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Body fat patterning and blood pressure levels: a comparative study between the Rai and the Lepcha in Sikkim

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ABSTRACT: We compared the perception of two ethnic groups in relation to health, obesity and blood pressure problems and its management, and to compare the body fat patterning and blood pressure levels between Rai and Lepcha ethnic groups. We chose Rai and Lepcha ethnic groups living in Ranka, a place which is 16 kilometres away from the city of Gangtok, Sikkim. The study involved 160 males (Rai = 80 and Lepcha = 80) of age 25–35 years. The participants were initially interviewed about their perception towards health, obesity and blood pressure problems and its management along with other socio-demographic and lifestyle variables. Later, body fat patterning and blood pressure levels of the participants were measured and compared between these two groups. Multiple linear regression analysis was performed to understand the association of body fat patterning and blood pressure levels with socio-demographic and lifestyle variables. Multivariate analysis of covariance (MANCOVA) was used to examine the relationship of ethnicity with both body fat patterning and blood pressure levels. We found a noticeable difference between Lepcha and Rai ethnic groups in perception towards health and obesity, blood pressure problems and its management. Similarly, a significant difference was observed in body fat patterning and blood pressure levels between Rai and Lepcha participants. MANCOVA revealed that the measures of body fat pattering and blood pressure levels differed significantly between these two ethnic groups, after controlling for lifestyle variables and age of the participants at time of interview. We concluded that there remains ethnic diversity, embedded in cultural behaviours and practices concerning health and obesity, hypertension and associated lifestyle patterns. Such practices, rooted in the belief system of an ethnic group is likely to inform the health condition of group members.

KEY WORDS: body fat pattern, blood pressure levels, Rai, Lepcha, Sikkim, West Bengal

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Introduction

Obesity has become a worldwide phenomenon contributing to the global burden of chronic diseases (Ng et al. 2014; Fox et al. 2019). Increased consumption of calorie-dense, less nutritive foods combined with reduced physical activity led to a rise in the incidence of obesity since the 1980s, both in developed and developing countries. Thus, in developing countries, often coexisting with under-nutrition, obesity became a complex phenomenon with serious psychosocial dimensions, affecting virtually all ages and socio-economic groups (Hruby and Hu 2015). Cross-cultural studies documented that ethnicity plays a significant role in determining the cases of obesity and related health issues in the global scenario (Lear et al. 2007; Carrol et al. 2008; Mohamud et al. 2011; Barreira et al. 2012; Carpenter et al. 2013; Sabanayagam et al. 2013; Wang et al. 2017).

In India, there is an increase in the trend of overweight, obesity, and hypertension among adult populations in distinct ethnic groups. For example, a study in Delhi reported that Khatri females had greater Body Mass Index (BMI) and Percent Body Fat (PBF) than males, while the trend was reversed for Waist Hip Ratio (WHR) and Waist to Height Ratio (WHR) (Mungreiphy et al. 2012). The high prevalence of overweight and obesity among the Marwaris in Kolkata were likely to be the reason behind high prevalence of hypertension in this community (Majumder et al. 1995; Das and Bose 2006). In another Kolkata based study, Ghosh et al. (2005) reported higher levels of BMI and WHR among Bengali Hindu females compared to Bengali Muslim females. Similarly, a high prevalence of obesity and hypertension was found among the Bengali Kayastha population (Sarkar et al. 2009).

Body fat patterning and blood pressure problems are not only influenced by ethnicity, but are also induced by lifestyle practises by the members of an ethnic group (Paeratakul et al. 2002; Gillum and Sempos 2005; Dressler et al. 2012). Thus, the members of an ethnic group have a shared collective understanding, that is informed by culture. For example, people of western countries preferred females with thin body shape, while in Asian countries, plump body shape was traditionally preferred (Sakamaki et al. 2005). Latino mothers believed that obese children were healthy, and they showed less concern about their child's weight. However, a few parents realised the problem and felt that obese children should be taken to a nutritionist or physician for seeking advice towards weight reduction (Pham and Harrison 2007). With modernization, there remained a gradual shift in the perception of a community towards body shape and lifestyle (Becker 2004) or it brought changes in the actual pattern of lifestyle among individuals, which eventually caused adverse effects on body fat patterning, blood pressure levels and health (Bardan and Laher 2012).

Some Indian studies attempted to examine the differences in the perception levels and objective measures of obesity, blood pressure problems and its management. For example, Marwari Hindu and the Bengali Hindu ethnic groups living in Kolkata showed noticeable differences in the perception levels and objective measures of obesity, blood pressure problems and its management. The same study revealed that body fat patterning differed significantly between these two ethnic groups after controlling

for the lifestyle variables (Ghosh et al. 2018). Another study in the urban centres of Howrah district demonstrated that there was a difference between perception towards and actual pattern of lifestyle practices among the members of two ethnic groups (Santals and Bengali Hindu), indicating lower cultural consonance. However, both variables were associated with body composition, blood pressure and blood sugar levels, but not with ethnicity, after removing the effects of socio-demographic variables (Kanrar et al. 2021). The present study aimed to compare the perception of the Rai and the Lepcha ethnic groups towards obesity and blood pressure problems and its management and also to compare body fat patterning and blood pressure levels between these two ethnic groups.

