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Interrelationships between Blood Pressure and Lipid Profile Characteristics among Postmenopausal Women at Naxalbari in Darjeeling, West Bengal

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ABSTRACT

Objective of the present study was to find association between blood pressure and lipid profile characteristics in postmenopausal women. A cross-sectional study was done in 2015 at Naxalbari in Darjeeling district of West Bengal, India. The sample included 129 postmenopausal women aged between 40- and 55-years, representing Dhimal community. Blood pressure (systolic and diastolic) was recorded and levels of triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were estimated. Derived lipid profile parameters were total cholesterol, non-HDL-C, Castelli Risk Index (CRI) I and II, atherogenic coefficient, and atherogenic index of plasma (AIP). Hypertension (systolic/diastolic 140/90 mmHg), hypertriglyceridemia (≥150 mg/dL), high LDL-C (≥130 mg/dL), and low HDL-C (<50 mg/dL) were diagnosed. Correlation and binomial logistic regression analyses were done to find the association between variables. Mean values of age and age at menopause were 50.34 years and 45.36 years, respectively. Prevalence of hypertension (65.89%), hypertriglyceridemia (21.71%), high LDL-C (43.41%), and low HDL-C (48.06%) were remarkable in the sample. Binomial logistic regression models after adjusting for age, showed that lipid parameters (TG, non-HDL-C, and AIP) significantly predicted hypertension. AIP was observed to be the best predictor of hypertension (Youden index = 0.52) and odds ratio showed that one unit increase in AIP had a chance of 24% rise in odds of having hypertension. Hypertensive postmenopausal women had higher mean values and prevalence of abnormal lipid profile characteristics. Age at menopause had significantly negative association with blood pressure and lipid profile parameters.

Key words: *menopause, hypertension, triglycerides, cholesterol*

Introduction

Cardiovascular diseases (CVDs) are the leading causes of mortality, taking an estimated 17.9 million lives each year that accounts for 31% of deaths globally[1]. Overweight, obesity, diabetes mellitus, dyslipidemia, and arterial hypertension are the major risk factors for the development of CVDs. Lipid metabolism alterations cause thrombotic occlusion of coronary artery and endothelial wall damage by lipid-rich plaques that may enhance risk for atherosclerosis[2]. The alterations in traditional lipid triad include low level of high-density lipoprotein cholesterol (HDL-C), high levels of triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C). Common derived parameters or composite lipid indices are total cholesterol, non-HDL-C, lipid ratios (Castelli Risk Index or CRI I and CRI II), atherogenic coefficient (AC), and atherogenic index of plasma (AIP). Arterial stiffness and CVD caused by the lipid metabolism alterations are reported to be age-related[3]. The AIP is the logarithm of the molar ratio of TG to HDL-C that is reported to have strong association with CVD[4].

Menopause is defined as the cessation of menstruation for 12 consecutive months, marking an end of reproductive years[5]. Menopause is often defined as premature (prior to 40 years of age) and early (between 40 and 44 years)[6]. However, mean age at menopause of women in India is reported to be 45.59 ± 5.59 years[7]. Menopause is associated with lipid metabolism disorders due to hormonal changes, such as decreased level of estrogen and elevated relative androgen level that may lead to the development of type 2 diabetes mellitus (T2DM), CVD, and metabolic syndrome[3,8,9]. Estrogen is produced primarily in the ovary in a metabolic pathway where LDL-C is used as substrate. Circulatory LDL-C cannot be utilized due to estrogen deficiency at menopause and thereby, results in the elevated LDL-C level in the blood that consequently enhances risk for CVD[10,11]. The non-HDL cholesterol and AIP are report-

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ed to be the effective indicators of CVD among postmenopausal women[12–15]. However, studies on association of derived lipid profile parameters with CVD in postmenopausal women are relatively less, particularly from India. The present study will help in further understanding of metabolic alterations due to hormonal changes and association of hypertension with lipid profile characteristics in postmenopausal women. This study can potentially serve as pilot for developing comprehensive community-based research among the populations of the region which would impact on epidemiology of CVD risks. In this background, objective of the present study was to find the association between blood pressure and lipid profile characteristics among postmenopausal women.

