

BLOOD PRESSURE IN RELATION TO BODY MASS INDEX AMONG THE MONPA: ALTITUDINAL DIFFERENCE

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Abstract: *Background and Objectives:* Many studies have well documented that there is a positive association between body mass index and systolic blood pressure as well as body mass index and diastolic blood pressure. The present study examines body mass index and blood pressure in two Arunachal Monpa populations namely the Dirang (low altitude population) and Tawang (high altitude population) Monpa.

Material and Methods: Healthy, 303 adult Dirang (Male: 146, Female: 157) and 472 Tawang (Male: 210, Female: 262) Monpa were randomly selected. The body mass index cut-off value for Asian people was considered as recommended by the WHO expert group (WHO 2000). While blood pressure values were classified according to the WHO expert committee (WHO 1996).

Results: This study reveals a positive relationship between body mass index and blood pressure. Mean SBP and DBP both were considerably higher among the Dirang than that of the Tawang Monpa. Blood pressure values were correlated more with body mass index among the Tawang Monpa than their counterparts.

Conclusion: Present study is indicative of altitudinal stresses on biological traits in highlander Tawang Monpas than that of the Dirang Monpas.

Introduction

Pi-Sunyer (1993) opined that body mass index (BMI) is positively and independently associated with morbidity and mortality from hypertension, cardiovascular disease, type II diabetes mellitus, and other chronic diseases. It is documented from many studies that there is a positive association between BMI and SBP (systolic blood pressure) and BMI

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and DBP (diastolic blood pressure) (Hubert et al. 1983, Mokdad et al. 2003, Gelber et al. 2007, Shuger et al. 2008 and many others). On the other hand, it is also documented that loss of body weight reduces blood pressure (BP) considerably (Neter et al., 2003, Harsha et al., 2008). The main physiological adaptations that occur in individuals located at high altitudes are probably due to hypoxia. Hypoxia due to high altitude exposes inhabitants to low atmospheric pressure and is often combined with other factors such as cold weather, desert areas, limited diets, and poor socioeconomic conditions (Miele et al., 2016). Contradicting results have been found in studies on the relationship between BP and chronic hypoxic-hypobaric conditions in individuals living at high altitudes. One study performed on Nepalese individuals living at high altitudes in a rural location found a lower prevalence of hypertension, suggesting that BP decreased with the increase in altitude (Shrestha et al., 2012). The exploration of the association between altitude and blood pressure may lead to a better understanding of the basic mechanisms of blood pressure control. Studies carried out in the Peruvian Andes at 3750 m and in Tibet at 2080 m (Sehgal et al., 1968) indicated that there was a reduction in systolic blood pressure (SBP) at high altitudes. There was, however, little effect on the level of diastolic blood pressure (DBP), (Appleton, 1967). An appreciable proportion of the world population lives 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). The principal objective of this study was to examine blood pressure and BMI in two Monpa groups namely, the Dirang and Tawang Monpa residing in the low and high altitudes of Arunachal Pradesh.

Material and Methods

A door-to-door survey was conducted to collect the necessary data. Dirang Monpa data were collected from April-May in 2014, while Tawang Monpa data were collected from May-June, 2015. Anthropometric and physiometric data were collected from the participants who reported not being suffering from any chronic or acute diseases at the time of the survey. Body height was recorded in centimetres and body weight was recorded in kilograms to the nearest 0.1 cm and 0.5 kg respectively, with the help of Martin’s anthropometer and standard weighing scale. BMI cut-off values for Asian people, recommended by the WHO expert group (WHO 2000) was considered in the present study. Physiometric measurements of SBP and DBP (mmHg) were measured by a mercury sphygmomanometer. Blood pressure values were classified according to the report of a WHO expert committee (WHO, 1996).