Materials and Methods

Study area and study population

This study was conducted in Ranka, which is under the jurisdiction of Gangtok subdivision of East Sikkim, India. Ranka is a *Gram Panchayat Unit* (GPU) (village administrative unit) situated 16 kilometres away from the city of Gangtok. The entire area is in the Eastern Himalayan range, at an elevation of 1650 meters from sea level. There are 135 families in this GPU with a total population size of 609 (306 males, 303 females) (Census of India 2011).

There are seven villages under Ranka GPU. Out of these we selected two villages (Rai Gaon and Phenzong) for this study. The Rai populations live in the Rai Gaon village, while the Lepcha populations live in the Phenzong village. These two villages were chosen because of operational convenience. The Rais, also known as *Kirant/Kirantis*, is one of the major communities amongst the Nepalese Hindu in Sikkim. The Rais have reportedly been settled in Sikkim from the 17th century (Subba 2011). They are distributed in all the districts of Sikkim, with fewer of them in the Northern District. Although Hinduism is the traditional religion of the Rai, many of the Rai families follow Christianity.

The Lepchas, also known as *Rong*, are the people living in the countries of Nepal (eastern), Bhutan (western), the state of Sikkim (mostly North Sikkim), and the Darjeeling district of West Bengal in India. The Lepchas are thought to be the earliest inhabitants of Sikkim, but have adopted many elements of the culture of the Bhutia people, who entered Sikkim from Tibet during the 14th century and afterward (Subba 2011). The Lepcha community usually live in the remotest valleys and speak in a Tibetan dialect and follow Buddhism, but still retain earlier features of shamanism.,

Traditionally, the Lepchas were hunters and gatherers, but are currently engaged in farming.

Study Participants

We involved young adult males of both the groups (the Rai and the Lepcha). A total of 160 males (80 males each from the Rai and the Lepcha communities) were recruited in this study. Age of the participants ranged between 25 and 35 years. The purpose of the study was explained to the participants and verbal informed consent was taken from the participants prior to the survey. Participation in the study was voluntary in nature. Prior to the study, ethical clearance was obtained from the Institutional Review Board of the University of Calcut-

ta. The study was conducted by one of the authors (SP) during the months of March and April 2019.

Data types

Socio-demographic characteristics

Socio-demographic characteristics, including age of the participants at the time of interview (in years), educational levels (in years), occupational types, monthly household expenditure [Indian National Rupees (INR)] were collected using a pre-tested structured schedule.

Perception towards health and obesity, blood pressure problems and its management and case studies were collected in these areas from a subsample (a total 12 case studies: 7 from the Rai group; 5 from the Lepcha group). Each of the cases was recorded using a voice recorder and the recordings were later transcribed. The perception towards health and obesity, blood pressure problems and its management of the participants were presented in the form of interview excerpts.

Lifestyle

Lifestyle information of the participants included food consumption,substance use, physical activities and medical history.

Food consumption and substance use

Data on food consumption was measured from the dietary practice of the participants using a 24-hour recall method. The participants were asked to report how often they consumed foods throughout the 24 hours prior to the interview date. Additionally, the participants were asked about substance use such as consumption of alcohol (at least once a week) and smoking habits (at least one cigarette a day).

Physical activities

The participants were asked to report how much time they spent on different physical activities (morning walk, agricultural and horticultural activities, and walking uphill and downhill and household chores) throughout the 24 hours period on a typical day.

Medical history

The participants were asked whether they ever checked their blood pressure level; were diagnosed with hypertension or had received any treatment for hypertension for the past one-month period preceding the date of the interview.

Measures of body fat patterning

Anthropometric measures such as stature, waist circumference (WC), hip circumference (HC) and triceps skin fold thickness (TSKF), subscapular skin fold thickness (SSKF), suprailiac skin fold thickness (SISKF) were taken from each participant following standard protocol (Lohman et al. 1988). Stature (to the nearest of 0.1 cm) was measured using a portable GPM anthropometer for each participant standing without shoes on a horizontal surface with the body stretched upward to the fullest extension and the head in the Frankfurt plane. WC and HC were measured to the nearest of 0.1 cm with a non-stretchable fibre glass insertion tape over light clothing. WC was measured at the minimum circumference of torso between the iliac crest and the rib cage. HC was measured horizontally at the level of maximum extension of the buttocks. TSKF was measured at the right upper arm in the midway between the point of acromion and olecranon process while the arm was hanging relaxed. SSKF was measured just below the tip of inferior angle of the scapula,

at an angle of about 45° to the vertical. SISKF was measured just above the iliac crest in the mid axillary line. These three skinfold thicknesses (to the nearest of 0.1 mm) were measured using Lange skinfold calliper that applies a pressure of 10g/mm^2 on the skinfold sites. Anthropometric index such as WHR was calculated using standard formulae: WHR = WC (cm)/ HC (cm).

