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A study on BMI among the Bhotia of Uttaranchal, India

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ABSTRACT

Objective: To investigate the nutritional status of the males and females in two subgroups of the Bhotia tribe (Marcha and Tolcha) inhabiting in three different altitudes in Uttaranchal, India. **Methods:** Data were collected from the Tolcha and Marcha, two sub-groups of the Bhotia, inhabiting in Chamoli district of Uttaranchal. Bhotia adults of both sexes were considered. Field investigation was conducted in three ecological zones (high, middle and low altitude) of the district during April–August, in the years 2002–2004. Anthropometric measurements were obtained in accordance with the techniques recommended by Weiner and Lourie (1981). The variables like height, weight, waist circumference, hip circumference, waist–hip ratio and blood pressure were studied in relation to BMI. **Results:** Relatively higher value of mean BMI is recorded among the females than that of the males, which is true for different altitudes, in both subgroups. The BMI also indicates an inverse relationship with altitude, except for the Tolcha males in high altitude. Lowest mean BMI is recorded in middle altitude among the Tolcha subgroup. Chronic energy deficient (CED) individuals are much more than twice the number among the males of both the subgroups inhabiting in different altitudes. Interestingly, the percentage of CED individuals increases with the altitude. **Conclusions:** Regression analysis indicates that height, weight, hip circumference and waist circumference are dependent on body mass index in the studied populations. Probable reason for poor nutrition status among the Tolcha and Marcha of high altitude might be due to the fact that the Tolcha and Marcha of high altitude consume lesser amount of proteins, fat, milk and milk products in general than their counterpart inhabit in lower and middle altitude.

1. Introduction

A good number of world population live at altitudes ranging from 3 000 to 5 200 m above sea level but it has not been established yet whether altitude constitutes a variable affecting energy requirements^[1]. Picon–Reategui^[1] further said that hypoxia has a stressful effect on physiology of the animal organism. However, other components of the high altitude environment, such as cold, rough terrain and low vapor tension, may also affect metabolic processes and, of course, nutrient requirements. Dietary and lifestyle changes have profound influences on the body mass and nutritional status of individuals living in developed countries. From a study of the prevalence of obesity among the Sherpa women^[2], the body weight and body mass index (BMI) were significantly higher for the urban low altitude than the high altitude. The rural, high altitude had the lowest body weight, triceps skin fold, and BMI.

A number of studies on the impacts of altitudinal stresses

on human biological traits have been conducted in different parts of the globe. Khalid^[3] conducted a cross-sectional study on school children and adolescents to find out the prevalence of childhood overweight and obesity in rural high and low altitude populations of southwestern Saudi Arabia and to identify specific at-risk groups within these groups. He identified risk factors for childhood overweight and obesity in Saudi Arabia. Among these, high altitude was a significant and independent factor. Mohanna *et al*^[4] described the lipid profile of a high altitude population and relate it to the waist circumference, body mass index, gender and age. Effects of stay in desert and high altitude on physical fitness and body composition of physically active individuals was examined by Amitabh *et al*^[5]. According to them, a combination of different factors *i.e.* higher resting pulse rate, increased blood pressure and body fat may be responsible for lower physical fitness index at high altitude. Side by side, Tripathi *et al*^[6] examined the serum and urinary electrolytes level in the subjects of two different environmental conditions. Nutritional status and prevalence of hypertension and the relationship between them in adult Tibetan refugee population in India at three different places have been investigated by Tripathy and

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Gupta[7]. No relationship between nutritional status and body composition with blood pressure was found by them. In terms of nutritional status and hypertension, Tibetans in India resemble populations from developed countries who are described as urban having a sedentary way of life. They [8] also studied the birth weight among Tibetans at different altitudes in India and examined whether the Tibetans are better protected from IUGR. Tyagi *et al*[9] examined aging process in a high altitude population and a population residing in plains with a special emphasis on gender differences in physical and physiological traits.

In another study, Lhamo *et al*[10] made an attempt to determine the prevalence of obesity at varying altitudes in Tibet and Nepal, and to estimate the effect of altitude on BMI, waist circumference (WC) and waist-to-height ratio (WHtR). According to their study, BMI, WC and WHtR decreases with increasing altitude.

