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Anthropometric Differences among the Tangkhuls Living in the Hill and Valley Region of Manipur

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Abstract

Background: Anthropometry and body composition analysis are important parameters to assess the health and fitness status of individuals. Studying the differences in anthropometry and body composition among populations can provide valuable insights into health disparities and inform targeted interventions to promote better health outcomes.

Aim: To examine the differences in anthropometric and body composition of the hill and valley Tangkhul males of Manipur

Materials and Methods: In this cross-sectional study, 590 Tangkhul males were recruited through a random sampling method, with 350 participants from the hill and 240 from the valley. Body composition was assessed using the Drink water and Ross method of fractional masses. Anthropometric variables, blood pressure, and blood sugar were obtained following standardized procedures. Descriptive statistics and t-tests were employed to analyze the collected data.

Results: The findings revealed significant differences in the anthropometric measurements and body composition components of the two populations ($p<0.05$).

Conclusion: These outcomes suggest that the hill and valley Tangkhuls have regional variation in their anthropometric measurements, with the hill population displaying a more favorable body composition attributed to their healthier lifestyle and ecological setting.

Keywords

Anthropometric, Tangkhuls, hill, valley, body composition**.**

Introduction

Anthropometric measurements and body composition analysis are essential tools for determining the variation of different body traits among individuals and populations. These techniques provide quantitative data on various aspects of the body. It is inexpensive and simple and has also proven accurate and widely accepted (WHO, 2006). As a non-invasive method of assessing the human body, the information obtained through these measurements can be used to monitor body composition and long-term health values and identify trends and patterns related to factors such as genetics, environment, and lifestyle.

Human ecology and lifestyle profoundly influence an individual's health. The most important contributing factor is one's way of life, which can be controlled, managed, and changed. However, with growing urbanization, socio-developmental changes have occurred over the last 40-50 years (Mishra, 2015). Dramatic changes in lifestyle from traditional to modern have led to physical inactivity due to technological advances. This shift in socio-economic conditions, in addition to a change in physical activity, and increased use of alcohol and tobacco, is also related to rapid increases in the prevalence of overweight, obesity and hence to other chronic and metabolic diseases (Popkin, 2001; Kim et al., 2001)

Regional differences in anthropometric and body composition may contribute to understanding health disparity and the increased risk of chronic diseases such as cardiovascular disease and diabetes. People of different geographical locations have specific anthropometric features. Hence, individuals adapting to different ecology have different body shapes, sizes, and dimensions. If genetic factors are held constant, differences among sub-populations may be interpreted as showing the impact of the environment and be used as criterion of under-development (Thibault et al., 1985). The optimal functioning of a body can be better evident under efficient and natural environmental conditions. The human body is framed in such a way that it can be bent, stretched, and do more tedious work. The body becomes stronger when it exerts more effort. Muscle and fat involvement are immensely important in shaping a body. When we do any work or exercise, it helps in improving our health and also brings changes in the various anthropometric variables of the human being.

The differences in body dimensions, body composition, and fitness levels due to environmental disparities have come to light in recent years. Nowadays, studies are conducted to evaluate the evolutionary importance of anthropometric characteristics and body composition variances between populations whose ancestors lived in different ecological settings. Human evolution occurs in order for humans to survive in their habitat. Every people have certain distinctive features in their form, action, and thought. Several studies' findings revealed that many differences exist between the plain and hill people (Baro, & Dihingia, 2014; Berryman et al., 2018; Fulco et al., 1985). In general, the people of hills must overcome more strenuous physical exertions in their daily activities than plain people. These differences are due to the lifestyle pattern of both groups. At the same time, some argue that when humans are exposed to hypoxic environments of moderate (1500-3500 m), high (3500-5300 m), and extreme (>5300 m), their bodies and metabolism change, and this is further influenced by the duration of the stay, individual adaptation to hypoxia, daily variations in body mass, hydration, and type of exposure (Kayser, 1994). Hypoxic environments are frequently shown to influence a person’s body composition (e.g., reductions in body weight, fat-free mass (FFM), fat mass (FM), and body water) (Hamad & Travis, 2006). Proposed factors responsible for these changes in body composition vary but mainly include an increased basal metabolic rate (BMR) and a negative energy balance (i.e., mismatch of energy intake and energy expenditure) (Kayser & Verges, 2013)