Furthermore, body weight, visceral fat, subcutaneous fat and skeletal muscle for the arm, leg, trunk and whole body, and PBF and BMI were measured on each participant following bioelectrical impedance technique. We used Omron Body Composition Monitor (HBF-362) for taking these measurements. The participants were wearing light apparel and without shoes at the time of taking all these measurements. Overweight (25.0–<30.0) and obese (≥30) was categorized based on the BMI values following World Health Organization (2006).

Blood pressure levels

Blood pressure [systolic blood pressure (SBP) and diastolic blood pressure (DBP)] levels were measured on left arm by auscultation method using a blood pressure monitor (Omron M2 Manual Inflation Blood Pressure Monitor, Japan). Hypertension was defined as mean systolic blood pressure (SBP) ≥ 140 mm Hg and/or mean diastolic blood pressure (DBP) ≥ 90 mm Hg following the guideline of the seventh report of Joint National Committee (JNC VII) (Chobanian et al. 2003).

Statistical analyses

We used descriptive statistics to understand socio-demographic profile and lifestyle (food consumption and substance use and physical activities and medical history) of the study participants. We applied Student's t test to compare the body fat patterning (BMI, WHR, PBF, TSKF, SSKF, SISKF, visceral fat, subcutaneous fat and skeletal muscle of whole body, trunk, arms and legs) and blood pressure levels (SBP and DBP) between the Rai and the Lepcha participants. Multiple linear regression analyses were applied to understand the association of body fat patterning and blood pressure levels with socio-demographic and lifestyle variables. All the measures of body fat patterning and blood pressure levels were used as dependent variables, while the set of socio-demographic and lifestyle variables were incorporated as independent variables in each separate model. Multivariate analysis of covariance (MANCOVA) was used to examine the association of body fat patterning and blood pressure levels with ethnicity after removing the effects of covariates such as socio-demographic (age of the participants at time of interview, educational levels, and monthly household expenditure) and lifestyle (physical activities) variables. In MANCOVA, measures of body fat patterning and blood pressure levels were incorporated as dependent variables. Continuous variables like age of the participants at time of interview, educational levels and monthly household expenditure and lifestyle pattern (duration of physical activities) were included as covariates. Ethnicity was included in this analysis as the grouping variable. A minimum p value of ≤ 0.05 was considered as statistically significant for all inferential statistics. The entire data were analyzed using Statistical Package for Social Science version 20.0 (IBM 2011).

Results

The mean age of the participants at time of interview was around 32 years. Out of 160 participants, half of them hailed from Lepcha group and the rest from the Rai group. All the Lepcha participants followed Buddhism, while more than half of the Rai followed Hinduism and a section (37.5%) followed Christianity. Majority of the Rai males attained education above the 12th standard, while most of the Lepcha males attained education below the 12th standard. The median monthly household expenditure of the participants for the Rai and the Lepcha were 9000 (INR) and 8000 (INR) respectively. More than half of the Rai were in service, while the majority of the Lepcha were either in service (45%) or in farming activities (45%) (Table 1).

Perception towards obesity, blood pressure level and its management

The Rai

Rai participants were conscious about their health. They were quite aware that accumulation of excess body fat might increase the risk of hypertension. Following are some of the excerpts from the members of the Rai group.

While describing the health-related issue, a 36-year-old participant said "Hypertension is harmful for our health. Regular morning walks may help reduce body fat and keep us physically fit. Being a diabetic patient, I regularly go for a morning walk, as advised by my doctor." The participant further said "Traditionally the Hindu Rai people did not consume beef and milk. Consumption of these food items are not good for health".

Another 34-year-old government employee said "We are more health conscious and try to remain slim and physically strong…".

Table 1. Socio-demographic characteristics of the participants (n=160)

Socio-demographic characteristics	Rai (n = 80)		Lepcha (n = 80)	
	n	%	n	%
Age of the participants at time of interview (in years) mean ± sd	32.80±4.38		32.28±4.08	
Religion				
Hindu	50	62.5	–	–
Christian	30	37.5	–	–
Buddhist	–	–	80	100.0
Educational levels of the participants				
<10th standard	8	10.0	15	18.8
10th–12th standard	28	35.0	34	42.5
>12th standard	44	55.0	31	38.8
Occupational types of the participants				
Business	10	12.5	3	3.8
Service	47	58.8	36	45.0
Farmer	16	20.0	36	45.0
Others*	7	8.8	5	6.2
Monthly household expenditure (in Indian rupees) median	9000		8000	

*others: driver, pension holder, politician.

Rai people usually avoid consumption of mutton (red meat) as it causes stomach infection..." "Regular physical exercise keeps the body fit and strong".

A 30-year-old agriculturist said "The Rais believe that their ancestors bless them for enjoying a long life. Thus, we are very much concerned about our health. We avoid mutton for stomach infection, and believe that if a pregnant lady consumes mutton during her gestational period, the baby may develop neurological problems".

A businessman of 35-year-old said "Obesity is a lifestyle disorder. However, obesity does not affect people at this young age. If we become obese after 50 years, we can't move up and down in this hilly area. We avoid fatty foods that possibly increase the chance of obesity".