Subjects of the present study, the Bhotias, are one of the major tribal groups of Uttarakhand Himalaya in India. They are of mongoloid origin and practice transhumance and speak Tibeto-Burman languages. The word Bhotia is a generic term for several groups of people inhabiting the ranges along the snowy peaks of the Himalayas. Etymologically, the word 'Bhotia' is believed to have originated from the term 'Bhot' or more correctly 'Bod' which means Tibet[11]. They have various local names throughout the Himalayan region. The Bhotias are divided into 8 sub-groups on the basis of religion, territory, occupation and dialect. The sub-groups are: (a) Jad, (b) Tolcha, (c) Marcha, (d) Johari, (e) Jethora, (f) Darmi, (g) Chaudansi and (h) Byansi. They practice endogamy at the territorial level and exogamy at the clan/ lineage level. Primary occupation of the Bhotia is agriculture. Secondary occupations are weaving-spinning and animal husbandry. Though business is their traditional occupation, presently some of them are involved in government jobs. Literature on BMI of adult Indians is available according to certain geographical areas as well as populations. However, very few studies have reported BMI values in Indian population living in different altitudes. The study of Tripathy and Gupta[7] is remarkable in these respects, who have studied BMI among the Tibetan adults of different altitudes in India. However, there is no such study among the Bhotia in this aspect, to the best of author's knowledge. The present study aims to evaluate if there exists any nutritional effect among the Bhotia of Uttarakhand living in different altitudinal levels.

2. Materials and methods

Data of the present study were collected by one of us (C.M.) from the Tolcha and Marcha, two sub-groups of the Bhotia, inhabiting in Chamoli district of Uttarakhand. Bhotia adults of both sexes were considered. Field investigation was conducted in three ecological zones (high, middle and low altitude) of the district during April–August, in the years 2002–2004. The Bhotia households, from which participants were drawn, located in 2 300 ft above sea level for lower altitude, 6 107 ft. above sea level for middle altitude and 11 461 ft. above sea level for higher altitudinal zone. Anthropometric measurements were obtained in accordance with the techniques recommended by Weiner and Lourie[12]. The study sample includes 1 875 subjects, comprising 938 males and 937 females. The Marcha sample consists of 1 017 adult individuals (male: 493, female: 524) and Tolcha sample consists of 858 adult individuals (male: 445, female: 413). The variables like height, weight, waist circumference, hip circumference, waist-hip ratio and blood pressure were studied in relation to BMI.

3. Results

Means and standard deviations of anthropometric measurements in different altitudes are presented for the Marcha and Tolcha sub-groups of the Bhotia in Table 1 for both the sexes. Among the Marcha, males mean height increases from lower to middle altitude, there after, it decreases in high altitude. But in case of weight and hip circumference, the mean values decreases as the altitude increases. So far waist circumference is concerned; the highest mean value is observed in low altitude followed by high altitude. In the Marcha females highest value of mean height as well as weight is observed in low altitude followed by high altitude. Highest waist circumference is observed in middle altitude followed by low altitude. Hip circumference decreases as the altitude increases. Comparison across sex shows that males have higher mean values of anthropometric measurements at all ecological zone except hip circumference.

In case of Tolcha means of height, weight, waist and hip circumference show similar trend with the Marcha irrespective of sex, except waist circumference and hip circumference in females. In this sex highest mean of waist circumference is observed in low altitude followed

Table 1
Means of anthropometric measurements in different altitudes.

Population	Sex	Altitude	Sample size	Height (cm)	Weight (kg)	Waist circumference (cm)	Hip circumference (cm)
Marcha	Male	Low	155	162.41 ± 5.81	57.27 ± 9.76	80.25 ± 10.12	91.15 ± 5.60
		Medium	124	163.42 ± 6.72	54.93 ± 7.93	76.56 ± 7.96	89.75 ± 4.99
		High	214	162.74 ± 6.14	54.29 ± 8.39	77.91 ± 8.57	89.04 ± 5.12
	Female	Low	216	151.00 ± 4.42	52.63 ± 8.51	75.03 ± 9.31	94.36 ± 7.71
		Medium	117	149.62 ± 4.73	50.35 ± 9.54	75.16 ± 9.87	92.80 ± 8.48
		High	191	150.15 ± 4.60	50.41 ± 7.89	72.13 ± 7.62	90.62 ± 6.43
Tolcha	Male	Low	150	163.46 ± 5.34	57.32 ± 10.57	81.14 ± 10.49	91.54 ± 6.04
		Medium	185	161.60 ± 5.35	51.49 ± 7.27	74.62 ± 7.54	87.62 ± 4.70
		High	110	162.78 ± 5.85	52.65 ± 8.55	76.88 ± 8.87	88.26 ± 5.38
	Female	Low	117	151.20 ± 5.03	53.57 ± 8.10	75.87 ± 9.07	93.65 ± 6.06
		Medium	187	149.83 ± 4.99	48.41 ± 6.95	72.90 ± 7.52	90.48 ± 5.86
		High	109	150.10 ± 4.59	48.60 ± 7.77	71.15 ± 8.05	89.63 ± 7.02