Participants and Methods

The present cross-sectional study was carried out during July and August 2015 among postmenopausal women representing Dhimal community at Naxalbari in Darjeeling district of West Bengal, India (Figure 1). Darjeeling is the northernmost district of the state of West Bengal. Naxalbari is located approximately 40 kilometers away from the nearest town Siliguri that is approximately 600 kilometers away from Kolkata, the provincial capital of the state. Ethical clearance was obtained from the institutional committee that was a prerequisite of a project (see Acknowledgements). Permission from the local Government authority was taken before the commencement of the study. The participants signed (or given thumb impression) the consent form. Blood samples were collected by a nurse at the rural health center.

The present study was an extension of a research project[16]. The initial study started in 2011–12 and continued up to 2015 through other projects and a doctoral thesis. People representing Dhimal, Limbu, Mech, Rai, Rajbanshi, and Muslim communities live in the villages at *Hatighisha* and *Maniram Gram Panchayat* of Naxalbari Police Station (*Gram Panchayat* or village council is a statutory body to execute community development programs in rural areas). Dhimal is an indigenous community of the region and primarily endogamous. They have matrimonial relations and thereby genetic connections with Dhimals from Nepal. Their primary occupation is agriculture. Demography and socioeconomic characteristics of the community had been reported earlier[17,18]. Studies on health and nutritional status of adult Dhimals are also reported earlier from the same region[18–22]. High degree undernutrition (BMI-based chronic energy deficiency 36.4%; men 27%, women 46%)[18], relatively low hemoglobin level (men 10 g/dL, women 9 g/dL)[19], and hypertriglyceridemia, high LDL-C, and low HLD-C were observed to be associated with hypertension among adult Dhimals[20]. Higher prevalence of undernutrition and hypertension (systolic blood pressure or SBP≥140 mm/Hg) were recorded among adults Dhimals, in comparison with peers representing other neighboring communities (Mech and Rajbanshi)[21, 22].

A household survey recorded 162 Dhimal women between 40 and 55 years of age and 139 women (87%) reported menopause. The present study selected 129 postmenopausal women from the list, representing the community. Other women did not agree to participate. In the survey, women participants were asked about their age of permanent cessation of menstruation for 12 consecutive months to determine menopause. Women were apparently healthy, did not report any disease in three months prior to the survey and did not receive any sur-

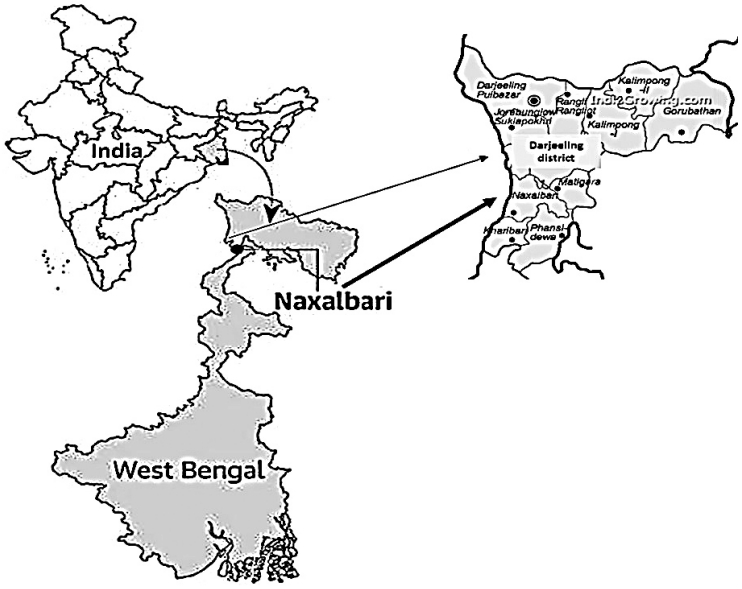

Fig 1. Location of the study. Source: Google Images.

gical or hormonal treatment. In a separate survey in connection with the research project, no women below 40 years of age reported menopause, and no one reported regular or irregular menstruation above 55 years of age. Mid-year age at menopause was considered for data analysis.