Another participant (involved in agricultural activities) aged 29 years said, "We avoid the consumption of beef and pork. These food items increase the chances of excess fat accumulation and cholesterol level in the body."

A 34-year-old political activist said "I despise accumulation of excess fat in the body. This excess deposition of fat reduces energy and increases the risk of hypertension." The participant further said "the Rais usually drink country liquor to get relief from body aches and fatigue. But I do not consume alcohol as per the advice of the doctor……since smoking is strictly prohibited in Sikkim, the Rai mostly follow the rules and never smoke. I also never smoke as smoking causes respiratory problems".

Another 30-year-old participant said "I follow a healthy lifestyle (such as moderate physical activity and consumption of staple foods), thus I do not have any health problems".

The Lepcha

The Lepcha participants appeared to have a different perception towards health compared to the Rai participants. Generally, the Lepcha were shorter in height than the Rai, owing to their ethnic origin. Although, a large section of the Lepcha participants were hypertensive yet seeking medical advice by them was conspicuously absent. Most of the Lepcha participants did not show any concern towards hypertension since they remained engaged in laborious work. Following are some of the excerpts of the Lepcha participants.

A 33-year-old participant said "We worship the Lord Buddha, thus we restrain from the habits of smoking and drinking alcohol. Moreover, we also avoid some types of meat because it causes stomach infection ….. the Lepcha believe in performing strenuous physical activities. We never visit hospitals for minor ailments. We have a strong belief that Lord Buddha will protect us from all illnesses; thus we prefer to offer prayer at the *Gumpha* to get rid of our ailments rather than visiting doctors".

A 30-year-old participant, involved in agricultural activities said "I have to work hard to produce my crop. I suffer from acute allergy and blood infection if I consume animal proteins. The consumption of animal protein is strictly forbidden in our religion".

A 33-year-old participant said "Being overweight is somewhat beneficial in cold climatic condition in the high-altitude. Here, excess body fat works as an insulator and helps to keep the body warm".

Another 32-year-old agricultural labour said "The members of the Lepcha community consume salted tea with butter several times in a day. It is a traditional practice. We believe that salted

tea provides a lot of energy to performing strenuous activities". The labourer added "I avoid taking medication for minor health issues and believe that laborious physical activities can prevent one from becoming obese and minor health problems".

A 35-year-old serviceman said "I am no more bothered of being hypertensive. High blood pressure level keeps the blood warm and helps us in coping with cold climate at this high altitude. The Lepcha consume salted butter tea on regular basis to keep their body warm".

The following are the comparative accounts of the measures of body fat patterning and lifestyle profiles of the Lepcha and Rai.

The Rai participants showed significantly higher values with respect to height, SISKF, WHR, and subcutaneous fat of leg compared to the Lepcha. On the other hand, the Lepcha had significantly greater values for TISKF, BMI, SBP, DBP than the Rai (Table 2).

An appreciable proportion of participants of both groups were overweight. A majority of the Lepcha participants were hypertensive (stage II) compared to the Rai; more than one third of the Rai participants were hypertensive (stage I) (Table 3).

Most of the Rai participants never took medicine for any metabolic disorder; however, approximately 80% of them checked their blood pressure

Table 2. Anthropometric characteristics, body fat patterning and blood pressure levels of the participants (n = 160)

Anthropometric characteristics, body fat patterning and blood pressure levels	Rai (n = 80)	Lepcha (n = 80)	*t*-value	*p*-value
Stature (cm)	162.93±0.54	160.45±0.52	3.292	0.001
Body weight (kg)	64.63±1.16	63.54±1.01	0.704	0.483
Waist circumference (cm)	88.36±1.10	85.70±0.86	1.897	0.060
Hip circumference (cm)	92.71±0.87	93.50±0.92	0.619	0.537
Triceps skinfold thickness (mm)	15.68±0.56	19.65±0.32	6.109	0.000
Subscapular skinfold thickness (mm)	19.22±0.53	18.86±0.62	0.438	0.662
Suprailliac skinfold thickness (mm)	16.88±0.67	12.99±0.57	4.413	0.000
Visceral fat*	9.58±0.52	9.27±0.44	0.454	0.650
Subcutaneous fat of whole body (%)	16.55±0.46	15.58±0.43	1.530	0.128
Skeletal muscle of whole body (%)	31.15±0.33	31.55±0.31	0.869	0.386
Subcutaneous fat of trunk (%)	14.98±0.41	14.01±0.41	1.651	0.101
Skeletal muscle of trunk (%)	26.16±0.72	25.18±0.38	1.197	0.233
Subcutaneous fat of leg (%)	23.87±0.59	21.87±0.61	2.336	0.021
Skeletal muscle of leg (%)	47.91±0.50	46.57±1.10	1.097	0.275
Subcutaneous fat of arm (%)	23.61±0.56	22.25±0.55	1.707	0.090
Skeletal muscle of arm (%)	37.16±0.47	37.91±0.25	1.392	0.166
Body mass index	23.56±0.40	24.67±0.37	2.014	0.046
Percent body fat	22.90±0.58	22.10±0.61	0.961	0.338
Waist-hip ratio	0.95±0.01	0.91±0.01	2.562	0.011
Systolic blood pressure (mmHg)	121.7±0.86	137.27±0.71	13.884	0.000
Diastolic blood pressure (mmHg)	85.5±0.56	101.93±0.64	12.928	0.000

*visceral fat levels are relative and not absolute values (source: Omron instruction manual).