by high altitude, whereas hip circumference decreases as altitude increases. It reveals from the comparison across sub-group that low altitude Tolcha males and females have higher means of anthropometric measurements, except hip circumference of female Marcha. In middle altitude a reverse trend is perceptible, i.e. Marcha males and females have higher mean values of anthropometric measurements, except, stature of Tolcha female. However, this difference is very low. But in high altitude as such no consistency is perceptible i.e. the Tolcha are taller than Marcha. Whereas, higher mean values of weight, waist and hip circumference observed among Marcha. Here Marcha females have higher mean values.

Table 2 delineates means of BMI values in different altitudes among Marcha and Tolcha males and females. The total values indicate that females show a considerably higher mean BMI than their counterpart, which is true for all three different altitudes, in both the sub-groups. Here BMI indicates an inverse relationship with altitude, except for the Tolcha males in the high altitude. Lowest mean BMI is recorded in middle altitude among the sub-groups. Table 3 shows the distribution of conicity index in different altitudes among the Marcha and Tolcha. It depicts that males have higher mean value of conicity index in comparison to females in each ecological zone and sub-groups. Highest value of conicity index is observed in low altitude in males among both the sub-groups, followed by high altitude. In case of females it increases as the altitude increase among Marcha. Among Tolcha, it increases up to middle altitude the again decreases.

Table 2
Means of BMI in different altitude.

Population	Sex	Altitude		
		Low	Middle	High
Marcha	Male	21.66	20.56	20.47
	Female	23.06	22.40	22.34
Tolcha	Male	21.39	19.69	19.84
	Female	23.43	21.57	21.54

Table 4 depicts the BMI classes in different altitudes among the Tolcha and Marcha. It clearly indicates that chronic energy deficient (CED) individuals are much higher in the males than their counterpart. This is true for both the sub-groups at different altitudes. Interestingly, percentage of CED individuals increases with the altitude. In Table 5 frequencies of centrally obese people are shown for both the groups residing in different altitude. Centrally obese males

Table 4
BMI classes in different altitude.

Population	Sex	Altitudinal zone	Sample size	CED-III (BMI<16.0)	CED-II (BMI=16.0-16.99)	CED-I (BMI=17.0-18.49)	Low weight normal (BMI=18.5-19.99)	Normal (BMI=20.00-24.9)	Obese-I (BMI=25.0-29.99)	Obese-II (BMI>30..0)
Marcha	Male	Low	155	15(9.7)	6(3.9)	1(0.6)	27(17.4)	84(54.2)	20(12.9)	2(1.3)
		Middle	124	20(16.1)	5(4.0)	1(0.8)	36(29.0)	55(44.4)	7(5.6)	-
		High	214	42(19.6)	7(3.3)	4(1.9)	60(28.0)	84(39.3)	16(7.5)	1(0.5)
	Female	Low	216	11(5.1)	2(0.9)	1(0.5)	23(10.6)	134(62.0)	33(15.3)	12(5.6)
		Middle	117	10(8.5)	-	-	25(21.4)	58(49.6)	19(16.2)	5(4.3)
		High	191	13(6.8)	2(1.0)	1(0.5)	34(17.8)	105(55.0)	31(16.2)	5(2.6)
Tolcha	Male	Low	150	19(12.7)	5(3.3)	3(2.0)	35(23.3)	65(43.3)	21(14.0)	2(1.3)
		Middle	185	45(24.3)	8(4.3)	7(3.8)	53(28.6)	69(37.3)	2(1.1)	1(0.5)
		High	110	24(21.8)	11(10.0)	5(4.5)	25(22.7)	38(34.5)	7(6.4)	-
	Female	Low	117	4(3.4)	1(0.9)	-	17(14.5)	61(52.1)	29(24.8)	5(4.3)
		Middle	187	12(6.4)	3(1.6)	4(2.1)	42(22.5)	99(52.9)	26(13.9)	1(0.5)
		High	109	16(14.7)	1(0.9)	1(0.9)	23(21.1)	53(48.6)	13(11.9)	2(1.8)

Figures in parenthesis indicate percentage values.

are found in lowest frequency (Marcha=4.8%, Tolcha=5.4%) in middle altitude, whereas in lower altitude their highest frequency (Marcha=17.4%, Tolcha=22.7%) is recorded. However, the males in high altitude stand in between in this respect. A different trend is perceptible when the females are taken into consideration. Centrally obese females are found in lowest frequency in high altitude (Marcha=12.6%; Tolcha=9.2%), whereas in middle altitude they are found in highest frequency (Marcha=23.9%, Tolcha=21.9%). However, the females in low altitude stand in between in this respect.