Dirang Monpa: Dirang Monpas are Buddhist by religion, and are one of the sub-groups of the Monpa tribe. They inhabit the hilly terrain (1600 m) of the West Kameng

district of Arunachal Pradesh. This district experiences moderate to heavy rainfall and in the winter it experiences severe cold. Dirang Monpas residing in Dirang town and its surrounding areas were selected for the 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 the Tawang district. This district experiences moderate to heavy rainfall and in the winter it experiences frost and snowfall. For the present study, Tawang Monpas residing in Tawang town and its surrounding areas were selected.

Results

Descriptive statistics of the variables like age, height, weight, BMI, SBP and DBP were described in Table 1 for both the genders and both the populations. While the average age of the Tawang Monpa men and women varies between 31.1 and 31.8 years, the same varies between 35.6 and 36.6 years for the men and women of the Dirang Monpa. The Tawang Monpa men in this study were taller and heavier than Dirang Monpa men in terms of the mean value (Tawang Monpa: height=165.6 cm, weight= 67.9 kg; Dirang Monpa: height=163.5 cm, weight= 65.2 kg). A more or less same trend was perceptible in the case of the height and weight of the women of both populations. The mean BMI was found to be similar in both the populations and both the genders with little variation. But mean SBP and DBP both were considerably higher among the Dirang than that of the Tawang Monpa. This is true for both the genders; the only exception in this respect was noticed for DBP among the Dirang Monpa men than their counterparts.

Table 1: Description of Variables

<i>Variables</i>	<i>Gender</i>	<i>Dirang Monpa: Mean±S.E.</i>	<i>Tawang Monpa: Mean±S.E.</i>
Age (years)	Male	35.6±0.9	31.1±1.0
	Female	36.6±1.1	31.8±1.0
Height (cm)	Male	163.5±5.8	165.6±6.3
	Female	153.1±4.9	154.2±5.8
Weight (kg)	Male	65.2±11.0	67.9±12.2
	Female	60.4±10.8	60.6±11.6
BMI (kg/M ²)	Male	24.3±0.3	24.7±0.3
	Female	25.8±0.3	25.5±0.3
SBP (mm Hg)	Male	129.8±0.8	128.9±0.8
	Female	125.8±0.8	124.2±0.6
DBP (mm Hg)	Male	85.0±0.5	85.3±0.7
	Female	84.1±0.6	83.2±0.5

It is apparent from Table 2 that more than 73% of the subjects fall in the category of normotension. A higher per cent of women represent this category than that men. This is true for both populations. A considerable per cent of the subjects represent the category of mild hypertension, which occurred in the highest per cent (20.95) among Tawang men, whereas its lowest per cent occurred among Tawang women (14.88). A negligible per cent of the subjects show moderate and severe hypertension as well as isolated systolic hypertension.

Table 2: Blood pressure levels (mm Hg)

Levels of blood pressure*	Dirang Monpa				Tawang Monpa			
	Male (n=146)		Female (n=157)		Male (n=210)		Female (n=262)	
	No.	%	No.	%	No.	%	No.	%
Normotension	107	73.29	122	77.71	158	75.24	212	80.92
Mild hypertension	25	17.12	28	17.83	44	20.95	39	14.88
Moderate & severe hypertension	2	1.37	5	3.19	5	2.38	7	2.67
Isolated systolic hypertension	12	8.22	2	1.27	3	1.43	4	1.53

*According to WHO (1996)

A higher per cent of men were recorded in normal BMI class in both populations (Table 3). This per cent was much higher among Dirang Monpa men (62.33) than their counterparts (43.31). But the Tawang Monpa per cent value does not vary much in this category (men= 52.38; women= 50.38). Overweight subjects were much higher among Dirang Monpa women than their counterparts (men= 27.40%; women= 42.68%). Whereas, a reverse trend was perceptible among the Tawang Monpa (men= 34.28%; women= 29.77%). Obese I BMI class subjects were comparatively higher among Tawang Monpa (men= 9.05%; women= 13.74%) than that of the Dirang Monpa (men= 8.22%; women= 8.28%). In the case of the obese II BMI class, a negligible per cent of the subjects were recorded in both populations. It is interesting to note that no subjects fall in the category of Obese III BMI class except Dirang Monpa women. Among whom, 1.27% of subjects fall in this class.