Table 3. Incidence of obesity and hypertension among the participants (n = 160)

Incidence of obesity and hypertension	Rai (n = 80)		Lepcha (n = 80)	
	n	%	n	%
Incidence of obesity				
Overweight	30	37.5	31	38.8
Obese	–	–	7	8.7
Incidence of hypertension				
Pre-hypertensive	29	36.2	–	–
Hypertensive (stage I)	27	33.8	11	13.8
Hypertensive (stage II)	12	15.0	69	86.2

Table 4. Medical history of the participants (n = 160)

Medical history	Rai (n = 80)		Lepcha (n = 80)	
	n	%	n	%
Under medication for any metabolic disorder*				
Yes	2	2.5	36	45.0
No	78	97.5	44	55.0
Ever checked blood pressure**				
Yes	64	80.0	61	76.2
No	16	20.0	19	23.8
Presence of hypertension problem among family members				
Yes	2	2.5	72	90.0
No	78	97.5	8	10.0

*At the time of interview, **during the past six months preceding the date of interview.

within the past six months period prior to the date of interview. More than half of the Lepcha participants never took medicine for any metabolic disorder; however (76%) of them checked blood pressure within the past six months period prior to the date of study. Most of the Lepcha participants reported to have a family history of high blood pressure (Table 4).

Food consumption pattern revealed that almost all the participants of both the groups consumed rice and tea several times in a day. The Rai participants consumed vegetables more frequently than the Lepcha participants. An appreciable number of Rai participants consumed chicken, beef, pork and buffalo, while the Lepcha participants consumed chicken (65%) and beef (35%). Milk was found to be consumed only by the Lepcha participants (Table 5).

None of the Lepcha participants smoked compared to 40% of the Rai participants. Alcohol consumption was reported by the Rai participants more frequently than that of the Lepcha participants (Table 6).

The Lepcha participants spent more time engaged in agricultural activities, while the Rai participants spent more time in horticultural activities. The Rai participants spent more time engaged in morning walk and in household chores compared to Lepcha participants. However, Lepcha participants spent more time in mountain hiking than that of the Rai participants (Table 7).

Results of multiple linear regression analyses shows that lifestyle (food con-

sumption, substance use and physical activities) were significantly associated with body fat patterning and blood pressure levels. For example, tea consumption was positively associated with BMI (β = 3.80), PBF (β = 8.4), SISKF (β = 12.48), visceral fat (β = 7.62), subcutaneous fat of trunk (β = 4.78) and leg (β = 10.65), and SBP (β = 2.92). On the other hand, tea consumption was inversely associated with skeletal muscle of whole body (β = −4.62) and leg (β = −6.75). Furthermore, the levels of fat in different parts of body increased with the consumption of foods such as pork, chicken, *bungchipa* and noodles, and decreased with increase in the consumption of foods such as momo, *rai shak* and green vegetables. Skeletal muscle mass in different parts of body increased with lower consumption of foods such as pork, chicken, *bungchipa* and noodles; and with the increase in consumption of foods such as momo, *rai shak*, green vegetables. Alcohol consumption was positively associated with TSKF (β = 3.06), visceral fat (β = 1.57) and DBP (β = 3.85), but inversely associated with skeletal muscle of arm (β = −1.86). The results further revealed that PBF (β = −0.15), TSKF (β = −0.06), subcutaneous fat of leg (β = −0.21) were inversely associated with increase in the duration of walking through uphill and downhill; however, the trend was reversed for skeletal muscle fat (β = 0.16). PBF and SISKF decreased with increase in the duration of agricultural (β = −0.21) and horticul-

Table 5. Food consumption (24-hour recall) of the participants (n = 160)

Food items	Rai (n = 80)		Lepcha (n = 80)	
	n	%	n	%
Rice	80	100.0	80	100.0
Tea	76	95.0	80	100.0
Pulses	63	78.8	72	90.0
Potatoes	29	36.2	32	40.0
Squash	50	62.5	37	46.2
Rai shak*	34	42.5	24	30.0
Green vegetables	42	52.5	32	40.0
Peas	21	26.2	4	5.0
Pumpkins	31	38.8	16	20.0
Bungchipa**	24	30.0	–	–
Khaja***	14	17.5	8	10.0
Chicken	32	40.0	52	65.0
Beef	27	33.8	28	35.0
Pork	27	33.8	–	–
Buffalo	28	35.0	–	–
Mutton	–	–	8	10.0
Momo	24	30.0	12	15.0
Noodles	23	28.7	16	20.0
Milk	–	–	52	65.0

*Rai shak (a kind of leafy vegetable available in Sikkim), **Bungchipa (chicken feather), ***Khaja (rice mixed with pulses).

