Factors associated with the CVD risk factors and body fat pattern of postmenopausal Hindu caste and Lodha tribal populations living in India: An exploratory study

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Abstract

Background

Loss in ovarian function during mid-life results in adverse changes in cardiovascular profile of women. The strength of the association between CVD risk factors and menopause differ cross culturally since several modifiable factors play significant roles in explaining CVD mortality than differences in endogenous estrogen. Very few of the studies from this subcontinent have been concerned with the menopause specific CVD risk factors, particularly among the tribal groups. Thus, we intended to study the variations in body fat pattern and CVD risk factors between Hindu caste and Lodha tribal postmenopausal women and how these risk factors can be predicted from differential socio-economic, reproductive and menstrual characteristics and lifestyle variables. The Lodha tribal populations is considered as Particularly Vulnerable Group (PVTG) in this country.

Methods

This cross-sectional study was conducted among the Bengali Hindu caste and Lodha tribal populations of the State of West Bengal, India covering three districts namely Howrah, Jhargram and East Midnapure. A total number of 197 postmenopausal participants have been recruited for this study (urban caste 69, rural caste 65 and rural Lodha 63). Data on blood sugar and total cholesterol levels, blood pressure, muscle mass, body fat distribution and sociodemographic, reproductive and menstrual history and lifestyle variables were collected following standard protocols. The entire data was analyzed with the help of statistical package for social science version 20.0(IBM corporation, 2011).

Results

This cross-sectional comparison of women at midlife, though exploratory in nature showed significant differences in body fat pattern and CVD risk factors between caste and tribal groups owing to the socioeconomic disparities, differences in reproductive characteristic and lifestyle factors.

Conclusion

The caste and tribal populations differed significantly in body fat pattern and CVD risk factors and the concomitants to these problems, suggesting interplay between menopause and modifiable factors in explaining CVD risk factors during mid-life.

Background

Cardiovascular disease (CVD) is recognized as the leading cause of death in both males and females, but the pathophysiological and clinical features of CVD are unique in the latter group. By far, CVD is the commonest cause of morbidity and mortality in postmenopausal women [1, 2]. Loss in ovarian function, and thereby a fall in the estrogen level during midlife results in adverse changes in glucose and insulin metabolism, body fat distribution, dyslipidemia, coagulation, fibrinolysis and vascular endothelial dysfunction, all of which increases the risk of CVD [3–10]. The Framingham heart study reported that women aged 50–59 years who experienced natural menopause are four times more likely at a risk of CVD compared to the premenopausal women of same age range [11]. Among Asian Indian women, the CVD risk factors like central obesity is higher among postmenopausal women compared to their premenopausal counterpart [12].

The strength of the association between CVD risk factors and menopause differ cross-culturally since several modifiable factors play significant roles in explaining CVD mortality than differences in endogenous estrogen. For example, the prevalence of CVD risk factors related to menopause varies across socioeconomic groups, early life events, family history, household stress, woman's attitudes and behaviors towards menopause and differential age at attaining menopause and rural-urban residence [13–16]. In India, the occurrence of premature menopause (before age 40) is most common among the rural agricultural workers, those who are non-literates, and have a low body mass index, signaling higher risks of CVD [17, 18]. Very few of the studies from this subcontinent have been concerned with the menopause specific CVD risk factors, particularly among the tribal groups [19–21]. Though some studies have been concerned with CVD risk factors among the primitive tribal groups, but they did not taken into consideration the issue of menopause [22, 23]. Most of these studies focused mainly on the age of onset of menopause, attitude and perception towards menopause, severity of menopausal symptoms and its variations across socio-economic groups [24–27].

Many of the ethnic minority groups of this country are socio-economically disadvantaged which exposed them to higher risks of inadequate food intake, poor hygiene and tobacco and alcohol consumption as well as lower access to health care [28, 29]. Thus, gaping disparities in health status of tribal women is observed when compared to metropolitan areas. This may in significant part occur from differing cultural practices and customs that in turn possibly results in the differing postmenopausal health outcomes among the caste and tribal women.

Studies reveal that the burden of CVD is now shifting from richer and better educated section to the poor and less educated section [34, 35]. In addition, the range of mean age at menopause of Indian women varied widely (41.9 and 49.4 years) leaving women of different cultural groups at increased risk of CVD [17, 30, 31]. Thus, an improved understanding of the concomitants associated with body fat pattern and increasing CVD risk factors during menopause among caste and tribal populations has become imperative. We hypothesized in this study that there will be a variation in body fat pattern and CVD risk factors between Bengali Hindu caste and Lodha tribal postmenopausal populations, within the state of West Bengal, India – a microcosm of ethnic, economic, rural/urban and health disparity. The intellectual merit of the present study is a perspective that incorporates multiple axes: menopause, ethnicity and urban/rural residence. Thus, we intended to study the variations in body fat pattern and CVD risk factors between Hindu caste and Lodha tribal postmenopausal women and how these risk factors can be predicted from differential socio-economic, reproductive and menstrual characteristics and lifestyle variables.