Blood pressure (BP) (systolic and diastolic, SBP and DBP respectively) was recorded using a digital baumanometer (Omron, M7 Intelli IT, HEM-7361T-EBK). Colorimetric method was used for clinical biochemistry tests following recommended laboratory procedures[23]. Levels of triglycerides (TG) (mg/dL), low-density lipoprotein cholesterol (LDL-C) (mg/dL), and high-density lipoprotein cholesterol (HDL-C) (mg/dL) were estimated. The diagnosis of hypertension (SBP/DBP 140/90 mmHg)[24], hypertriglyceridemia (≥150 mg/dL), high LDL-C (≥130 mg/dL), and low HDL-C (<50 mg/dL) followed standard criteria[25]. Derived lipid profile parameters were calculated as follows[26]:

Total Cholesterol (TC) (mg/dL) = HDL-C + LDL-C + 20 percent of TG level

Non-HDL-C (mg/dL) = Total cholesterol (TC) – HDL-C

Castelli Risk Index I (CRI-I) = (TC/HDL-C)

Castelli Risk Index II (CRI-II) = (LDL-C/HDL-C)

Atherogenic coefficient (AC) = (TC- HDL-C)/HDL-C

Atherogenic index of plasma (AIP) = [$\log_{10}$ (TG/HDL-C]

The outcomes for AIP were further classified as low risk: AIP < 0.11, intermediate risk: AIP = 0.11–0.21 and high risk: AIP > 0.21. Considering the sample size at levels, AIP has been categorized in two groups: low plus intermediate risk and high risk.

SPSS statistical software (version 15.00) was used for data analysis. Baseline characteristics (mean values and standard deviation) of age, SBP, DBP, and lipid profile parameters (TG, LDL-C, HDL-C, TC, non-HDL-C, CRI I, CRI II, AC, and AIP) were computed. Data were normally distributed and followed assumption of Shapiro-Wilk test ($p>0.05$) that has been carried out separately in normotensive and hypertensive groups except for blood pressure (systolic and diastolic). Student's *t*-test was used to find significant difference between two independent variables that were normally distributed. Mann-Whitney U test was used to estimate significant difference of blood pressure between normotensive and hypertensive groups. Parametric and nonparametric correlation analyses were done to find association between variables. Binomial logistic regression analysis was run to predict hypertension from the lipid profile characteristics, after adjusting for age. Statistical significance was set a priori at $p< 0.05$.

Results

Mean value of age in the sample of postmenopausal women (n = 129) was 50.34 (± 4.02) years. Mean value of reported age at menopause was 45.36 (± 4.37) years that was different among normotensive (47.05 ± 1.99 years) and hypertensive (42.94 ± 2.12 years) women. Prevalence of hypertension (65.89%, n= 85), hypertriglyceridemia (21.71%), high LDL-C (43.41%), and low HDL-C (48.06%) were remarkable in the sample. AIP-based high-risk lipid profile was estimated among 86.05% women. Prevalence of hypertriglyceridemia was lower among normotensive (16.4%) in comparison with hypertensive women (27.1%). Likewise, hypertensive women showed higher percentages of high LDL-C (48.2%), low HDL-C (49.4%), and AIP (high risk) (89.4%) in comparison with the corresponding rates recorded among normotensive women (38.6%, 46.7%, and 82.9%, respectively).

Mean values of lipid profile characteristics (TG, LDL-C) and derived parameters (TC, non-HDL-C, CRI I and II, AC, and AIP) were higher among hypertensive women (n = 85) with significant difference ($p<0.05$) from the corresponding values estimated among normotensive women (n = 44) (Table 1). Blood pressure (SBP and DBP) had significantly positive ($p<0.05$) correlation with TG (ρ = SBP 0.39), LDL-C (ρ = SBP 0.35, DBP 0.26), TC (ρ = SBP 0.33, DBP 0.21), non-HDL-C (ρ = SBP 0.35) and other derived parameters (CRI I and II, AC, AIP). Age at menopause had significantly negative correlation ($p<0.05$) with lipid profile characteristics except LDL-C and HDL-C (Table 2). Duration of menopause (difference between chronological age and age at menopause) did not show significant correlation with blood pressure and lipid profile parameters (results are not presented).