Tables 4a and 4b discerned a gradual rise of SBP and DBP with the rise in BMI levels among the Dirang and Tawang Monpa respectively. However, except few, almost all the BMI class SBP and DBP mean values were recorded to be higher among the Tawang Monpa than that of the Dirang Monpa.

Table 3: Body mass index (BMI)

BMI class*	Dirang Monpa				Tawang Monpa			
	Male (n=146)		Female (n=157)		Male (n=210)		Female (n=262)	
	No.	%	No.	%	No.	%	No.	%
Underweight (≤ 18.5)	1	0.68	4	2.55	6	2.86	6	2.29
Normal (18.5-24.9)	91	62.33	68	43.31	110	52.38	132	50.38
Overweight (25.0-29.9)	40	27.40	67	42.68	72	34.28	78	29.77
Obese - I (30.0-34.9)	12	8.22	13	8.28	19	9.05	36	13.74
Obese – II (35.0-39.9)	2	1.37	3	1.91	3	1.43	10	3.82
Obese – III ≥ 40.0	-	-	2	1.27	-	-	-	-

* According to WHO (1998)

Table 4a: Mean and SD of blood pressure at different levels of BMI: Dirang Monpa

BMI class*	SBP				DBP			
	Male		Female		Male		Female	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Underweight (≤ 18.5)	118.80	8.32	118.80	8.79	78.60	3.58	78.80	7.56
Normal (18.5-22.9)	124.34	7.91	121.89	11.92	81.55	4.30	81.57	7.29
Overweight (23.0-24.9)	130.52	7.86	129.09	10.93	85.68	5.09	85.97	7.53
Obese (≥ 25.0)	136.38	11.20	133.61	8.24	88.15	6.05	87.02	9.89

* According to WHO (2000)

Table 4b: Mean and SD of blood pressure at different levels of BMI: Tawang Monpa

BMI class*	SBP				DBP			
	Male		Female		Male		Female	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Underweight (≤ 18.5)	121.25	6.58	119.25	5.12	78.75	1.83	79.00	3.38
Normal (18.5-22.9)	124.18	6.06	123.04	7.78	81.67	5.48	82.39	4.61
Overweight (23.0-24.9)	129.90	8.77	130.98	5.81	84.97	6.23	85.10	6.35
Obese (≥ 25.0)	136.11	10.70	134.81	9.30	88.17	8.68	87.60	10.84

* According to WHO (2000)

Relationship between body mass index and blood pressure

To understand the relationship between BMI and BP, the coefficient of correlation value has been calculated. Considering the values of BMI as a regressor (i.e. 'x') and the values of BP as regressand (i.e. 'y') the regression equations (y) of Fig. 1- Fig. 8 are as follows:

Dirang Monpa

BMI vs SBP for male: $R^2= 0.2711$; $y=1.5371x + 92.392$ (Fig. 1)

BMI vs DBP for male: $R^2= 0.2432$; $y=0.8088x + 65.025$ (Fig. 2)

BMI vs SBP for female: $R^2= 0.1811$; $y=1.1142x + 100.75$ (Fig. 3)

BMI vs DBP for female: $R^2= 0.1323$; $y=0.7889x + 64.935$ (Fig. 4)

Tawang Monpa

BMI vs SBP for male: $R^2= 0.3179$; $y=1.5399x + 92.452$ (Fig. 5)

BMI vs DBP for male: $R^2= 0.1663$; $y=0.8275x + 64.655$ (Fig. 6)

BMI vs SBP for female: $R^2= 0.2686$; $y=1.1257x + 101.46$ (Fig. 7)

BMI vs DBP for female: $R^2= 0.1534$; $y=0.5584x + 71.1$ (Fig. 8)

For a graphic representation, the regression lines have been drawn (Fig.1-Fig. 8). These suggest that there exists a positive relationship between BMI and BP though these are of lower magnitude.

Discussion

Traditional populations around the world were generally believed to have low blood pressure (Mungreiphy et al. 2011). A high level of blood pressure is noted among the study population. This trend is corroborative of changing socioeconomic environment and blood pressure levels among the Dirang and Tawang Monpa.