Methods

Study area

This cross-sectional study was conducted among the Bengali Hindu caste and Lodha tribal populations of the state of West Bengal, India. Lodha populations have been declared as one of the Particularly Vulnerable Tribal Groups (PVTGs) of this country on the basis of certain characteristics like low level of literacy, pre agricultural level of technology, and declining or stagnant population. Data for this study were collected from urban and rural areas of West Bengal, a state located in the eastern part of India. The study participants were selected from three districts of West Bengal namely- Howrah, East Midnapur and Jhargram. The urban Hindu caste (UHC) participants were selected from the Howrah district covering four municipal wards (41, 45, 46 and 48) of the Howrah Municipal Corporation (HMC) under the jurisdiction of Howrah *Sadar* Subdivision. The rural Hindu caste (RHC) participants were selected from Bhagawanpur 1 Community Development Block (CDB) of Egra sub-division of the district of East Midnapur. The rural Hindu caste participants have been selected from four villages of Bhagawanpur 1 CDB namely- Banlauri, Kalaberia, Kotlauri and Kuralbar. The rural Lodha (RL) participants were selected from Jhargram CDB of the Jhargram district. Eight Lodha villages namely- Sugnibasa, Shalukgeria, Ramchandrapur, Jorakhali, Suabasa, Kismat Bharatpur, Jaralata and Kanyaduba were selected for this study. The rural blocks were carefully selected considering the fact that these are far apart from urban facilities.

Study participants

300 participants were initially enrolled for the present study. The inclusion criteria of the study are as follows: married with at least one surviving child, have attained natural menopause and with no reported history of metabolic disorders. Total number of 103 participants was excluded from the study either because of not fulfilling the inclusion criteria of the study or did not volunteer to participate (25 from UHC, 30 from RHC and 48 from RL). Most of the refusals came from rural Lodha participants since they were not comfortable in providing blood samples for estimating blood sugar and cholesterol levels. Participants who went through surgical menopause and took medicines for any metabolic abnormalities have been excluded from the study. Unmarried participants were excluded from the study to ensure that all the women had been exposed to certain reproductive events (pregnancy, use of contraception, lactation, parity). The hormonal changes during the above mentioned reproductive events are found to affect menopause as well as CVD. Finally, a total number of 197 postmenopausal participants were recruited for this study (69 UHC, 65 RHC and 63 RL). Postmenopausal status of the participants was defined as those who had stopped menstrual bleeding spontaneously at least for the last twelve months (32). The purpose of the research was explained to and verbal and written informed consent was taken from the participants. The study was approved by the Institutional Human Ethical committee, University of Calcutta.

Data collection

The participants were interviewed in person by one of the authors (DK) to gather information about their socio-demographic and reproductive variables using a pretested structured schedule which was used in earlier studies conducted on the same population [30, 33]. Data on sociodemographic variables include age of the participants at the time of interview (years), educational levels and occupational types of the participants and their husbands and per capita monthly household expenditure (in Indian rupees). Data on menstrual characteristics include age at menarche (years) and menstrual bleeding length (days) prior to menopause. Reproductive history of the participants includes age at marriage (years), pregnancy record, contraceptive use, and breastfeeding history (in case of the last child) and age at menopause (years). Age at menarche was ascertained by asking the participants the actual date of the incident, if not then the nearest month. A few of the participants could recall their age at menarche when some landmark and/or personal event (like her birthday) which occurred around the time of her menarche was referred. Age at menopause was ascertained by asking the participants for how long their menstruation has stopped. A few of the participants recalled the time by some landmark events like her grandchild's birthday or any other specific event that took place around that time. Finally, age at menopause was calculated by subtracting the years after menopause from the age of the participants at the time of interview. Data on pregnancy record include number of conception (number of live births, still births and miscarriages), and ages at first and last pregnancy.

Data on dietary behavior and food consumption pattern of the participants were taken using a pretested food frequency schedule [34]. The schedule includes eighteen food items that are commonly available within the study area and generally consumed by the participants. The participants were asked to report how often they consumed these food items within the past one week period prior to the date of interview. Each of the food items were categorized into eight responses, ranging from zero (representing never) to seven (all seven days in a week). Later, the food consumption pattern was categorized into three categories based on the following criteria- regularly (5–7 days consumption), occasionally (2–4 days consumption) and rarely/never(less than two days or never).

Data on physical activity were obtained by using a pretested 'physical activity' schedule [35]. The schedule includes physical activity related to daily chores (cooking, washing dishes and clothes, mopping, dusting, watching television, listening music, walking, bicycling, physical exercise and doing crafts) of the participants. In addition to these daily chores, data were collected from RHC and RL populations about the duration of time spent by them on agricultural activities. For RL, in addition, information was collected on the duration of time they spent in collection of wood from the forest. The participants were asked to report how many minutes/day/week they remain engaged in these activities. Later, we estimated Metabolic Equivalent (MET) score following International Physical Activity Questionnaire (IPAQ). The physical activity level was represented as MET minutes a week. MET minutes represent the amount of energy spend in carrying out physical activity. The score assigned for particular activities were as follows- moderate physical activities (household chores) were considered as 4 METS, walking as 3.3 METS and vigorous physical activities (like, physical exercise, agriculture, and wood collection) as 8 METS. We calculated MET minutes/week by multiplying the given MET value with number of minutes the activity was carried out in a typical day and by the number of days the activity was undertaken in a typical week. For example, if a participant was engaged in mopping for at least 30 minutes (in a day) for 3 days in a week, then the MET score of the participant will be- $4 \times 30 \times 3 = 360$ MET. Finally, we added the MET minutes estimated for each category of physical activity to get a total MET minutes of physical activity in a week. On this basis, we grouped the level of physical activity into three categories- High (up to 3000 MET minutes a week), moderate (up to 600 MET minutes a week)and low(below 600 MET minutes a week) level of activity [36, 37].