In light of the foregoing, we hypothesize that the Tangkhul population that migrated to the valley/plain region of Manipur have different anthropometric characteristics and body composition compared to their counterparts still living in hill settlements. The study, therefore, aim to investigate the regional differences in the anthropometric parameters and body composition of the hill and valley Tangkhuls.

Materials and Methods

Study population

The Tangkhuls are a major ethnic group living in the Indo-Burma border area occupying the Ukhrul and Kamjong district in Manipur. They are primarily found in the hills and valleys of the region. The origin of Tangkhul-Naga is traced back to the history of the nomadic ages. The Tangkhul-Naga come, with other tribes on the hills, came to Manipur, Nagaland, Assam, and Arunachal Pradesh from China through Myanmar, entering their present habitats in successive waves of immigration on 9th to 11th century BC (Shimray, 1985). Initially, the Tangkhul tribe of Manipur lived in the hilly regions, surrounded by lush green forests and beautiful mountains. They were simple yet content people who lived harmoniously with nature and practiced their traditional beliefs and customs. Over time, they migrated to the valley regions for better opportunities and life. The present study was conducted in the Ukhrul district and Imphal east and west districts of Manipur. The Ukhrul district is one of the hilly districts in Manipur, which is 84 km apart from the capital. It lies at varying altitudes ranging from a minimum of 913 m to a maximum of 3115 m above Mean Sea Level (MSL). Imphal is the state capital of Manipur, and Imphal east and west are plain valley districts with an elevation of 786 m above MSL. Hill ranges surround the valley districts of Manipur in all directions.

Sample size and sampling

The sample size was determined at 95% CI with an error of ±5 using the formula $N=Z^2PQ/d^2$ (Lemeshow & Lwanga, 1991). The minimum total sample size required for this study was 546 participants. A cross-sectional data of 590 Tangkhul adult males (350 hills and 240 valleys) was randomly sampled from nine villages in the Ukhrul district and five valleys in the Imphal east and west districts of Manipur. The ages of the subjects range from 20-80 years. A pre-tested interview schedule, including anthropometric measurements, blood pressure, and blood sugar, were used. The study protocol was approved by the Institutional Human Ethics Committee of Manipur University.

Inclusion criteria

Only those participants of proper Tangkhul origin and valley Tangkhuls who have settled in the valley districts for over twenty years were eligible.

Exclusion criteria

Individuals undergoing medication for high blood pressure and blood sugar, unwilling to consent or respond, mentally or physically unstable, and bedridden individuals were excluded from the present study.

Anthropometric variables

Anthropometric variables viz, height, weight, triceps, sub-scapular, supra-illiac, abdominal, thigh and calf skinfold thickness, humerus bi-epicondylar width, femur condylar width, wrist girth, ankle girth, relax arm girth, chest girth, thigh girth, calf girth, forearm girth, bi-acromial width, transverse chest width, bi-illiocristal breadth, and antero-posterior chest depth were measured from each participant following the standard protocol of Singh and Bhasin (2004). Body height was measured using an anthropometer with the participant standing barefoot and with feet together, with 0.5 cm accuracy. Body weight was measured on a balance scale with a precision of 0.1 kg while the participant was barefoot and possibly in minimal clothing. For skinfold measurements, the Holtain skinfold caliper was applied 1 cm below the marked area, and a reading in mm (millimeters) was taken 2 seconds after the pressure was released on the lever arm of the caliper. Three measurements were recorded in each participant, and the mean value was taken for analysis. The measurements recorded were free from observer bias.