Binomial (binary) logistic regression analysis was done to predict hypertension (SBP/DBP = 140/90 mmHg) among postmenopausal women in response to the lipid parameters (TG, non-HDL-C, AIP), after controlling for age (regression models 1, 2, and 3 respectively) (Table 3). Regression models predicting hypertension by LDL-C, HDL-C, TC were not significant. Regression coefficients of the derived parameters (CRI I and II, AC) as independent variables were like the value of AIP in Model 3. There were no missing data in the regression models (Total = 129; normotensive = 44, hypertensive = 85).

In the Models 1 and 2, TG and non-HDL-C significantly predicted hypertension with correct classification rate (68.22% and 69.0% respectively) and Youden index (0.39 and 0.50 respectively). Wald estimates of the predictors were also significant (TG = 5.54, non-HDL-C = 4.32, $p< 0.05$). The Model 3 demonstrated best results in comparison with two other models. AIP significantly predicted hypertension after adjusting for age with highest correct classification rate (71.32%) and Youden index (0.52). The sensitivity was 77.35% and the specificity was 76.09%. Model fitting tested by Hosmer-Lemeshow's goodness of fit test showed that observed and predicted probabilities matched an assumption ($p> 0.05$). Nagelkerke R square showed 42% variation in the outcome variable (hypertension). Wald estimate was significant (9.53, $p< 0.05$). Odds ratio explained by Exp(B) interpreted that one unit increase in AIP had a chance of 24% rise in odds of having hypertension. The area under ROC curve (Figure available from the author on request) was 0.70 for hypertension stating almost 70.0% of all possible pairs of normotensive

TABLE 1

DESCRIPTIVE STATISTICS OF BLOOD PRESSURE AND LIPID PROFILE OF NORMOTENSIVE AND HYPERTENSIVE POSTMENOPAUSAL WOMEN (n=129)

Variables	Total	Normotensive	Hypertensive	Mann-Whitney U Test*	p-value
	Mean (SD) (n=129)	Mean (SD) (n=85)	Mean (SD) (n=44)		
AM (years)	45.36 (4.37)	47.05 (1.99)	42.94 (2.12)	13.72	**<0.0001**
SBP (mmHg)	140.33 (13.76)	125.11 (3.83)	148.20 (9.84)	–9.37*	**<0.0001**
DBP (mmHg)	89.41 (11.20)	79.25 (3.50)	94.67 (10.15)	–8.16*	**<0.0001**
TG (mg/dL)	122.86 (79.56)	101.29 (43.21)	134.02 (91.21)	2.25	**0.03**
HDL-C (mg/dL)	38.11 (10.31)	39.69 (9.85)	37.29 (10.50)	1.26	0.21
LDL-C (mg/dL)	119.14 (33.90)	109.54 (35.15)	124.11 (32.34)	2.35	**0.02**
TC (mg/dL)	157.29 (35.69)	149.26 (36.86)	161.45 (34.56)	1.86	0.07
Non-HDL-C	119.18 (33.91)	109.57 (35.15)	124.16 (32.34)	2.36	**0.02**
CRI-I	4.43 (1.61)	3.90 (1.07)	4.70 (1.77)	2.73	**0.01**
CRI-II	3.42 (1.61)	2.90 (1.07)	3.70 (1.77)	2.73	**0.01**
AC	3.43 (1.61)	2.90 (1.07)	3.70 (1.77)	2.73	**0.01**
AIP	0.48 (0.24)	0.39 (0.20)	0.52 (0.25)	3.12	**<0.0001**

SD: Standard deviation; AM: Age at menopause; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; TG: Triglycerides; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; TC: Total cholesterol; Non-HDL-C: Non- high-density lipoprotein cholesterol; CRI I: Castelli Risk Index I; CRI II: Castelli Risk Index II; AC: Atherogenic coefficient; AIP: Atherogenic index of plasma. * Z-value of Mann-Whitney U (hypertensive=1; normotensive=0).