We measured random blood sugar (mg/dl) and total cholesterol levels (mg/dl) for all the participants. Although, there are certain limitations for using random blood glucose (RBG) test for estimation of diabetes, studies show that RBG values at least 100 mg/dl is strongly associated with diabetes compared to the other risk factor like family history, hypertension, even after adjustment for other factors. The International Diabetes Federation guidelines recommended screening for individuals with random glucose values between 100 and 199 mg/dl [38, 39]. Blood samples were drawn from the tip of the second finger of the left hand and analyzed using blood sugar monitoring kit (Accu-check Active Blood glucose monitoring system, Model no. GB10803608) and Multi-care-in meter (Model no. IN2140129). Blood pressure (mmHg) of the participants was measured using Omron's automatic blood pressure monitor (Model no. HEM-7121). Two consecutive readings of blood pressure were taken in the gap of ten minutes, and then the mean was calculated. Mean arterial pressure (mmHg) for each participants was calculated using the formula- $MAP = SBP + 2(DBP)/3$.

Body weight (to the nearest of 0.1 kg), visceral fat, subcutaneous and skeletal fat for whole body and torso along with one anthropometric index, percent body fat (PBF) were measured for each participants in light clothing without shoes using Omron's Body Composition Monitor(Model No. HBF-362). Muscle mass was measured by using Rossmax Body Fat Monitor (Model no. WF260). Each measurement was taken twice to assure the reliability of the instruments.

Anthropometric measurements like stature, waist circumference (WC) and hip circumference (HC) were measured following standard protocol [40]. Stature (to the nearest 0.1 cm) was measured using a portable GPM anthropometer for each participant standing without shoes on horizontal surface. WC and HC were measured to the nearest of 0.1 cm with a non-stretchable fiber 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. Other anthropometric indices like waist-hip ratio (WHR), fat free mass(FFM) and fat mass(FM) were calculated following standard formulae:

$$WHR = WC\ (cm)/HC\ (cm)$$

$$FM = PBF/100 \times Weight\ (kg)$$

$$FFM = Weight - FM$$

The study was conducted during the time period of June 2018 to December 2019.

Statistical analysis

We used descriptive statistics to find out the distribution of socio-demographic characteristics, reproductive and menstrual history, food consumption pattern and physical activities, anthropometric characteristics, body fat measures (subcutaneous and skeletal fat for whole body and torso, PBF, WC, HC, WHR, visceral fat, muscle mass, FM and FFM), blood sugar, total cholesterol and blood pressure levels of the participants. We applied Kolmogorov-Smirnov test to understand the distribution of each variable. Analysis of variance (ANOVA) was applied to compare blood sugar, total cholesterol and blood pressure levels and body fat measures across the three populations. Post-hoc test (Scheffe's test) was applied to understand the differences between the study populations independently. Kruskal-Wallis test was applied as a substitute of ANOVA for those variables that did not follow the normal distribution. Two-tailed test of significance have been applied for the analysis. The variables that differed significantly across the three study populations were selected as independent variables in multiple linear regression analysis. Sociodemographic, reproductive and menstrual history and lifestyle variables (food habit and physical activities) were selected as independent variables in the model. Stepwise multiple linear regression was conducted to find out the best suit model. Collinearity of the independent variables was also checked. The variables that showed higher collinearity were removed in the final model. The WHO (2008) Asian specific cutoff for women has been used to determine the central obesity- for WC > 88cm was considered as risk category, while ≥ 0.85 was considered as risk category in case of WHR. Participants with blood sugar level < 200 mg/dl were considered as non- diabetic and those with ≥ 200mg/dl as diabetic; participants with total cholesterol level ≥ 240 mg/dl were labeled as high cholesterol level and those, with < 240 mg/dl were labeled as normal; participants with SBP ≥ 140 mmHg and DBP ≥ 90 mmHg and MAP ≥ 100 were considered to be hypertensive [41]. Chi square test has been performed to understand the distribution of these CVD risk factors across the three populations. A minimum 'p' value of 0.05 was considered as statistically significant level for all inferential statistics. The entire data was analysed with the help of statistical package for social science version 20.0(IBM corporation, 2011).

Results

Age of the participants reported at the time of interview, working status, occupational and educational categories and per capita monthly household expenditure of the participants differed significantly across the three populations. Majority of the participants from RHC (71.8%) and RL (80.5%) were engaged in agricultural activities. Majority of the participants from RL (95.2%) were non-literate (Table 1).

Table 1 Socio-demographic characteristics of the participants (n=197)

Socio-demographic variables	UHC (n=69)	RHC (n=65)	RL (n= 63)	F value/Kruskal-wallis test/ χ2 test	p value
Mean age of the participants at the time of interview(mean±sd)	53.12±7.48	55.45±8.17	59.35±6.20	12.02	0.0001
Working status of the participants Working Non-working	 22 (31.9) 47 (68.1)	 39 (60.0) 26 (40.0)	 41 (65.1) 22 (34.9)	 17.16	0.0001
Occupational categories of the participants Service Business Agriculture and wood collection	 2 (9.1) 20 (90.2) -	 - 11 (28.2) 28 (71.8)	 - 8 (19.5) 33 (80.5)	 45.05	 0.0001
Educational categories of the participants Literate Non-literate	 62 (89.9) 7 (10.1)	 60 (92.3) 5 (7.7)	 3 (4.8) 60 (95.2)	 137.65	 0.0001
Educational categories of the spouses of the participants Literate Non-literate	 69 (100) -	 58 (89.2) 7 (10.8)	 6 (9.5) 57 (90.5)	158.10	0.0001
Per capita monthly household expenditure (INR)	151.51*	79.80*	59.44*	97.35	0.0001

*mean rank; figures in the parentheses indicate percentage values.

The reproductive and menstrual characteristics of the participants differed significantly across the three populations. However, the pattern was not similar for each of these variables. All the participants from RL did not use any kind of contraceptives. Mean age at menopause was found to be significantly advanced among the UHC followed by the RHC and RL (Table 2).