Body composition analysis

The four-compartment model of body composition, i.e., fat mass, muscle mass, skeletal mass, and residual mass, was estimated based on twenty-one (21) anthropometric measurements according to Drinkwater & Ross (1980). According to this method, the fractional masses were derived from their respective subset indicators using the Z-score method. Fat mass was computed from the triceps skinfold, sub-scapular skinfold, supra-iliac skinfold, abdominal skinfold, thigh skinfold, and calf skinfold. Muscle mass was computed using the relaxed arm, chest, thigh, and calf girth. Skeletal mass was derived from humerus bi-epicondylar width, femur condylar width, wrist girth, and ankle girth. While residual mass was estimated using bi-acromial width, transverse chest width, bi-iliocristal breadth, and antero-posterior chest depth. Z (proportionality value) of Phantom fat mass, muscle mass, skeletal mass, and residual mass were computed following the Z score formula.

Z-score calculation:

The Z-score of all the subset indicators were calculated using the formula:

$$Z = \frac{1}{s}[v\,(\frac{170.18}{h})^{d} - p]$$

Where,

Z is proportionality values
s = standard deviation for the given variable
v = variable (observed value of subset indicator)
170.18 = phantom height
h = height of the subject
d = dimensional constant whose values are one (1) for all lengths, breaths, girths and skinfold
p = phantom value of all variable/ subset indicator.

Fractional masses calculation:

The fractional masses can be directly calculated using the given formula:

$$M = [(\underline{Z} \times s) + p]/[\frac{170.18}{h}]^{3}$$

Where,

M is the fractional mass
$\underline{Z}$= mean Z score of all the subset indicators corresponding to their fractional mass
s = standard deviation for the given variable
p = phantom value for the given fractional masses.
170.18 = phantom height
h = height of the subject.

Blood pressure

Blood pressure was measured using a standard mercury sphygmomanometer and a stethoscope (Beevers et al., 2001). All measurements were taken on the left hand for consistency while the participants were seated. Hypertension was defined as either SBP ≥ 140 or DBP ≥ 90 mmHg as per the Joint National Committee VII (JNC VII) criteria for hypertension diagnosis (Chobanian et al., 2003).

Blood sugar

Accu-Check Blood Glucose Monitor manufactured by Roche Diagnostics was used to measure blood sugar levels using a one-time-used strip. All the participants were screened for blood sugar levels by Random Blood Sugar (RBS) test using the 'Accu Check' device. Participants with RBS at a level of ≥ 200 mg/dl were considered hyperglycemic or elevated blood sugar levels (Blood sugar level, 2019).

Lifestyle and socio-economic factors

Physical activity pattern was classified as physically active with moderate and vigorous-intensity-activity achieving at least 600 MET minutes and physically inactive who did not meet the criteria mentioned above (Bull et al., 2009). In the present study, individuals who smoke any tobacco product regularly were considered smokers. While according to National Institute on Alcohol Abused and Alcoholism (NIAAA) alcoholic is defined as those individuals who consumed alcohol daily, i.e., for men, more than four (4) drinks on any day or more than fourteen (14) drinks per week . One drink equates to twelve (12) ounces of beer, five (5) ounces of wine, and 1.5 ounces of spirits (NIAAA, 2010). The monthly income of the family was collected from each household, then the average per-capita monthly income was calculated. By applying the equation, $\overline{x} \pm 4(Sd)/\sqrt{N}$ the income group was classified as HIG (High Income Group), LIG (Low Income Group), and MIG (Middle Income Group) (Khongsdier, 2002).

Statistical Analysis

Descriptive statistics were performed to determine the percentage, mean, and standard deviation. An Independent sample t-test was used to compare the hill and valley populations. A P-value of

0.05 was considered significant. The entire data were analyzed using Statistical Package for social sciences Version 20.0 (IBM Corp., Armonk, N.Y., USA).