It is well established that nutritional status is an important factor in determining blood pressure. In epidemiological research, understanding the relationship between BMI and BP is important (Datta Banik 2014). Tesfaye et al. (2007) reported a positive correlation between BMI and BP among adult Caucasian populations. BMI had been observed to be related to BP among adults in Sweden (Henriksson et al. 2003), Pakistan (Khan et al. 2008), and India (Santhirani et al. 2003, Gupta 2004, Kusuma et al. 2004, Das et al. 2005, Desmukh et al. 2006, Gopi Chand and Rao 2007, Reddy et al. 2010 and many others cf. Datta Banik 2014).

The high-altitude environments might be expected to cause some physiologic distress to the inhabitants, particularly by exhibiting a moderate degree of pulmonary hypertension,

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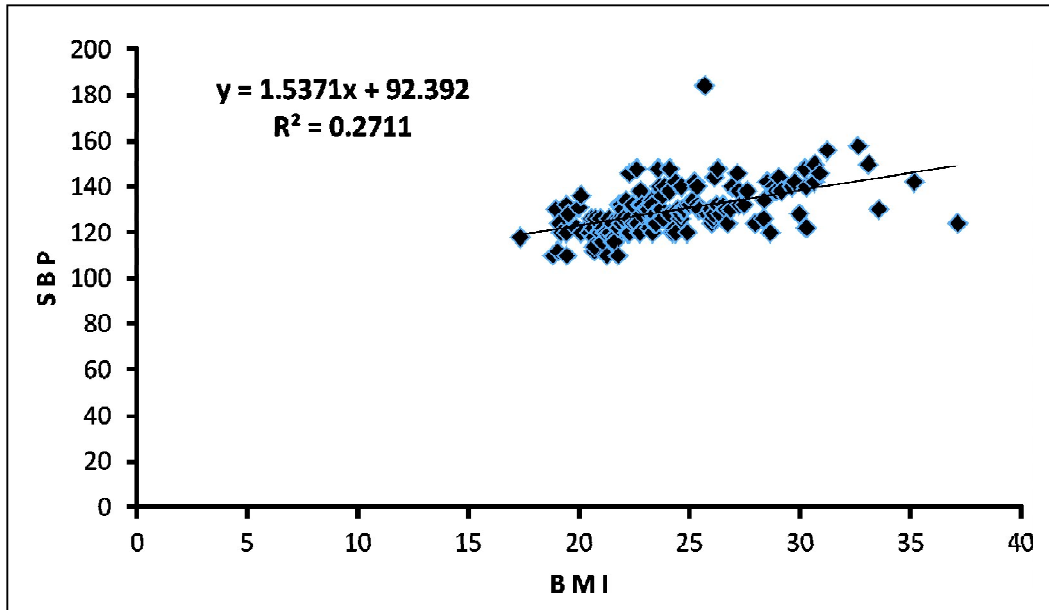