Table 6. Substance use among the participants (n = 160)

Substance use	Rai (n = 80)		Lepcha (n = 80)	
	n	%	n	%
Smoking*				
Yes	32	40.0	–	–
No	48	60.0	80	100.0
Alcohol use**				
Yes	38	47.5	25	31.2
No	42	52.5	55	68.8

*at least one cigarette a day, **at least once a week.

Table 7. Physical activities (24 hour recall) of the participants (n = 160)

Duration of physical activities (in minutes)	Rai (n = 80)	Lepcha (n = 80)
	mean±se	mean±se
Morning walk	16.8±0.91	5.62±0.42
Agricultural activities	40.87±2.45	96.0±2.40
Horticultural activities	36.98±1.23	25.47±1.10
Walking uphill and downhill	26.81±0.35	55.37±0.75
Household chores	25.15±1.54	10.50±0.20

Table 8. Results of multiple linear regression analyses showing the association of body fat patterning and blood pressure levels with socio-demographic and lifestyle variables (n = 160)

Dependent variables	Independent variables	β	Std error	*t*-value	*p*-value	C. I.	
						lower	upper
BMI	Consumption of noodles	1.565	0.621	2.518	0.012	0.337	2.792
	Consumption of chicken	1.563	0.508	3.076	0.002	0.559	2.566
	Consumption of tea	3.801	1.557	2.441	0.015	0.725	6.877
WHR	Consumption of pork	0.073	0.016	4.572	0.000	0.041	0.105
	Consumption of momo	0.044	0.015	2.925	0.004	0.014	0.074
	Consumption of *rai shak*	−0.044	0.013	−3.365	0.001	−0.071	−0.018
TSKF	Ethnicity (Rai)	−6.607	0.892	−7.406	0.000	−8.371	−4.844
	Consumption of alcohol	3.066	0.816	3.753	0.000	1.452	4.680
	Consumption of tea	9.016	1.970	4.574	0.000	5.122	12.911
	Consumption of green vegetables	−4.478	0.862	−5.194	0.000	−6.181	−2.774
	Age of the participants at time of interview	0.196	0.066	2.945	0.003	0.064	0.328
	Consumption of pork	3.930	0.984	3.993	0.000	1.985	5.875
	Duration of walking uphill and downhill	−0.066	0.027	−2.382	0.018	−0.122	−0.011
SSKF	Age of the participants at time of interview	0.159	0.095	1.658	0.009	−0.031	0.348
SISKF	Ethnicity (Rai)	4.275	0.821	5.206	0.000	2.652	5.898
	Consumption of *khaja*	4.159	1.130	3.680	0.000	1.926	6.392
	Consumption of chicken	4.936	0.938	5.262	0.000	3.083	6.790
	Consumption of tea	12.482	2.708	4.608	0.000	7.130	17.833
	Consumption of pork	6.517	1.387	4.697	0.000	3.776	9.259
	Duration of horticultural activity	−0.043	0.016	−2.717	0.007	−0.075	−0.012
	Duration of agricultural activity	−0.211	0.004	−2.504	0.013	−0.319	−0.012
PBF	Duration of walking uphill and downhill	−0.151	0.040	−3.749	0.000	−0.230	−0.071
	Consumption of chicken	3.099	0.823	3.764	0.000	1.472	4.726
	Consumption of momo	−3.084	0.986	−3.124	0.002	−5.033	−1.134
	Consumption of tea	8.421	2.579	3.264	0.001	3.325	13.519
	Consumption of pork	3.485	1.208	2.884	0.004	1.098	5.873
Visceral fat	Consumption of chicken	2.983	0.727	4.102	0.000	1.546	4.420
	Consumption of tea	7.621	2.112	3.607	0.000	3.447	11.795
	Consumption of alcohol	1.574	0.622	2.539	0.012	0.349	2.799
	Consumption of *rai shak*	1.597	0.657	2.432	0.016	0.299	2.895
	Consumption of pork	2.316	0.957	2.421	0.016	0.426	4.207
Subcutaneous fat of whole body	Occupational types (Farmer)	−1.324	0.636	−2.078	0.039	−2.582	−0.065
	Consumption of *bungchipa*	1.657	0.784	2.114	0.036	0.108	3.206
Subcutaneous fat of trunk	Occupational types (Farmer)	−1.154	0.581	−1.985	0.048	−2.302	−0.006
	Consumption of tea	4.786	1.649	2.902	0.004	1.528	8.044
	Ethnicity (Rai)	2.325	0.643	3.613	0.000	1.054	3.597
	Duration of walking uphill and downhill	0.129	0.040	3.191	0.001	0.049	0.209