TABLE 2

CORRELATION MATRIX OF CHARACTERISTICS IN POSTMENOPAUSAL WOMEN (n=129)

Variables	SBP (mmHg)^{NP}	DBP (mmHg)^{NP}	AM (years)^{P}
DBP (mmHg)	0.67**	–	–
AM (years)	–0.75**	–0.59*	–
TG (mg/dL)	0.39*	0.13	–0.42**
HDL-C (mg/dL)	–0.10	–0.16	0.01
LDL-C (mg/dL)	0.35*	0.26*	–0.25
TC (mg/dL)	0.33*	0.21*	–0.24*
Non-HDL-C	0.35**	0.26	–0.25*
CRI I	0.39*	0.32**	–0.23*
CRI-II	0.39*	0.32**	–0.23*
AC	0.39*	0.32**	–0.23*
AIP	0.34**	0.21*	–0.41**

SBP: Systolic blood pressure; DBP: Diastolic blood pressure; AM: Age at menopause; FPG: Fasting plasma glucose; TG: Triglycerides; HDL-C: High density lipoprotein cholesterol; LDL-C: Low density lipoprotein cholesterol; TC: Total cholesterol; Non-HDL-C: Non- high-density lipoprotein cholesterol; CRI I: Castelli Risk Index I; CRI II: Castelli Risk Index II; AC: Atherogenic coefficient; AIP: Atherogenic index of plasma; NP = Spearman's rho; P = Pearson's correlation coefficient (r); p-values ** <0.0001, *<0.05.

TABLE 3

BINARY LOGISTIC REGRESSION OF LIPID PROFILE PARAMETERS TO PREDICT HYPERTENSION AMONG POSTMENOPAUSAL WOMEN (n=129)

Model	Predictors	B	S.E.	Wald	p-value	Exp(B)	95.0% C.I. for Exp(B)		CC (%)	AUC	Sensitivity	Specificity	YI
							Lower	Upper					
1	Constant	–2.64	1.51	3.07	0.08	0.07							
	Age (years)	0.04	0.03	2.04	0.15	1.04	0.98	1.10					
	TG (mg/dL)	0.01	0.00	5.54	**0.02**	1.01	1.00	1.02	68.22	0.64	70.12	68.55	0.39
2	Constant	–2.94	1.52	3.74	1	0.05	0.05						
	Age (years)	0.04	0.03	2.27	0.13	1.04	0.99	1.10					
	Non-HDL-C (mg/dL)	0.01	0.01	4.32	**0.04**	1.01	1.00	1.02	69.00	0.67	76.47	73.91	0.50
3	Constant	–3.185	1.564	4.146	0.04	0.04							
	Age (years)	0.053	0.030	3.134	0.08	1.05	0.99	1.12					
	AIP	0.21	0.06	9.53	**<0.001**	1.24	1.08	1.39	71.32	0.70	77.35	76.09	0.52

B: Regression coefficient; S.E: Standard error; C.I.: Confidence interval; CC: Correct classification; AUC: Area under curve; YI: Youden index; TG: Triglycerides; Non-HDL-C: Non-high-density lipoprotein cholesterol; AIP: Atherogenic index of plasma.

and hypertensive women, the logistic regression model for AIP would assign a higher probability to the hypertensive women.

Discussion

A remarkable section of the postmenopausal Dhimal women was hypertensive (66%). Women with earlier age at menopause had higher risk for elevated levels of TG, LDL-C, TC and non-HDL-C. Prevalence of hypertriglyceridemia and high LDL-C were also remarkable in the sample. Mean value of HDL-C was low in the sample (38.11 mg/dL) that was not significantly different among normotensive (39.69 mg/dL) and hypertensive women (37.29 mg/dL). However, there was a tendency of lowering of HDL-C with the rise of blood pressure. Hypertensive women had earlier age at menopause than normotensive peers.