Figure 1: Diagram plotting BMI values to SBP values: Dirang Monpa male

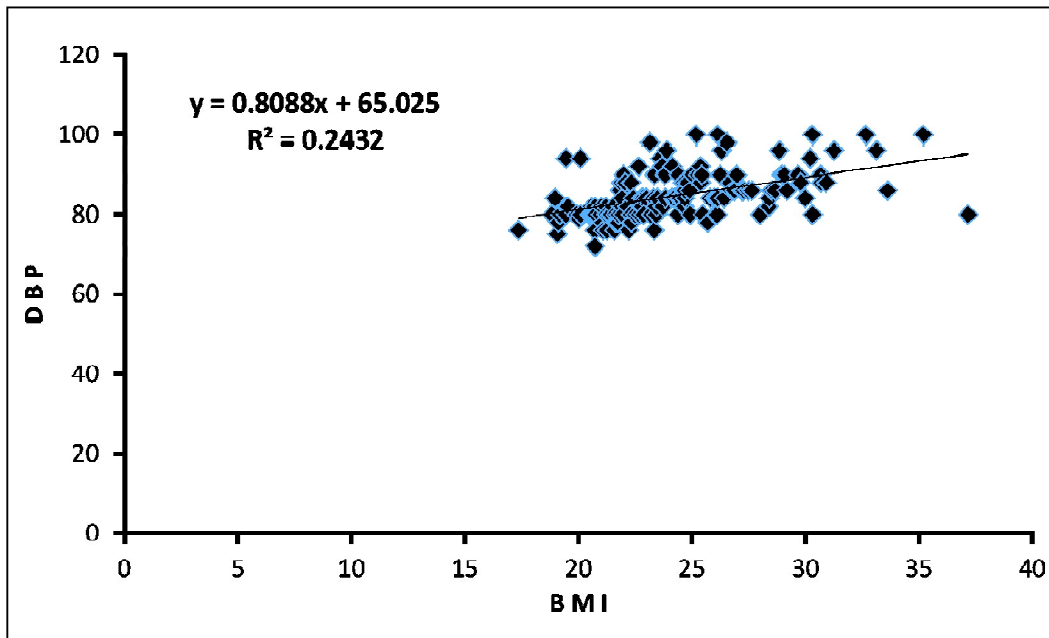


Figure 2: Diagram plotting BMI values to DBP values: Dirang Monpa male

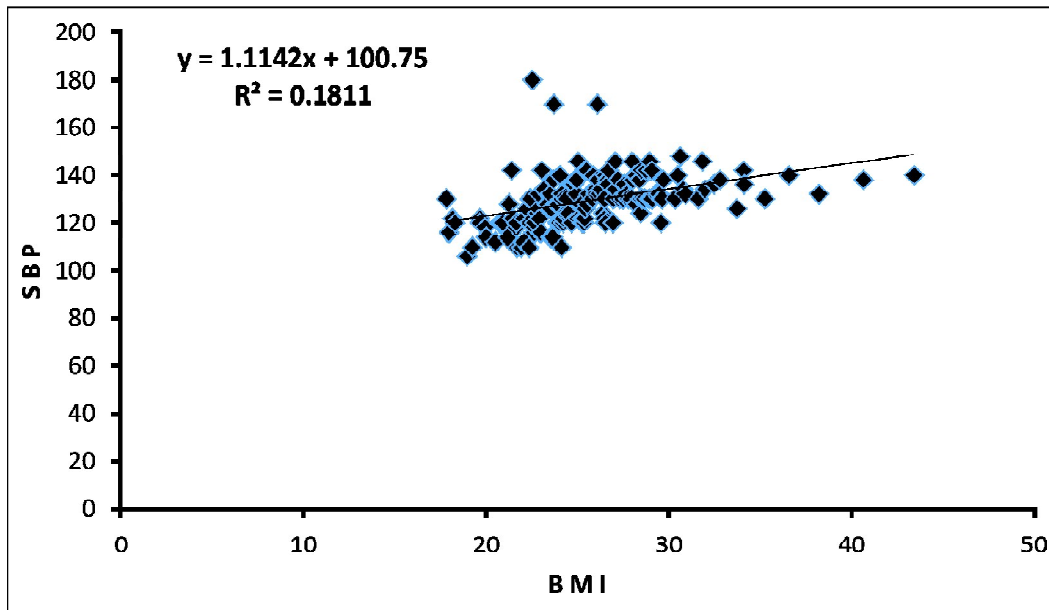