Table 2 Menstrual and reproductive history of the participants (n=197)

Menstrual and reproductive characteristics	UHC (n=69)	RHC (n=65)	RL (n= 63)	F value/Kruskal-wallis test/ χ2 test	p value
Mean age (years) at menarche(mean±sd)	12.41±1.85	14.18±1.73	13.79±0.98	23.45	0.0001
Mean age (years) at marriage(mean±sd)	19.25±4.77	16.29±2.49	14.22±5.56	21.18	0.0001
Age at first pregnancy (mean±sd)	21.22±4.99	18.26±2.34	17.56±2.57	19.95	0.0001
Age at last pregnancy (mean±sd)	26.26±5.28	30.18±5.52	26.56±5.97	10.01	0.0001
Number of conception					
One	11 (15.9)	1 (1.5)	5 (7.9)	21.68	0.0001
Two	21 (30.4)	6 (9.2)	12 (19.0)		
More than two	37 (53.6)	58 (89.2)	46 (73.0)		
Ever experience of fetal loss				17.12	0.0001
Yes	32 (46.4)	27(41.5)	9 (14.3)		
No	37 (53.6)	38(58.5)	54 (85.7)		
Duration of breastfeeding(month)	75.14*	113.21	110.48	19.09	0.0001
Ever use of contraceptive					
Yes	21 (30.4)	23 (35.4)	-	27.10	0.0001
No	48 (69.6)	42 (64.6)	63(100)		
Mean age (years) at menopause(mean±sd)	42.68±7.80	46.56±4.78	48.74±5.18	16.51	0.0001

*mean rank; figures in the parentheses indicate percentage values

It appears from the table 3, that the participants from the three groups differed significantly in the consumption pattern of each of the food items. Barring regular consumption of roots and tubers, soya and meat, the frequency of regular consumption of other food items seems to be significantly higher among the UHC and RHC participants compared to RL. The physical activity level and the frequency of substance abuse differed significantly across the three groups. Majority of the RL participants (84.1%) were engaged in high level of physical activity compared to UHC and RHC. Majority of the participants from RL (90.5%) reported to have chewed tobacco on a regular basis followed by UHC and RHC. Majority of the participants from RL (79.4%) reported to consume alcohol on a regular basis, while none of the participants from the caste groups reported to consume alcohol (Table 3).

Table 3 Pattern of food consumption and physical activity level among the participants (n=197) (last seven days recall period)

Food items	UHC (n=69)	RHC (n=65)	RL (n=63)	Chi square test/ Fisher's exact test	p value
Intake of pulses					
Regularly	39 (56.5)	30 (46.2)	18 (28.6)	24.80	0.0001
Occasionally	8 (11.6)	1 (1.5)	16 (25.4)		
Rarely/never	22 (31.9)	34 (52.3)	29 (46.0)		
Intake of green vegetables					
Regularly	63 (91.3)	61 (93.8)	31 (49.2)	46.96	0.0001
Occasionally	2 (2.9)	-	16 (25.4)		
Rarely/never	4 (5.8)	4 (6.2)	16 (25.4)		
Intake of roots and tubers					
Regularly	54 (78.3)	47 (72.3)	52 (82.5)	8.25	0.04
Occasionally	-	-	3 (4.8)		
Rarely/never	15 (15.7)	18 (27.7)	8 (12.7)		
Intake of soya products					
Regularly	4 (5.8)	4 (6.2)	12 (19.0)	22.93	0.0001
Occasionally	7 (10.1)	2 (3.1)	15 (23.8)		
Rarely/never	58 (84.1)	59 (90.8)	36 (57.1)		
Intake of meat					
Regularly	-	1 (1.5)	17 (27.0)	60.57	0.0001
Occasionally	5 (7.2)	6 (9.2)			

Rarely/never	64 (92.8)	58 (89.2)	31 (33.3) 25 (39.7)		
Intake of fish					
Regularly	50 (72.5)	56 (86.2)	11 (17.5)		
Occasionally	7 (10.1)	5 (7.7)	27 (42.9)	73.61	0.0001
Rarely/never	12 (17.4)	4 (6.2)	25 (39.7)		
Intake of egg					
Regularly	17 (24.6)	11 (16.9)	4 (6.3)		
Occasionally	6 (8.7)	11 (16.9)	22 (34.9)	18.81	0.001
Rarely/never	46 (66.7)	43 (66.2)	37 (58.7)		
Intake of fruits					
Regularly	22 (31.9)	9 (13.8)	1 (1.6)		
Occasionally	8 (11.6)	-	6 (9.5)	35.20	0.0001
Rarely/never	39 (56.6)	56 (86.2)	56 (88.9)		
Intake of milk					
Regularly	20 (29.0)	13 (20.0)	3 (4.8)		
Occasionally	1 (1.4)	-	-	16.38	0.001
Rarely/never	48 (69.6)	52 (80.0)	60 (95.2)		
Intake of snacks					
Regularly	60 (87.0)	40 (61.5)	31 (49.2)	27.46	0.0001
Occasionally	1 (1.4)	-	5 (7.9)		
Rarely/never	8 (11.6)	25 (38.5)	27 (42.9)		
Intake of sweets					

Regularly	38 (55.1)	20 (30.8)	-		
Occasionally	4 (5.8)	1 (1.5)	5 (7.9)	62.53	0.0001
Rarely/never	27 (39.1)	44 (67.7)	58 (92.1)		
Intake of tea					
Regularly	61 (88.4)	31 (47.7)	49 (77.8)		
Occasionally	-	-	-	28.36	0.0001
Rarely/never	8 (11.6)	34 (52.3)	14 (22.2)		
Physical activity					
High	55 (79.7)	46 (70.8)	53 (84.1)	9.58	0.04
Moderate	13 (18.8)	11 (16.9)	8 (12.7)		
Low	1 (1.4)	8 (12.3)	2 (3.2)		
Habit of tobacco chewing					
Yes	11(15.9)	6 (9.2)	57(90.5)	111.20	0.0001
No	58 (84.1)	59 (90.8)	6 (9.5)		
Alcohol consumption					
Yes	-	-	50 (79.4)	-	-
No	69 (100)	65 (100)	13 (20.6)		

It appears from table 4, all the other variables used for measuring fat patterning (except the whole body skeletal fat) and variables of CVD risk factors (SBP, DBP, MAP, random sugar, total cholesterol) differed significantly across the three populations. The table also shows that expect for skeletal fat related to trunk and arm, muscle mass, SBP, DBP and MAP, the UHC showed highest values, followed by RHC and

RL. The post hoc tests also suggest significant differences between UHC and RHC (barring a few), RHC and RL and UHC and RL (Table 4).