Menopause is a risk factor for cardiometabolic diseases including metabolic syndrome (MetS), T2DM, and CVD[9]. The study[9] reported MetS in postmenopause was due to the loss of protective role of estrogen and increased circulating androgen, resulting in the changes to body fat distribution, and development of visceral fat and central obesity. Changes in body composition, particularly fat mass and fat free mass were also related to the dysregulation of lipid metabolism and CVD among postmenopausal women[27–29]. Endogenous sex hormones influence lipid metabolism because the receptors for estrogen and androgen are expressed in visceral and subcutaneous adipocytes[3]. During premenopausal age, estrogen increases gluteo-femoral fat storage[28,30]. In postmenopausal age, due to the relative decline of estrogen production and relative increase of androgen level, women gain more visceral fat and lose gluteo-femoral fat[31,32]. Excess visceral fat is associated with increased lipolysis rate of TG into fatty acid and glycerol and causes enhanced hepatic insulin resistance. Therefore, loss of fat free mass, redistribution of body fat from gluteo-femoral to visceral or abdominal, raised central obesity, weight gain, T2DM, increased levels of TG, LDL-C and reduced HDL-C are reported in postmenopausal women compared to their premenopausal peers of similar age-group[3].

Studies from India[33] and Nepal[34] reported that postmenopausal women had higher TG, LDL-C, and lower HDL-C levels than premenopausal women and the former group was at greater risk for developing CVDs compared to the latter. In the study carried out in Kathmandu, Nepal[34], estimated AIP in postmenopausal women was 0.22 which was lower than the mean value estimated in the present study. The age range of the participant women was between 30 and 60 years. AIP had significant correlation ($p< 0.05$) with systolic blood pressure ($r = 0.20$) and diastolic blood pressure ($r = 0.45$)[34]. A study from rural areas of Bangladesh selected 265 postmenopausal women aged 40 to 70 years. Mean values of age and age at menopause of women were 53.51 ± 7.5 years and 44.83 ± 5.22 years respectively[13]. Mean value of AIP was 0.16 that showed significant association with LDL-C and TC.

In a cohort-based study, 4,644 postmenopausal women aged 50 years and above and undergoing coronary angiography in Anzhen Hospital, Beijing, China were selected; 3,039 had coronary artery disease (CAD) and 1,605 were non-CAD patients[14]. The CAD patients had higher TG, LDL-C, non-HDL-C, CRI I, AIP, and lower HDL-C than non-CAD patients with significant differences in the mean values. Mean value of AIP in the sample was 0.14 showing higher value in CAD patients (0.15) than non-CAD patients (0.10). AIP had significantly positive correlation ($p< 0.05$) with TG ($r = 0.84$), non-HDL-C ($r = 0.34$), CRI I ($r =$

0.68), and CRI II (r = 0.44). In a logistic regression model, AIP was found to be the most powerful independent predictor (unadjusted odds ratio 1.82) of CAD risk after adjusting for age, and parameters estimating anthropometric and lifestyle characteristics among Chinese Han postmenopausal women[14]. Similar results were obtained in the present study; AIP significantly predicted hypertension in the logistic regression model with comparatively lower odds ratio (1.24).

A case–control study selected 348 postmenopausal CAD cases and 348 controls in Xinjiang, China[15]. The CAD patients had higher levels of TG, LDL-C, and TC. The mean values of nontraditional lipid profiles, namely, non-HDL-C, CRI I, CRI II, AC, and AIP were significantly higher in the CAD patients. Mean value of AIP among CAD patients (0.20) was significantly different ($p< 0.001$) from the value recorded among controls (0.10). AIP was positively and significantly correlated ($p< 0.05$) with other lipid parameters showing coefficients for TG (r = 0.78), non-HDL-C (r = 0.30), CRI II (r = 0.63), and CRI II (r = 0.47). In a multivariate logistic regression model, AIP was an independent predictor of CAD with odds ratio 3.29 at 95% confidence interval levels (1.84–5.88, $p< 0.001$).