Figure 3: Diagram plotting BMI values to SBP values: Dirang Monpa female

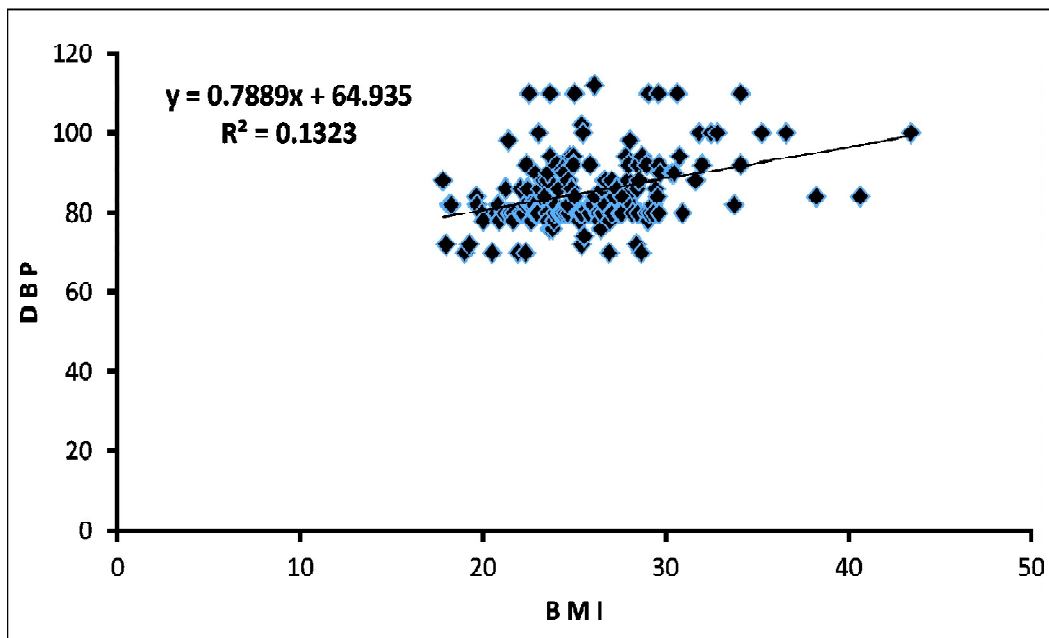


Figure 4: Diagram plotting BMI values to DBP values: Dirang Monpa female

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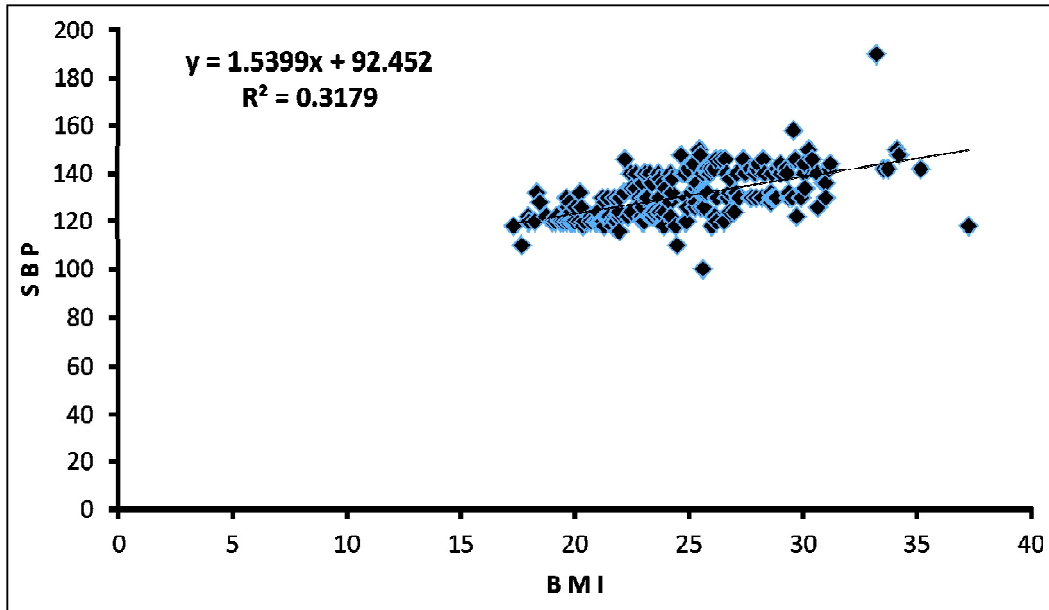