Results

Table 1. Socio-demographic characteristics of the study population

Variable	**Hill n=350**	**Valley n=240**
	n (%)	**n (%)**
Age group		
20-29	67 (19.14)	44 (18.33)
30-39	62 (17.71)	44 (18.33)
40-49	60 (17.14)	40 (16.66)
50-59	56 (16.00)	41 (17.10)
60-69	53 (15.14)	35 (14.58)
70-79	52 (14.87)	36 (15.00)
Mean of Age	**Mean ± SD**	**Mean ± SD**
	46.77±17.19	47.09±17.34
Occupation		
None	18 (5.14)	20 (8.33)
Government service	19 (5.43)	38 (15.83)
Self employed	48 (13.71)	49 (20.42)
Student	41 (11.71)	46 (19.17)
Farmer	90 (25.71)	05 (2.08)
Daily wagers	50 (14.29)	22 (9.17)
Trading	28 (8)	29 (12.08)
Pensioner	17 (4.86)	15 (6.25)
Others	39 (11.15)	16 (6.67)
Level of Education		
None	35 (10)	06 (2.50)
Primary	56 (16)	08 (3.33)

Secondary	88 (25.14)	40 (16.67)
Higher Secondary	95 (27.14)	69 (28.75)
Bachelor	60 (17.15)	84 (35)
Masters	16 (4.57)	33 (13.75)
Income		
High income	79 (22.57)	69 (28.75)
Middle income	95 (27.14)	61 (25.42)
Low income	176 (50.29)	110 (45.83)
Physical activity		
Active	193 (55.14)	102 (42.50)
Inactive	157 (44.86)	138 (57.50)
Smoking Tobacco		
Smokers	88 (25.14)	49 (20.42)
Non-smokers	262 (74.86)	191 (79.58)
Alcohol consumption		
Alcoholic	25 (7.14)	20 (8.33)
Non-alcoholic	325 (92.86)	220 (91.67)

Notes: n-number, SD-standard deviation, %-percentage

Among the 590 Tangkhul males studied, 350 were from the hill, and 240 were from the valley settings. The mean age ± SD was 46.77±17.19 for the hill and 47.09±17.34 for the valley populations, indicating a similar age distribution between the two groups. The majority of the hill dwellers were farmers (25.71%), while the valley dwellers were more likely engaged in self-employed (20.42%) and government jobs (15.83%). The hill population was more physically active (55.14%) and had more smokers (25.14%) than the valley counterpart. The valley population, on the other hand, had a slightly more prevalence of alcoholics (8.33%). Other demographic information, including the level of education, income, and age-wise distribution, are shown in Table 1.

Table 2. Comparison of height, weight and indices of hill and valley males

Variables	**Hill**		**Valley**		**t-Value**
	Mean	**SD**	**Mean**	**SD**	
Height (cm)	163.92	5.17	163.01	4.97	2.15*
Weight (Kg)	57.39	8.05	58.86	9.17	2.01*
BMI (kg/m^2)	21.35	2.87	22.12	3.13	3.00*
FMI (kg/m^2)	2.97	0.70	3.25	0.74	4.69**

Notes: BMI=Body Mass Index, FMI=Fat Mass Index, SD-standard deviation, Significant level * $p < 0.05$; ** $p < 0.01$.

Table 2 shows the mean height, weight, and indices of the hill and valley population. The hill settlers are significantly taller (t =2.15, p<0.05) than the valley. While the valley settlers have significantly higher weight (t =2.01, p<0.05)), BMI (t =3.00, p<0.05), and FMI (t =4.69, p<0.01) than the hill.

Table 3. Skinfolds comparison of different body parts among hill and valley males

Variables	**Hill**		**Valley**		**t-Value**
	Mean	**SD**	**Mean**	**SD**	
Triceps skf. (mm)	9.19	2.69	10.36	2.85	5.01**
Sub-scapular skf. (mm)	12.43	3.15	13.75	3.82	4.42**
Supra iliac skf. (mm)	13.94	4.55	15.06	4.68	2.90**
Abdominal skf. (mm)	16.38	4.99	18.29	5.53	4.28**
Thigh skf. (mm)	13.75	3.77	14.62	3.61	2.82**
Calf skf. (mm)	12.02	3.52	13.02	3.50	3.39**

Notes: Skinfold measurements in mm, skf.=skinfold, SD-standard deviation, Significant level * $p < 0.05$; ** $p < 0.01$.