Table 4 Distributions of fat patterning and CVD risk factors among rural and urban caste groups and rural tribal group (n=197)

UHC (n=69)	RHC (n=65)	RL (n=63)	F value/ Kruskal-Wallis test	p value	Post-hoc test
mean±sd	mean±sd	mean±sd			
25.21±4.23	21.12±3.65	17.93±3.36	61.59	0.0001	UHC vs RHC= 0.001 UHC vs RL= 0.001 RHC vs RL= 0.001
0.95±0.08	0.88±0.09	0.84±0.08	23.40	0.0001	UHC vs RHC= 0.0001 UHC vs RL= 0.0001 RHC vs RL= 0.03
8.86±4.94	5.16±3.05	2.38±1.87	54.64	0.0001	UHC vs RHC= 0.0001 UHC vs RL= 0.0001 RHC vs RL= 0.0001
31.01±4.70	27.27±4.48	23.36±3.56	52.17	0.0001	UHC vs RHC= 0.0001 UHC vs RL= 0.0001 RHC vs RL= 0.0001

21.69±1.79	21.57±2.60	22.13±2.37	1.06	0.34	UHC vs RHC= 0.95 UHC vs RL= 0.54 RHC vs RL= 0.38
27.90±4.57	24.81±4.69	21.44±4.01	34.72	0.0001	UHC vs RHC= 0.0001 UHC vs RL= 0.0001 RHC vs RL= 0.0001
16.03±1.91	16.48±2.65	17.40±2.21	6.095	0.003	UHC vs RHC= 0.52 UHC vs RL= 0.003 RHC vs RL= 0.07
48.40±5.28	46.34±5.90	42.56±6.34	16.68	0.0001	UHC vs RHC= 0.12 UHC vs RL= 0.0001 RHC vs RL= 0.0002
23.60±3.87	25.33±3.38	27.40±2.79	20.56	0.0001	UHC vs RHC= 0.01 UHC vs RL=

						0.0001 RHC vs RL= 0.003
	42.10±5.42	36.63±7.10	31.95±4.80	49.62	0.0001	UHC vs RHC= 0.0001 UHC vs RL= 0.0001 RHC vs RL= 0.0001
	34.28±2.47	32.42±3.40	30.97±3.02	20.50	0.0001	UHC vs RHC= 0.002 UHC vs RL= 0.0001 RHC vs RL= 0.02
	107.14*	114.85	73.73	18.81	0.0001	UHC vs RHC= 0.49 UHC vs RL= 0.001 RHC vs RL= 0.0001
	136.49±21.48	135.37±22.96	152.65±28.77	9.99	0.0001	UHC vs RHC= 0.96 UHC vs RL= 0.001 RHC vs RL= 0.0001
	87.14±10.72	85.83±10.60	95.44±15.14	11.54	0.0001	UHC vs

					RHC= 0.82 UHC vs RL= 0.001 RHC vs RL= 0.0001
110.35*	85.43	100.57	6.46	0.03	UHC vs RHC= 0.008 UHC vs RL= 0.39 RHC vs RL= 0.17
21.60±5.79	16.73±4.80	12.82±3.59	54.44	0.0001	UHC vs RHC= 0.0001 UHC vs RL= 0.0001 RHC vs RL= 0.0001
35.88±5.46	30.44±6.40	26.22±4.76	49.66	0.0001	UHC vs RHC= 0.0001 UHC vs RL= 0.0001 RHC vs RL= 0.0001
28.84±3.28	30.82±3.28	33.26±2.67	33.44	0.0001	UHC vs RHC= 0.001 UHC vs RL= 0.0001

					RHC vs RL= 0.0001
89.16*	84.95	124.27	18.38	0.0001	UHC vs RHC= 0.62 UHC vs RL= 0.0001 RHC vs RL= 0.0001

*mean rank

It appears from table 5, all of the body fat measures (barring WHR, trunk and skeletal fat) showed positive associations with the spouses completed years of education, while muscle mass showed negative association. All of the body fat measures and total cholesterol level showed positive association with urban residential status. While skeletal fat related to trunk and arm, and muscle mass showed negative association. PBF, Visceral fat, subcutaneous fat related to whole body, trunk and arm and MAP were likely to increase with increase in age of the participants; torso skeletal fat and muscle mass were likely to decrease with increase in age of the participants. Blood sugar level showed negative association with age at menopause, meat consumption and physical activity level. Participants, who were exclusively homemaker showed positive association with WHR and FM. PBF, subcutaneous fat related to whole body and trunk showed negative association with tobacco chewing, while MAP and skeletal fat related to trunk showed positive association. PBF and trunk subcutaneous fat shows negative association with age at first pregnancy. The R square values indicate that the models can explain 12-60 percent of the variance (Table 5).