Table 3
Means of conicity index in different altitude.

Population	Sex	Altitude		
		Low	Middle	High
Marcha	Male	1.2410	1.2129	1.2390
	Female	1.1668	1.1912	1.1438
Tolcha	Male	1.2590	1.2143	1.2420
	Female	1.1696	1.1786	1.1493

To find out the relationship of BMI with other independent, variables regression analysis is performed. For this purpose the values of height, weight, hip circumference, and waist circumference are taken into consideration. The results of co-efficient of regression are furnished in Table 6. It could be seen from the Table that there exist significant association between BMI and each of the variables. Relationship of BMI with stature is negative in all the cases. Height and weight both show highly significant relationship with BMI.

3. Discussion

The female Bhotias in the present study is characterized with higher BMI than their counterpart, which is true for all three altitudes in both the sub-groups. BMI means indicate an inverse relationship with altitude. This finding corroborate with the finding of Lhamo *et al*[10]. A more or less similar trend is perceptible between two sub-groups of the Bhotia. However, lowest mean of BMI is recorded in middle altitude in Tolcha sub-group. Throughout the world, the source of food at high altitude is very limited. Picon-Reategui[1] suggested that protein intake at high altitude might be quantitatively and qualitatively adequate for maintaining nitrogen balance in adults, but the amino acid mixture might not be adequate for meeting the requirements for child growth. Both the Bhotia sub-groups considered in the present study are characterized by habitual physical

Table 5
Centrally obese people.

Population	Altitudinal zone	Male		Female		Total	
		Normal	Centrally obese	Normal	Centrally obese	Male	Female
Marcha	Lower	128(82.6)	27(17.4)	185(85.6)	31(14.4)	155	216
	Middle	118(95.2)	6(4.8)	89(26.1)	28(23.9)	124	117
	High	184(86.0)	30(14.0)	167(87.4)	24(12.6)	214	191
Tolcha	Lower	116(77.3)	34(22.7)	93(79.5)	24(20.5)	150	117
	Middle	175(94.6)	10(5.4)	146(78.1)	41(21.9)	185	187
	High	94(85.5)	16(14.5)	99(90.8)	10(9.2)	110	109

Table 6
Relationship of BMI with other variables.

Population	Attitude	Weight	Height	Hip circumference	Waist circumference
Marcha male	Low	-0.258	0.372	0.250	0.150
	Middle	-0.254	0.377	-0.464	0.944
	High	-0.248	0.373	-0.519	0.969
Marcha female	Low	-0.305	0.441	0.064	0.365
	Middle	-0.293	0.437	0.130	0.293
	High	-0.306	0.439	0.003	0.491
Tolcha male	Low	-0.258	0.367	-0.207	0.664
	Middle	-0.240	0.383	-0.292	0.742
	High	-0.242	0.370	-0.476	0.929
Tolcha female	Low	-0.299	0.434	0.170	0.245
	Middle	-0.283	0.443	0.376	0.016
	High	-0.283	0.445	0.087	0.361

activity due to primary and secondary occupations. They are non-vegetarian, who consume large quantities of carbohydrates—but small amount of proteins and fats. Consumption of milk and milk products is also low among them. Side by side, consumption of alcoholic beverages among them is a traditional practice and hence very common.

It appears from the present study that the Tolcha and Marcha inhabit in high altitude. And in general consume lesser amount of proteins, fat, milk and milk products than their counterpart inhabit in lower and middle altitude. This might be the probable reason for poor nutrition status among the Tolcha and Marcha of high altitude. It also reveals from the present study that though consumption of alcohol is a traditional custom among them irrespective of sex, the males are always found to consume more alcohol than the females. This might be one of the reasons behind low level of mean BMI among the males than the females.

Conflict of interest statement

We declare that we have no conflict of interest.

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