Table 3 depicts the skinfold thickness of the body parts of the hill and valley population. The valley population has significantly greater triceps skinfold (t =5.01, p<0.01), thigh (t =2.82, p<0.01), and calf skinfold (t =3.39, p<0.01) than the hill counterparts. Significant differences are further observed in sub-scapular skinfold (t =4.42, p<0.01), supra iliac skinfold (t =2.90, p<0.01), and abdominal skinfold (t =4.28, p<0.01) between the two populations.

Table 4. Hill and valley comparison of circumferences of different body parts

Variables	**Hill**		**Valley**		**t-Value**
	Mean	**SD**	**Mean**	**SD**	
Wrist girth (cm)	16.51	1.68	16.34	1.84	1.18
Forearm girth (cm)	23.28	3.09	22.16	2.69	4.64**
Relaxed arm girth (cm)	25.98	2.80	24.26	3.72	6.07**
Chest girth (cm)	86.06	6.13	85.72	5.35	0.72
Thigh girth (cm)	39.52	5.17	39.12	4.56	0.98
Calf girth (cm)	31.63	4.19	30.25	4.36	3.83**
Ankle girth (cm)	21.60	1.67	21.31	1.80	1.99*

Notes: SD-standard deviation, Significant level * $p < 0.05$; ** $p < 0.01$.

Table 4 compares circumferences of different body parts of the hill and valley populations. The hill inhabitants, compared to the valley, have a higher mean in all the girth measurements. However, significant differences between the two populations were observed in forearm girth (t =4.64, p<0.01), relaxed arm girth (t =6.07, p<0.01), calf girth (t =3.83, p<0.01) and ankle girth (t =1.00, p<0.05).

Table 5. Comparison of width, breadth and depth of body parts of hill and valley males

Variables	**Hill**		**Valley**		**t-Value**
	Mean	**SD**	**Mean**	**SD**	

Humerus width (cm)	6.46	1.10	6.19	1.17	2.79*
Femur width (cm)	8.52	1.09	7.99	1.12	5.65**
Bi-acromial breadth (cm)	34.06	2.80	35.20	3.29	4.65**
Chest breadth (cm)	31.22	2.85	30.71	2.44	2.29*
Chest depth (cm)	17.95	3.17	19.42	2.59	6.19**
Bi-illiocristal breadth (cm)	28.26	2.31	27.80	2.41	2.30*

Notes: SD-standard deviation**,** Significant level * $p < 0.05$; ** $p < 0.01$.

The Comparison of width, breadth, and depth measurements of body parts of the hill and valley males are presented in table 5. The hill dwellers were found to have significantly greater humerus width (t =2.79, $p<0.05$), femur width (t =5.65, $p<0.05$), chest breadth (t =2.29, $p<0.05$) and bi-illiocristal breath (t =2.30, $p<0.05$) as compared to the valley counterparts. On the contrary, the valley population has significantly greater bi-acromial breadth (t =4.65, $p<0.01$) and chest depth (t= 6.19, $p<0.05$) than the hill population.

Table 6. Comparison of body composition, blood pressure and blood sugar of the hill and valley setting

Variables	**Hill**		**Valley**		**t-Value**
	Mean	**SD**	**Mean**	**SD**	
Fat mass (kg)	7.98	1.93	8.66	2.09	4.01**
Muscle mass (kg)	21.11	3.77	19.95	3.85	3.63**
Skeletal mass (kg)	9.59	2.49	9.03	2.74	2.55*
Residual mass (kg)	15.65	2.30	16.06	2.25	2.15*
SBP (mmHg)	129.22	13.06	132.37	15.02	2.64*
DBP (mmHg)	85.23	8.99	86.71	11.34	1.69
RBS (mg/dL)	112.96	30.96	119.58	36.71	2.36*

Notes: SBP=Systolic Blood Pressure, DBP=Diastolic Blood Pressure, RBS=Random Blood Sugar, SD-standard deviation**,** Significant level * $p < 0.05$; ** $p < 0.01$.