Table 5 Predictors for variables related to fat patterning and CVD risk factors: Multiple linear regression

Dependent variable	Independent variables	Unstandardize coeficient	t value	p value	CI at 95%		R square
					lower	upper	
BMI	Urban residence	3.98	5.31	0.0001	2.50	5.45	0.40
	Completed years of education of the spouses	0.35	4.81	0.0001	0.21	0.50	
	Total number of conception	0.37	2.30	0.02	0.05	0.70	
PBF	Completed years of education of the spouses	0.29	2.81	0.005	0.08	0.50	0.27
	Age of the participants at the time of interview	0.29	6.09	0.0001	0.19	0.38	
	Urban residence	2.76	3.06	0.003	0.98	4.54	
	Age at first pregnancy	-0.22	-2.30	0.02	-0.41	-0.03	
	Tobacco chewing	-1.75	-2.16	0.03	-3.35	-0.15	
WHR	Urban residence	0.07	5.24	0.0001	0.04	0.10	0.20
	Exclusively homemaker	0.03	2.94	0.004	0.01	0.06	
Visceral fat	Urban residence	3.74	5.48	0.0001	2.39	5.09	0.39
	Completed years of education of the spouses	0.25	3.50	0.001	0.11	0.39	
	Age of the participants at the time of interview	0.10	2.91	0.004	0.03	0.17	
	Fish consumption	0.27	2.68	0.008	0.07	0.47	
Whole body subcutaneous	Completed years of	0.32	3.56	0.0001	0.14	0.51	0.40

fat	education of the spouses						
	Urban residence	3.71	4.58	0.0001	2.11	5.29	
	Age of the participants at the time of interview	0.16	3.87	0.0001	0.08	0.25	
	Tobacco chewing	-2.06	-2.82	0.005	-3.51	-0.62	
Trunk subcutaneous fat	Completed years of education of the spouses	0.34	3.55	0.0001	0.15	0.53	0.35
	Age of the participant’s at the time of interview	0.21	4.87	0.0001	0.12	0.29	
	Urban residence	3.54	4.30	0.0001	1.91	5.16	
	Tobacco chewing	-1.91	-2.58	0.01	-3.36	-0.45	
	Age at first pregnancy	-0.18	-2.04	0.04	-0.35	-0.007	
Trunk skeletal fat	Age of the participants at the time of interview	-0.17	-8.77	0.0001	-0.21	-0.13	0.41
	Urban residence	-1.34	-4.11	0.0001	-1.99	-0.07	
	Tobacco chewing	1.21	4.18	0.0001	0.64	1.78	
	Exclusively homemaker	-0.83	-2.91	0.004	-1.40	-0.27	
	Age at first pregnancy	0.10	2.69	0.008	0.02	0.17	
Arm subcutaneous fat	Completed years of education of the spouses	0.44	3.50	0.001	0.19	0.70	0.24
	Age of the participants at the time of interview	0.23	3.96	0.0001	0.11	0.34	
	Age at marriage						

	Urban residence	-0.22	-2.44	0.01	-0.41	-0.04	
	Tobacco chewing	2.43	2.23	0.02	0.28	4.58	
		-2.01	-2.05	0.04	-3.95	-0.07	
Arm skeletal fat	Completed years of education of the spouses	-0.31	-4.66	0.0001	-0.45	-0.18	0.34
	Age of the participants at the time of interview	-0.18	-5.84	0.0001	-0.24	-0.12	
	Urban residence	-2.18	-3.60	0.0001	-3.37	-0.98	
	Age at first pregnancy	0.15	2.41	0.01	0.02	0.28	
	Fish consumption	-0.21	-2.42	0.01	-0.39	-0.04	
	Milk consumption	0.18	2.09	0.03	0.01	0.35	
Leg subcutaneous fat	Completed years of education of the spouses	0.42	3.59	0.0001	0.19	0.65	0.36
	Urban residence	4.85	4.34	0.0001	2.65	7.06	
	Fish consumption	0.42	2.53	0.01	0.09	0.75	
Leg skeletal fat	Age of the participants at the time of interview	-0.21	-7.14	0.0001	-0.27	-0.15	0.41
	Total number of wastage	0.88	4.14	0.0001	0.46	1.30	
	Age at first pregnancy	0.15	2.95	0.004	0.05	0.25	
	Urban residence	1.32	3.01	0.003	0.45	2.19	
	Age at menopause	0.08	2.59	0.01	0.02	0.15	
Blood sugar level	Age at menopause	-1.75	-3.50	0.001	-2.74	-0.76	0.12
		-0.002	-2.50	0.01	-0.004	-0.001	

	Physical activity level	-3.34	-2.01	0.04	-6.61	-0.06	
	Meat consumption						
Blood total cholesterol level	Age at marriage	-2.19	-2.80	0.006	-3.73	-0.64	0.05
	Urban residence	19.48	2.43	0.01	3.68	35.29	
Muscle mass	Urban residence	-2.60	-4.94	0.0001	-3.64	-1.56	0.44
	Age of the participants at the time of interview	-0.22	-7.80	0.0001	-0.27	-0.16	
	Completed years of education of the spouses	-0.23	-4.10	0.0001	-0.35	-0.12	
		-0.23	-2.93	0.004	-0.38	-0.07	
	Fish consumption	0.20	2.72	0.007	0.05	0.35	
	Milk consumption	-0.55	-2.35	0.01	-1.01	-0.09	
	Total number of wastage						
Fat mass	Completed years of education of the spouses	0.45	4.74	0.0001	0.26	0.64	0.42
	Urban residence	3.56	3.93	0.0001	1.77	5.35	
	Exclusively homemaker	1.56	2.25	0.02	0.19	2.93	
	Fish consumption	0.33	2.45	0.01	0.06	0.59	
	Milk consumption	-0.26	-2.04	0.04	-0.52	-0.009	
Mean arterial pressure	Age of the participants at the time of interview	0.59	4.02	0.0001	0.30	0.87	0.14
	Tobacco chewing	6.57	2.95	0.004	2.18	10.95	

Only significant values are presented

The central obesity was found to be higher among the UHC and RHC participants. 77.8% of the RL participants were found to be hypertensive, followed by RHC (55.4%) and UHC participants (55.1%). The incidence of diabetes and high total cholesterol level was found to be lower among all the populations (Table 6).