Dependent variables	Independent variables	β	Std error	*t*-value	*p*-value	C. I.	
						lower	upper
Subcutaneous fat of leg	Occupational types (Farmer)	−2.066	0.743	−2.779	0.006	−3.535	−0.597
	Duration of walking uphill and downhill	−0.213	0.035	−5.950	0.000	−0.284	−0.142
	Consumption of chicken	3.818	0.744	5.129	0.000	2.347	5.289
	Consumption of tea	10.657	2.435	4.375	0.000	5.844	15.469
	Consumption of pork	5.955	1.140	5.222	0.000	3.702	8.208
	Consumption of momo	−2.572	0.937	−2.743	0.006	−4.425	−0.719
Subcutaneous fat of arm	Occupational types (Farmer)	−1.613	0.811	−1.989	0.048	−3.215	−0.011
	Consumption of *bungchipa*	2.306	0.998	2.310	0.022	0.334	4.278
Skeletal muscle of whole body	Age of the participants at time of interview	−0.142	0.048	−2.915	0.004	−0.239	−0.046
	Consumption of tea	−4.626	1.402	−3.299	0.0012	−7.397	−1.856
	Consumption of pork	−1.651	0.609	−2.718	0.007	−2.855	−0.447
	Consumption of chicken	−2.648	0.799	−3.313	0.001	−4.227	−1.069
	Consumption of momo	3.216	0.946	3.399	0.000	1.347	5.085
	Duration of walking uphill and downhill	0.167	0.045	3.674	0.000	0.077	0.256
	Consumption of *rai shak*	1.793	0.812	2.208	0.028	0.188	3.398
Skeletal muscle of leg	Age of the participants at time of interview	−0.366	0.125	−2.921	0.004	−0.613	−0.118
	Duration of horticultural activity	−0.119	0.022	−4.987	0.000	−0.153	−0.066
	Consumption of *rai shak*	4.673	1.162	4.021	0.000	2.377	6.979
	Consumption of potato	−3.844	1.102	−3.487	0.000	−6.022	−1.666
	Consumption of green vegetables	−2.929	1.040	−2.816	0.005	−4.984	−0.874
	Consumption of tea	−6.751	3.208	−2.104	0.037	−13.09	−0.412
Skeletal muscle of arm	Age of the participants at time of interview	−0.183	0.051	−3.531	0.000	−0.285	−0.080
	Consumption of *bungchipa*	−2.119	0.635	−3.335	0.001	−3.374	−0.864
	Consumption of alcohol	−1.863	0.542	−3.436	0.000	−2.934	−0.792
	Consumption of noodles	−1.224	0.542	−2.257	0.025	−2.296	−0.152
SBP	Ethnicity (Rai)	−14.74	0.944	−15.61	0.000	−16.61	−12.87
	Age of the participants at time of interview	0.738	0.104	7.050	0.000	0.531	0.944
	Consumption of pork	3.143	0.955	3.297	0.001	1.255	5.030
	Consumption of tea	2.923	1.364	2.143	0.034	0.228	5.617
	Ethnicity (Rai)	−16.30	1.233	−13.22	0.000	−18.74	−13.87
DBP	Age of the participants at time of interview	0.555	0.138	4.007	0.000	0.281	0.829
	Consumption of alcohol	3.856	1.209	3.189	0.001	1.4678	6.244

BMI (body mass index), PBF (percent body fat), WHR (waist-hip ratio), TSKF (triceps skinfold thickness), SSKF (subscapular skinfold thickness), SISKF (suprailliac skinfold thickness), SBP (systolic blood pressure), DBP (diastolic blood pressure).

tural activities (β = −0.04) respectively. Socio-demographic variables such as age of the participants at time of interview, ethnicity and occupational types of the participants were significantly associated with the measures of body composition and blood pressure levels. For example, Rai participants were likely to have lower levels of TSKF (β = −6.60), SBP (β = −14.74) and DBP (β = −16.30) and greater SISKF (β = 4.27) and subcutaneous fat of trunk (β = 2.32) compared to their Lepcha counterpart. Age of the participants at the time of the interview was positively associated with TSKF (β = 0.19), SSKF (β = 0.15), SBP (β = 3.14) and DBP (β = 0.55); but the trend was inverse for skeletal muscles of whole body (β = −0.14), leg (β = −0.36) and arm (β = −0.18). Subcutaneous fat of the whole body (β = −1.32), trunk (β = −1.15), arm (β = −1.61) and leg (β = −2.06) were likely to be reduced in farmer compared to the participants in other occupational pursuits (Table 8).

The result of MANCOVA shows that body fat patterning and blood pressure levels differed significantly with respect to ethnicity. For example, ethnicity independently showed significant effect on TISKF, SISKF, SBP, and DBP after removing the effects of the covariates such as socio-demographic and lifestyle variables (Table 9).

Discussion

In this study, we chose two ethnic groups (Rai and Lepcha), inhabiting the same ecological setting (high altitude regions) but representing distinct cultural milieu. We attempted to compare the perception of the Rai and Lepcha groups regarding health and obesity, blood pressure problems and its management. Later, we compared body fat patterning and blood pressure levels between these two ethnic groups.