Table 6 shows the comparison of body composition components, blood pressure, and blood sugar levels of the two populations. The valley population possesses significantly greater fat mass (t =4.01, $p<0.01$) and residual mass (t =2.15, $p<0.05$) than the hill. However, the hill population possesses significantly greater muscle mass (t =3.63, $p<0.01$) and skeletal mass (t =2.55, $p<0.05$) as compared to the valley. The valley population also shows significantly higher SBP (t =2.64, $p<0.05$) and random blood sugar level (t =2.36, $p<0.05$) than the hill. However, significant differences were not observed for DBP between the two populations.

Discussion

The main objective of the study was to examine the potential difference in the anthropometric measurements and body composition of the Tangkhul tribes living in the hill and valley settings of Manipur. The hill dwellers were significantly taller than the valley, while regarding body weight measurement, the valley was significantly heavier with higher BMI and FMI compared to the hill counterparts. The finding is in conformity with earlier other studies (Maken & Varte, 2016; Singh et al., 2017). In the comparison of the anthropometric measurements of the two populations, the hill dominated in the girth measurements, and the valley overtook in the skinfold measurements. Baro & Dihingia (2014), in a study among people in hilly and plain areas, found that the hill people have more calf and thigh girth, indicating that they have better thigh and calf muscles. While other studies found that the urban valley population has greater skinfold thickness than the inhabitants of the rural hill areas (Adediran et al., 2013; Sola et al., 2011). Further, significant differences were found in comparing the width, breadth, and depth measurements of different body parts of the hill and valley Tangkhuls ($p<0.05$). The finding is in accord with an earlier study (Thibault et al., 1985).

The body composition analysis of the two populations also showed that the hill inhabitants possess greater muscle and skeletal mass while the valley has greater fat and residual mass. The hill and valley populations also exhibited differences in their body metabolism regarding blood pressure and blood sugar levels. The valley population showed higher SBP, DBP, and RBS than the hill counterparts. All these variations in anthropometric, body composition and body metabolism of the two population are likely due to disparities in their ecology and lifestyles. The hill people were primarily farmers and manual laborers with low incomes; the valley, on the other hand, were mostly employed and had a high income. Therefore the valley people have reduced physical activity fostered by available and affordable transportation, sedentary jobs, and automatic appliances. All this finding is in accord with earlier studies reflecting the effect of westernization on body composition as well as CVD. (Sola et al., 2011; Ekezie et al., 2011).

On the contrary, the hill people have a contrasting pattern of lifestyle in which long distances are walked on the hill slopes, and strenuous activities are performed in their daily activities for livelihood. Thus the hill people possess more muscle and skeletal mass, and the anthropometric measurements indicate a more favorable body composition than the valley people. In a study among highlanders, Greksa et al. 1994, concluded that the change in body composition at high altitudes is also linked with the general influence of genetic involvement in adaptation to hypoxia. Other disparities in the behaviors, such as alcohol consumption, smoking tobacco, and dietary habits, could also be a factor for the differences in the hill and valley Tangkhuls of Manipur.

Conclusion

It has been concluded that the anthropometric and body composition of the Tangkhul tribes in Manipur exhibits significant regional differences. The hill Tangkhul exhibits a better, more favorable body composition and physical attributes than the valley, owing to its healthier lifestyle, practices, and natural environment. These outlooks suggest a linkage between lifestyle and environment in anthropometry and the body composition of the Tangkhuls. Healthcare professionals and researchers can leverage this information to address health disparities and promote better public health outcomes.

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