Table 6 Distribution of CVD risk factors among caste and tribal group (n= 197)

CVD risk factors	UHC (n=69)	RHC (n=65)	RL (n= 63)	χ2 test	p value
Blood sugar level(mg/dl)					
Non-diabetic(<200)				4.94	0.08
Diabetic (≥200)	62 (89.9)	63 (96.9)	62 (98.4)		
	7 (10.1)	2 (3.1)	1 (1.6)		
Waist circumference					
Normal (<88)	30 (43.5)	56 (86.2)	62 (98.4)	61.51	0.0001
Risk (>88)	39 (56.5)	9 (13.8)	1 (1.6)		
WHR					
Normal (<0.85)	12 (17.4)	21 (32.3)	40 (63.5)	30.94	0.0001
Risk (≥0.85)	57 (82.6)	44 (67.7)	23 (36.5)		
SBP(mmHg)					
Normal (≤139)	43 (62.3)	40 (61.5)	21 (33.3)	14.08	0.001
Hypertensive (≥140)	36 (37.7)	25 (38.5)	42 (66.7)		
DBP(mmHg)					
Normal (≤89)	45 (65.2)	44 (67.7)	23 (36.5)	15.71	0.0001
Hypertensive (≥90)	24 (34.8)	21 (32.3)	40 (63.5)		
MAP					
Normal(<100)	31 (44.9)	29 (44.6)	14 (22.2)	9.29	0.01
Hypertensive(≥100)	38 (55.1)	36 (55.4)	49 (77.8)		
Total cholesterol level					
Normal(<240)	59 (85.5)	60 (92.3)	51 (81.0)	3.54	0.17
High(≥240)	10 (14.5)	5 (7.7)	12 (19.0)		

*(WHO, 2008)

Discussion

Our study reveals that UHC participants have higher body fat distribution and are more prone to CVD risk factors (central obesity, blood sugar level, total cholesterol level) compared to the RHC and RL participants. Urbanization and economic development may bring improvement in the socio-economic status (SES), push a population to nutritional transition and adopt sedentary lifestyle [42, 43]. This makeover of lifestyle leads to the increased prevalence in central obesity, glycemic abnormality, dyslipidemia and hypertension irrespective of their place of residence [44, 45]. A number of previous studies show consistency with our study where urban women showed higher body fat distribution compared to their rural counterpart [46, 47]. For example, studies from India and western countries show positive association between education, income and body fat distribution [48, 49], but the trend is not universal [50–52].

Completed years of education of the spouses of the participants shows positive association with all the body fat measures in our study; this is in disagreement with [53, 54] or non-significant in some earlier studies [55, 56]. For example, a study conducted among Japanese women showed educational attainment of the spouses of the participants at high school level or lower had higher risk of obesity compared with women whose spouses attained higher level of education than the former group [54]. Our study contradicts to this finding; the literacy rate of the spouses of the participants showed positive association with central obesity. Perhaps, attainment of higher educational level of the spouses is associated with the higher social position and higher income leading to over nutrition and adoption of sedentary lifestyle. The prevalence of central obesity of rural and urban caste participants was 82.6% and 67.7% respectively which corroborates with some Indian studies [57, 58].

We found age at menopause as a significant predictor for higher blood sugar level. Early cessation of menstruation is associated with suppression of estrogen at a premature age. This phenomenon affects the insulin resistance by lowering the sex hormone binding globulin concentration of the blood and changing the body fat distribution from gynoid to android type [59, 60]. For example, in one US based study, women who experienced natural menopause before 40 years had a 50 percent higher chance of CVD related mortality than those reporting menopause at 50 years or later [61]. The UHC participants of our study reached menopause at an earlier age compared to the RHC and RL participants (48.74 ± 5.18). So, the early age at menopause might be a reason for the increased blood sugar level among the urban Hindu caste populations.

Our study shows that the RL participants are more prone to hypertension and have higher total cholesterol level compared to the UHC and RHC participants, but the trend is reverse for blood glucose level and in the prevalence of central obesity. We found an association between chewing of tobacco and increase in mean arterial pressure and decrease in body fat (PBF, subcutaneous fat related to whole body and trunk). A study conducted in an Indian city (Mumbai) shows all forms of tobacco use were associated with low body fat, irrespective of age, education, and religion (62). In our study, majority of the RL participants chew tobacco on a regular basis which might be a reason behind their low body fat and increased hypertension because tobacco produce free radicals that deplete antioxidants like Vitamins C, E, and carotenoids and cause oxidative damage to DNA, proteins and lipids [63, 64]. Studies show that consumption of anti-oxidant-rich foods such as green-leafy vegetables and fruits perhaps reduce the oxidative stress caused by tobacco; but the Lodha participants of our study lack these items in their dietary practices and thereby remains at a risk of tobacco induced oxidative stress.

Our study shows physical activity has an inverse association with the blood sugar level; this could be a reason behind the lower incidence of diabetes among the tribal participants. A recent study conducted among Chinese women reveals that a higher degree of physical activity was associated with lower blood glucose level regardless of sex, menopausal status and first-degree family history of diabetes [65]. Physical inactivity and obesity are critical and modifiable risk factors of diabetes; this could be a justification of the increased blood sugar level among the urban Hindu caste participants as most of them were found to be engaged in sedentary activities.