A community-based cohort study among Chinese women aged 35 to 64 years reported association of menopause with raised LDL-C, TG levels; CRI I was highest during transitional age at menopause that were important determinants of atherosclerosis and CVD. No significant change was observed in HDL-C level with menopause[11]. In a retrospective study among 1,015 women aged 34–76 years from 20 provinces of China who visited the Beijing Obstetrics & Gynecology hospital had elevated levels of LDL-C, TC, and low HDL-C during postmenopausal age[35]. A comparative study between premenopausal (n = 3,094) and postmenopausal (n = 1,037) women aged between 40 and 59 years was carried out in the Checkup Department of Beijing Tongren Hospital, China (during 2012–2014)[36]. In that study, overall prevalence of dyslipidemia among postmenopausal women was higher than premenopausal women (69.7% vs. 24.3% respectively) and mean values of TG, LDL-C, non-HDL-C, and CRI 1 were significantly higher in postmenopausal women compared to the estimated values among premenopausal peers. Logistic regression analysis after adjusting for age, anthropometric characteristics (body mass index or BMI, waist circumference), blood pressure, and fasting plasma glucose, showed that menopause (pre and post) was independently associated with dyslipidemia[36].

A study reported higher levels of lipids and lipoproteins at the transition from pre- to postmenopausal age of Korean women[37]. These changes were associated with follicle stimulating hormone level alteration at menopause. Another cross-sectional study carried out in Kangbuk Samsung Hospital Total Healthcare Center, Korea, during 2012–2013 selected 1,553 women aged 44–56 years[8]. Higher mean values and increased prevalence of dyslipidemia were observed across menopausal ages. The present study showed similar patterns of the results obtained in the studies from China and Korea. However, in the present study, pre- and perimenopause status of women was not considered.

A comparative study between 25–49-year-old premenopausal (n = 30) and 50–70-year-old postmenopausal (n = 50) women from the University of Nigeria and the Teaching Hospital at Enugu, reported higher mean values of lipid parameters and lower HDL-C in the second group with significant difference[38]. Mean value of AIP among postmenopausal women was 0.15. Mean values of lipid profile characteristics were found to increase with the duration of menopause from 10 to 20 years[38]. Mean value of age of 45– to 80-year-old 108 postmenopausal women from Yaoundé University Teaching Hospital, Cameroon was 56.4 years. AIP values ranging between –0.40 and 0.85 had mean value 0.21 that showed significant association with TC, blood pressure (systolic and diastolic) and CVD assessed by Framingham risk score (FRS)[39]. The AIP was positively and significantly ($p< 0.001$) correlated with TC (r = 0.37), FRS (r = 0.37) and blood pressure, SDB (r = 0.35), DBP (r = 0.37) in that study. A study from urban regions of Vitoria, Brazil selected 901 women and reported that both HDL-C and non-HDL-C were good predictors of the risk for increased arterial stiffness in postmenopausal women[12]. Postmenopausal women had higher TG (145.0 mg/dL) LDL-C (161.6 mg/dL), non-HDL-C (191.2 mg/dL) and hypertension (42.7%) than corresponding values 106.6 mg/dL, 135.2 mg/dL, 156.5 mg/dL, and 18.4%, respectively in premenopausal women.

The studies from Nigeria[38] and Nepal[34] selected pre- and postmenopausal women with wide age range. The comparative studies between pre- and postmenopausal women in age-matched samples could give more precise results to understand the changes that had taken place due to menopause and the associated physiological changes in the endocrine system and metabolism. A study from Naxalbari, Darjeeling reported 40– to 44-year-old postmenopausal women had higher mean values of body fat (%), fasting plasma glucose, and lipid profile characteristics in comparison with the values recorded in premenopausal peers[40]. In that perspective, a comparative study of lipid parameters among pre- and postmenopausal women considering wider age range will be done in future to see the differences and similarities of the results obtained in the previous studies from other countries. The present study showed similar patterns of results in postmenopausal women with respect to higher mean values and prevalence of lipid parameters in hypertensive group. Estimated mean value of HDL-C was lower among hypertensive women.