Our results showed a conspicuous difference in body fat patterning between the Rai and Lepcha groups; the Lepcha were shorter and had higher BMI than the Rai. This finding is indicative of a higher level of overall adiposity among

Table 9. Results of MANCOVA showing the effect of ethnicity on body fat patterning and blood pressure levels (n = 160)

Factors	Covariates	Type III sum of squares	*F*-value	*p*-value
Main effect of ethnicity	TSKF	59.543	4.229	0.042
	SSKF	8.025	0.335	0.564
	SISKF	162.332	7.041	0.009
	BMI	0.724	0.077	0.781
	PBF	63.667	3.027	0.084
	Visceral fat	12.860	0.941	0.334
	Subcutaneous fat of whole body	17.450	1.674	0.198
	Skeletal muscle of whole body	4.290	0.748	0.389
	Subcutaneous fat of trunk	27.973	3.293	0.072
	Skeletal muscle of trunk	53.299	2.468	0.119
	Subcutaneous fat of leg	48.486	2.597	0.109
	Skeletal muscle of leg	14.743	1.817	0.180
	Subcutaneous fat of arm	41.112	0.370	0.544
	Skeletal muscle of arm	20.070	1.409	0.237
	WHR	0.019	1.807	0.181
	SBP	926.015	28.810	0.000
	DBP	860.984	21.244	0.000

the Lepcha, which eventually made them hypertensive. The result of MANCOVA reinforces this finding. Thus, it appeared that ethnicity largely determines the body fat patterning and blood pressure levels as observed in other studies (Lin et al. 2004; Kumar et al. 2006; Carrol et al. 2008; Brummett et al. 2012).

The study on ethnic variation in adult body fat patterning and blood pressure levels has been recapitulated in anthropological research for a long period of time. However, there are few studies on body fat patterning and blood pressure levels among individuals in the purview of both ethnicity and culture. Thus, it is interesting to examine how cultural processes develop perception towards health that eventually influencing the body fat patterning and blood pressure levels among the individuals. Dressler et al. (1996) initiated to develop a model 'cultural consonance' that is referred to as an individual's reported behaviour corresponded to the culturally prototypical pattern. A Kolkata based study (Ghosh et al. 2018) documented that Marwaris and Bengali Hindu participants showed a consonance between their perceptions and behaviors. This reaffirms the idea that members of an ethnic group have a shared knowledge and perception towards obesity and blood pressure, which is influenced by culture. Cultural transmission is embodied in their lifestyle practices, where they influence cardiovascular health outcomes.

In this study, we found a noticeable difference in the perception towards health and obesity, blood pressure problems and its management between the Rai and the Lepcha participants. The Lepcha were not bothered of being hypertensive and never considered it as the risk factor for health. Rather they considered higher blood pressure helps them to cope with the cold climatic condition at high-altitude. The Lepcha believe that consumption of salted tea with butter on the regular basis increases body energy levels for performing strenuous physical activities at a high-altitude. They also perceived that regular involvement in tireless activities would keep them physically strong. Despite their involvement in strenuous work (such as agricultural activities and walking uphill and downhill), we found a higher incidence of hypertension along with greater level of adiposity among the Lepcha. This finding is consistent with other studies conducted in different ethnic populations living in high altitude areas (Norbo et al. 2015; Shen et al. 2017).

Among the Rai group, most of the participants perceived obesity to be largely associated with an increased risk of hypertension. They believed that obesity helps reduce physical energy and promotes health problems. This type of attitude probably increased greater health awareness regarding being overweight and hypertension by following a healthy lifestyle (such as moderate exercise and consumption of staple foods). However, hypertension and the level of adiposity also remained high among the Rai. It appeared that the Rai population living in high-altitude areas, had the same problem of hypertension and a greater level of adiposity as found among the Lepcha.

In our study, the consonance between the perception and the behaviours were reflected among the participants of both the ethnic groups. For example, despite being hypertensive, the Lepcha remained unaware about their own body weight and blood pressure levels, unlike the Rai. The Lepcha also believed that performing religious rituals protected them from

ailments. Contrary to this, the Rai preferred to seek medical advice to manage obesity and hypertension, and adopted lifestyle for health promotion. This could have been an effect of cultural consonance as suggested by Dressler in several studies (Dressler et al. 1991; Dressler et al. 1996; Dressler et al. 2004; Dressler et al. 2005; Dressler 2007; Dressler et al. 2008; Dressler et al. 2012).

Studying body fat patterning and blood pressure levels among ethnic groups through the lens of cultural consonance model reaffirms the major strength of the study. However, since the study was based on a small sample size, the results might not have reflected the general trend for these two ethnic groups. The research would have been more insightful if we quantified human perception towards obesity, blood pressure level and its management and used in multivariate analyses.

Conclusion

We conclude from this comparative study that cultural behaviours and practices between the Rai and Lepcha relating to health and obesity, hypertension and associated lifestyle pattern showed significant difference. Where such practices, are rooted in the belief system of an ethnic group it is more likely that they will influence the health outcomes of group members.

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The Authors' contribution

All the authors were responsible for the set up of the study, analyses and interpretation of the data and writing of the manuscript. Data collection was done by SP. Ethical clearance was obtained by the Institutional Review Board of the University of Calcutta.

Conflict of interest

The authors declare that there is no conflict of interest.

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