We observed an inverse association between consumption of meat and blood sugar level. Studies show that regular intake of meat leads to increased blood sugar level due to iron overload [66, 67], which is contradictory to our findings. Majority of the RL participants consume meat (poultry product) on a regular basis. Poultry product contains less calorie, highly digestible (with low levels of collagen) proteins, unsaturated lipids, B group vitamins and minerals like iron, zinc and copper and also has a low glycemic index value which helps in controlling the blood sugar level [68]. Future studies are required to confirm or refute this hypothesis.

Our study further revealed that working status of the participants is a significant predictor of body fat measures like waist-hip ratio and fat mass showing consistency with some previous studies [69, 70]. For example, in SWAN longitudinal cohort study it has been reported that physical activity has inverse association with changes in percent body fat, waist circumference, independent of aging and menopausal status [71]. The UHC participants of our study are mostly non-working, while the majority of the participants from RHC and RL are engaged in high intensity physical activity like agriculture and wood collection. This could be a reason behind the increased level of body fat among the urban participants compared to their rural counterpart.

Pregnancy and childbirth can additionally modify a woman’s risk of midlife obesity and CVD [72–74]. Women’s reproductive history may influence short and long term cardio-metabolic and cardiovascular trajectories later in life. Reproductive characteristics and pregnancy history in women are increasingly recognized in cardiovascular and obstetric society guidelines, with premature age of menopause and adverse pregnancy outcomes in particular now codified as risk-enhancing factors for CVD [75]. Our study showed that parity is positively associated with BMI, while age at first pregnancy shows inverse association with PBF and subcutaneous fat of trunk and positive association with the skeletal fat of arms and legs. Childbirth at a younger age and increased parity are independently associated with central obesity for women later in life due to increased stress or changes in the lifestyle factors which is in partial agreement with our study [72, 76]. For example, studies on Korean and US postmenopausal women showed similar results [73, 74]. Younger age at first childbirth is sometimes associated with disruption in education and occupational attainment which can increase the risk of obesity. Earlier exposure to high levels of estrogen by early pregnancy may lead to an increased body fat which in turn is speculated to influence CVD risk factors through complex interaction between oxidative stress, inflammation, the renin-angiotensin-aldosterone system, and the renal sympathetic nervous system [73, 74]. During pregnancy, the release of corticotrophin releasing hormone from placenta drive the hypothalamic pituitary-adrenal axis and cortisol concentrations in pregnant women may contribute to the pathophysiological mechanism of obesity later in life [78]. But, a recent study conducted among Korean postmenopausal women showed no significant association between age at first childbirth and central obesity after controlling for confounding variables [77]. We found an association between higher incidence of central obesity and higher parity among rural caste participants. Carrying a child to full term is associated with maternal metabolic changes and weight gain that persist after pregnancy. This could partially explain why RC participants have higher incidence of central obesity, unlike their urban counterpart. The RL participants of our study mostly conceived for the first time at a younger age (below 19) and show higher parity compared to the other two groups. But the prevalence of central obesity is not predominant among the Lodhas perhaps due to their high intensity physical activity.

We observed age of the participants to be a significant predictor for increase in body fat and mean arterial pressure showing consistency with some previous studies where degenerative effect of age has been reported [79, 80]. This could be attributed to the age specific changes at the cellular level, including oxidative stress, inflammation, and apoptosis, changing in the calcium plumping capacity, and overall myocardial deterioration and degeneration [81].

This exploratory study conforms to our hypothesis that there exists significant differences in body fat pattern and CVD risk factors between caste and tribal groups owing to the socioeconomic disparities, differences in reproductive characteristic and lifestyle factors.

There are certain limitations in this study. Estimation of fasting blood sugar level and the total lipid profile analysis, taking a larger sample size and a closer observation on the lifestyle practices (may be on a subsample) on the participants could have improved the findings of the study. Postmenopausal women become susceptible to health problems by reason of genetics, differences in attitude and perception and finally, their access to adequate health care services. Thus, inclusion of the data on these domains would give a better understanding of the cross-cultural difference in CVD risk factors of the caste and tribal group of the present study.

Conclusions

In the present study, all the three groups (UHC, RHC and RL) differed significantly in body fat distribution and CVD risk factors, reinforcing the role of both modifiable factors and endogenous estrogen in the occurrence of CVD. Hence, there remains a dire need to conduct research on cross cultural differences in postmenopausal health outcomes for better understanding of the menopause specific CVD risk factors. This will help the policy makers to develop appropriate measures for midlife women and will present an opportunity for prevention and early intervention.

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Abbreviations

CVD- Cardiovascular Disease

BMI- Body Mass Index

PBF- Percent Body Fat

WC- Waist circumference

HC- Hip circumference

WHR- Waist Hip ratio

FFM- Fat Free Mass

FM- Fat Mass

SBP- Systolic Blood Pressure

DBP-Diastolic Blood Pressure

MAP- Mean Arterial Pressure

PVTGs- Particularly Vulnerable Tribal groups

Declarations

Ethics approval and consent to participate- All participants gave their informed consent in writing after the study aims and procedures were carefully explained to them in their own language. The study was approved by the Institutional Ethical Committee for Bio Medical and Health Research involving human participants, University of Calcutta, West Bengal, India.

Consent for publication- Not applicable.

Availability of data and materials- The datasets used/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests- The authors declare that they have no conflict of interest.

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Author's contributions- The first author of this article (DK) has contributed fifty percent by collecting the data and analyzing the data and partially drafting the manuscript. The second author (SR) has contributed fifty percent by designing the study and reviewing the manuscript.

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