Figure 5: Diagram plotting BMI values to SBP values: Tawang Monpa male

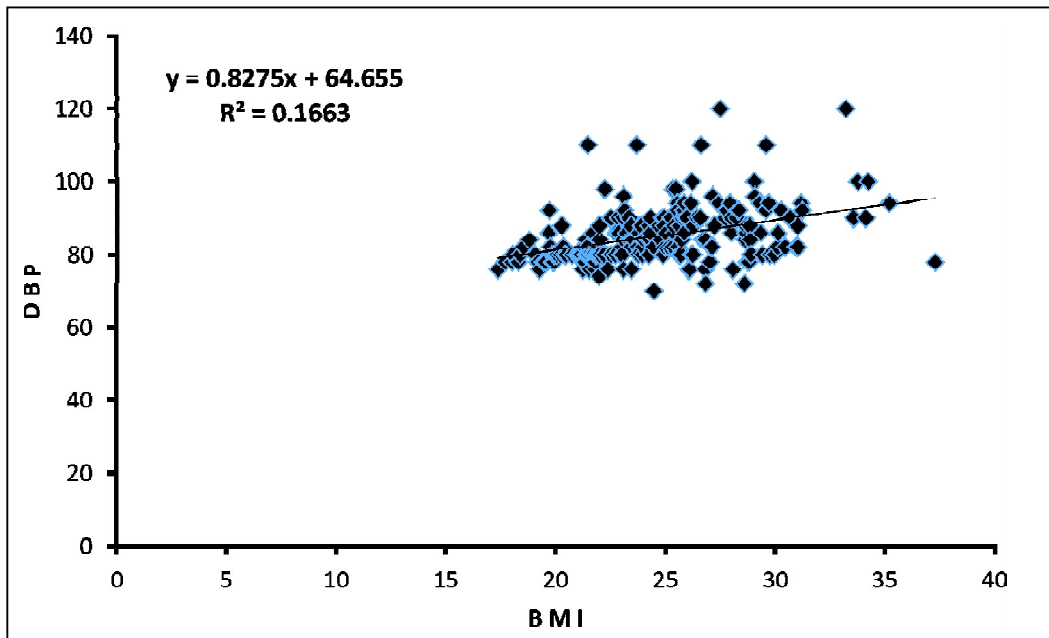


Figure 6: Diagram plotting BMI values to DBP values: Tawang Monpa male

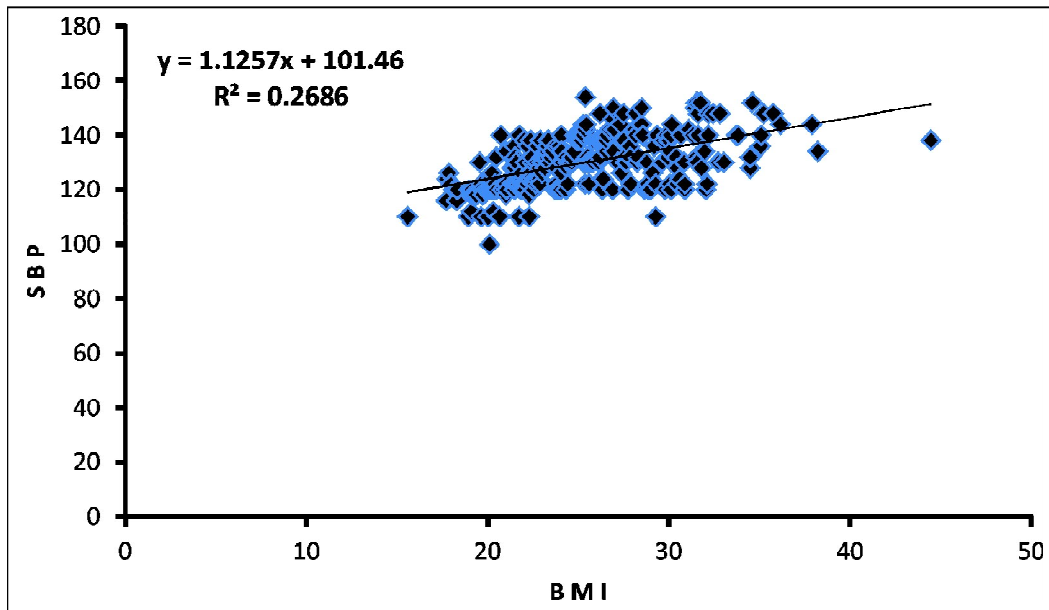


Figure 7: Diagram plotting BMI values to SBP values: Tawang Monpa female

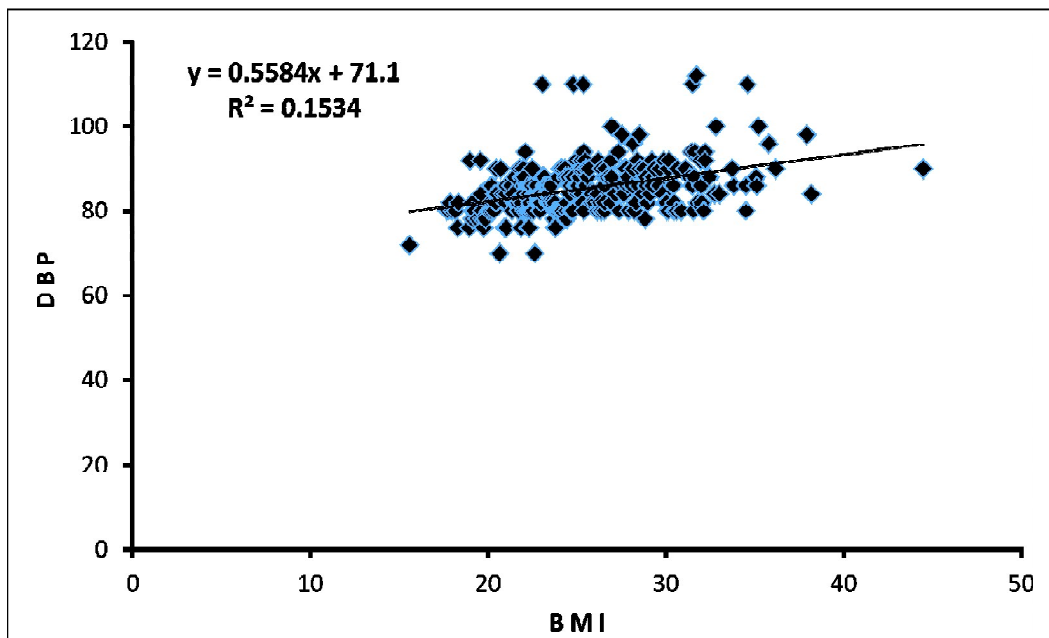


Figure 8: Diagram plotting BMI values to DBP values: Tawang Monpa female

but lesser levels of systemic pressure, than their lowland counterparts (Gupta et al. 1989). It was found from the present study that mean SBP and DBP both were considerably higher among the Dirang than that of the Tawang Monpa. This is true for both the genders, the only exception in this respect was noticed for DBP among the Dirang Monpa men than their counterparts. It can be recapitulated that Tawang Monpa of Arunachal Pradesh live in high altitude area, while the Dirang Monpa lives in a low-altitude area of the state. Thus the findings of the present study corroborate the findings of the study conducted by Gupta et al. (1989). The coefficient of correlation values was also comparatively higher among Tawang Monpa than Dirang Monpa. Thus BP values were correlated more with BMI among the Tawang Monpa than their counterparts.

Conclusion

Mean SBP and DBP both were considerably higher among the Dirang than that of the Tawang Monpa. This study reveals a positive relationship between BMI and BP. BP values were correlated more with body mass index among the Tawang Monpa than their counterparts. This study reveals a positive relationship between BMI and BP. It signifies altitudinal stresses on biological traits in highlander Tawang Monpas. The present study also revealed that BP values were correlated more with BMI among the Tawang Monpa than their counterparts. This justified the results of localized morphological adaptation as well as genetic make-up in the studied populations.

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