mode of life, seasonal migrations to higher altitudes and other stresses common in nomadic modes of life. Lower values of lung functions in Tibetan may be due to the fact that Tibetans are mostly traders and workers, while other two populations, being compared with Tibetans, Bods of Leh and Kulu are exposed to more environmental hazards.

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#### REFERENCES

- Anderson, H.R.: Respiratory abnormalities in Papua, New Guinea children, the effect of locality and domestic wood smoke. *Int. J. Epidemiology*, 7: 63-72 (1978).
- Bhasin, M.K. and Singh, L.P.: Lung functions and their correlation with height and weight among Dogras of Jammu and Kashmir, India. *J. Hum. Ecol.*, 1: 287-290 (1990).
- Cotes, J.E., Anderson, H.R. and Patrick, J.M.: Lung function and the response to exercise in native New Guineans: Role of genetic and environmental factors. *Philosp. Trans. Royal Soc., B* 268, 349-361 (1974).
- Cotes, J.E., Dabbs, J.M., Hall, A.M., Axford, A.T. and Lamence, K.: Lung volumes, ventilatory capacity and transfer factor in healthy British boy and girl twins. *Thorax*, 28: 709-715 (1973).
- Goldman, H.I. and Becklake, M.R.: Respiratory function tests. Normal values at median altitude and prediction of normal results. *Am. Rev. Resp. Dis.*, 79: 457-467 (1958).
- Jain, S.K. and Ramiah, T.J.: Normal standard of pulmonary function tests for healthy Indian men 15-40 years old. Compensation of different regression equations (Prediction formula), *Ind. J. Med. Res.*, 57: 1453-1466 (1969).
- Jones, P.R.M., Baber, F.M., Herwood, C. and Cotes, J.E.: Ventilatory capacity in healthy Chinese children: relation to habitual activity. *Ann. Hum. Biol.*, 4: 151-161 (1977).
- Kopetzky, M.T., Maselli, R. and Elliot, E.R.: Pulmonary function studies with simple equipment in 323 normal children. *J. Aller. Clin. Immuno.*, 53: 1-8 (1974).
- Malik, S.L. and Singh, I.P.: Lung Functions in Highlander Bods of Ladakh. *Am. J. Phys. Anthropol.*, 51: 383-388 (1979).
- Marshall, W.A.: *Human Growth and its Disorders*. Academic Press, London, (1977).
- Miklashevskaya, N.N.: Growth of head and face in boys of various ethnic groups in U.S.S.R.: *Hum. Biol.*, 38: 231 (1966).
- Singh, I.P. and Bhasin, M.K.: Anthropological studies among Pangwalas and Gaddis of Himachal Pradesh, North India. *Anthrop. Anz.*, 41: 137-148 (1983).
- Singh, I.P. and Bhasin, M.K.: *A Laboratory Manual on Biological Anthropology. Section I. Anthropometry*. Kamla-Raj Enterprises, Delhi (1989).
- Singh, R.: *Age Changes in Biological Variables in Transhumant and Settled Populations: A Comparative Study of Gaddi Rajputs and Brahmans of Sub-tehsil Bharmour District Chamba and District Kangra, Himachal Pradesh*. Ph.D. Thesis, University of Delhi, Delhi (1979).
- Tanner, J.M., Whitehouse, R.H. and Takahasi, M.: Standard from birth to maturity for height, weight, height velocity and weight velocity. British children 1965 Part I. *Arch. Dis. Child.*, 41: 454 (1966a).
- Tanner, J.M., Whitehouse, R.H. and Takahasi, M.: Standard from birth to maturity for height, weight, height velocity and weight velocity, British Children 1965. Part II. *Arch. Dis. Child.*, 41: 613 (1966b).
- Weiner, J.S. and Lourie, J.A.: *Human Biology—A Guide to Field Methods. IBP Handbook No.9*. Blackwell, Oxford (1969).