Limitations of the study

Shortcomings of the present study had some impacts on the findings. The first limitation includes the cross-sectional nature of the design that does not elucidate causal inferences. The second limitation is the homogeneous sample with a relatively small size, which limits the generalization of the results obtained for all postmenopausal

women or for other ethnically and culturally different groups of women. Longitudinal studies should be conducted with a larger and heterogeneous sample to validate the results and provide more information. Third, the menopausal status of the study population was unclear due to the lack of serum hormone measurements and assessment. Women participants were not asked about the symptoms to evaluate perimenopause status and therefore, the study was limited to the postmenopausal women only (without menstruation for 12 consecutive months). Framingham risk score was not done to estimate risk for CVD. Dietary habits, smoking, alcoholism, and exercise had associations with hypertension and lipid profile characteristics in postmenopausal women as reported earlier[12,14,37]. BMI-based overweight and obesity, body fat (%), central obesity measured by waist circumference, and fasting plasma glucose level are also reported to be associated with menopause[3,9,29]. The end of reproductive age also had several psychosocial impacts in women's lives[41]. These parameters were not included in the present study and should be explored in future.

Conclusions

The present study from Darjeeling district in West Bengal, India contributes important results on association of elevated lipid profile characteristics with hypertension in postmenopausal Dhimal women that conform to the results of previous studies across the world. Age at menopause had significantly negative association with blood pressure and lipid profile parameters. AIP was found to be the best predictor of hypertension among lipid profile parameters. In absence of similar report from this part of the world, the present study calls for future research from the same and other parts of India, representing different communities. The results of the present study indicate alarming health conditions of postmenopausal women that call for intervention programs.

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Conflict of interest

The author declares no competing interest.

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POVEZANOST KRVNOG TLAKA I LIPIDNOG PROFILA MEĐU ŽENAMA U POSTMENOPAUZI U NAXALBARIJU U POKRAJINI DARJEELING, ZAPADNI BENGAL

S A Ž E T A K

Cilj ovog istraživanja bio je pronaći povezanost između krvnog tlaka i karakteristika lipidnog profila kod žena u postmenopauzi. Studija poprečnog presjeka napravljena je 2015. u Naxalbariju u okrugu Darjeeling u Zapadnom Bengalu, Indija. Uzorak je uključivao 129 žena u postmenopauzi u dobi između 40 i 55 godina, iz etničke skupine Dhimal. Mjeren im je krvni tlak (sistolički i dijastolički) te procijenjene razine triglicerida (TG), kolesterola lipoproteina visoke gustoće (HDL-C) i lipoproteinskog kolesterola niske gustoće (LDL-C). Izvedeni parametri lipidnog profila bili su ukupni kolesterol, ne-HDL-C, Castellijev indeks rizika (CRI) I i II, koeficijent aterogenosti i aterogeni indeks plazme (AIP). Dijagnosticirana je hipertenzija (sistolički/dijastolički 140/90 mmHg), hipertrigliceridemija (≥150 mg/dL), visoki LDL-C (≥130 mg/dL) i nizak HDL-C (<50 mg/dL). Povezanost između varijabli ispitana je korelacijskom i logističkom regresijskom analizom. Prosječne vrijednosti dobi i dobi u menopauzi bile su 50,34 godine, odnosno 45,36 godina. Utvrđena je visoka prevalencija hipertenzije (65,89%), hipertrigliceridemije (21,71%), visokog LDL-C (43,41%) i niskog HDL-C (48,06%). Binomni logistički regresijski modeli nakon prilagodbe za dob, pokazali su da lipidni parametri (TG, non-HDL-C i AIP) značajno predviđaju hipertenziju. Uočeno je da je AIP najbolji prediktor hipertenzije (Youdenov indeks = 0,52), a omjer izgleda pokazao je da je povećanje AIP-a za jednu jedinicu povećalo vjerojatnost hipertenzije za 24%. Žene s hipertenzijom u postmenopauzi imale su više srednje vrijednosti i prevalenciju abnormalnih karakteristika lipidnog profila. Dob u menopauzi pokazala je značajnu negativnu povezanost s krvnim tlakom i parametrima lipidnog profila.