

RESEARCH ARTICLE

Association between age at menarche and age at menopause among women of an indigenous population of North Bengal, India

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Abstract

Menarche and menopause are two major components of a woman's reproductive life. Ages at menarche and menopause vary widely between and within populations and are influenced by various factors, both genetic and environmental. The present community-based cross-sectional investigation aimed to assess the association between ages at menarche and natural menopause among women belonging to the indigenous Rajbanshi population of North Bengal, India. The investigation was carried out from January 2015 to May 2015 among 510 Rajbanshi women aged between 45 and 55 years residing in the district of Darjeeling, West Bengal, India. A structured schedule was used to collect data on ages at menarche and natural menopause, marital status, parity, education, age of first and last pregnancies, duration of breastfeeding, nature of occupation, health status, smoking and monthly family income. Anthropometric measurements of height and weight were recorded and Body Mass Index (BMI) calculated. The statistical analyses, which included descriptive statistics and binary logistic regression (BLR), were done using SPSS. The women's mean age of menarche and median age of natural menopause were 12.52 years and 50 years, respectively. The BLR analysis indicated that education, age at first pregnancy had significant effects on the age at natural menopause among women who experienced menarche at <12 years of age ($p < 0.05$). In the case of women who attained menarche at ≥ 12 years of age, marital status, age at last pregnancy, parity, education, duration of breastfeeding, smoking, occupation, monthly income and BMI had a greater influence on age at natural menopause. There appears to be an indirect association between age at menarche and age at natural menopause, along with different predictor variables, among the Rajbanshi women.

Keywords: Menarche; Menopause; India

Introduction

Menarche and menopause are two major components of the reproductive life of women. The interval between these two events determines the natural reproductive period during which women can procreate. Mounting evidence indicates that early or late occurrences of these events are linked to heightened risks of chronic diseases such as endometriosis, metabolic disorders and breast cancer. Menarche, the first menstrual bleeding, is a sentinel marker for onset of the reproductive lifecycle of a woman and is preceded by a complex cascade of hormonal changes that culminates in reproductive capabilities and results in a complex series of physiological and molecular events, patterns of physical growth and body composition (DiVall & Radovick, 2008; Boynton-Jarrett *et al.*, 2013; Yermachenko & Dvornyk, 2014). Menopause refers to the permanent

cessation of menstruation resulting from loss of follicular activities of the ovaries and it occurs when the decrease in follicles reaches a critical number (Ginsberg, 1991; Gold, 2011). Natural menopause, as defined by the World Health Organization (WHO), is ‘the permanent cessation of menstruation, recognized as having occurred after 12 months of amenorrhoea, not attributed to hormone use or surgery for the removal of the uterus or ovaries’ (WHO, 1996).

Sievert (2014) pointed out that the discipline of anthropology remains well suited to the study of menopause as there is a great deal of variation in age at menopause across populations, along with the meaning of menopause across cultures. Longevity, rather than capacity for menopause, sets humans apart from other primates. A developmental perspective suggests that early childhood may be a critical time for the environment to irreversibly influence the number of oocytes or rate of follicular atresia and, ultimately, age at menopause (Sievert, 2014).

Mounting evidence has established the significance of menarche as both a footprint for chronic disease risks and compass for health and developmental trajectories (Forman *et al.*, 2013; Boynton-Jarrett *et al.*, 2013; Li *et al.*, 2016). An earlier age at menarche is associated with ovarian failure (Chang *et al.*, 2007), risk of gall stone disease (Ryu *et al.*, 2016), hypertension (Bubach *et al.*, 2018), risk of cancer at adulthood (Werneck *et al.*, 2018), cardiovascular disease (Peters & Woodward, 2018) and metabolic disorders (Kim & Je, 2019). Recent studies have indicated an increased risk for endometriosis (Matalliotakis *et al.*, 2017; Ottolina *et al.*, 2018) and fatty liver disease (Yi *et al.*, 2017) with early age at menarche. Studies have also reported that several diseases and conditions are associated with later age at menarche. These include depression (Graber *et al.*, 2004) and lower bone mineral density (Eastell, 2005). The risks become compounded as there has been a steady decrease or secular trend in the age at menarche in both developed and developing countries (e.g. Park *et al.*, 2018; Shen *et al.* 2019). Over the past few decades, a secular trend towards an earlier age at menarche has been established in several countries such as Brazil (Silva & Padez, 2006), Mexico (Marván *et al.*, 2016) and Switzerland (Lehmann & Scheffler, 2016). In India too there has been a reduction of nearly one month per decade in the age at menarche, suggesting a secular trend (Bagga & Kulkarni, 2000; Pathak *et al.*, 2014).

There is also evidence of associations of certain non-communicable diseases and poor health with early age at menopause. It has been shown that early age at menopause is associated with osteoporosis (Kritz & Barrett, 1993), lower bone density (Osei-Hyiaman *et al.*, 1998) and cardiovascular and coronary diseases (Atsma *et al.*, 2006). A later age at menopause has been linked to breast and endometrial cancers (Ginsberg, 1991; Gold, 2001; Gold *et al.*, 2011). A search of the existing literature search showed that a number of determinant factors significantly influence the ages at menarche and natural menopause. These include biological (e.g. genetic, nutritional and reproductive history), socio-cultural (e.g. educational, occupational and rural–urban residence), reproductive (e.g. parity and type of contraceptives used) and lifestyle factors (e.g. smoking and use of tobacco and dietary habits) (Pallikadavath *et al.*, 2016; Koukouliata *et al.*, 2017; Bae *et al.*, 2018; Park *et al.*, 2018; Lawn *et al.*, 2018; Shen *et al.*, 2019).

Ages at menarche and natural menopause have been implicated in numerous health consequences for women in later life. Hence, an understanding of the association between these two ages and their health risks could help with effective prevention and management of health problems that women may subsequently develop. For example, the most common diseases that pose significant health issues and economic burdens in both developed and developing countries are cardiovascular diseases, osteoporosis, breast cancer and Type 2 diabetes (Sasser *et al.*, 2005; Qui *et al.*, 2013). An understanding of the relationship between ages at menarche and menopause may also lead to an exploration of the underlying mechanisms of follicular atresia, fertility and disease across the life span, as suggested by Forman *et al.* (2013). Moreover, the duration of the reproductive period is closely linked to ages at menarche and menopause. For a better understanding of the independent role of reproductive period in disease risk, reliable knowledge about the relation

of age at menarche with age at menopause and with duration of the reproductive period is important (Bjelland *et al.*, 2018). No consistent results have been reported in previous studies on the association between ages at menarche and natural menopause. On the one hand, studies have reported that women with early menarche experience early menopause (Nagata *et al.*, 2000; Henderson *et al.*, 2008; Brand *et al.*, 2015; Ruth *et al.*, 2016; Mishra *et al.*, 2017). On the other hand, other researchers have observed the opposite: that women with early menarche exhibited a late menopause (vanKeep *et al.*, 1979; Boulet *et al.*, 1994). Several studies have observed no such associations (Nagel *et al.*, 2005; Rizvanovic *et al.*, 2013; Bjelland *et al.*, 2014; Zsakai *et al.*, 2015). If age at menarche is not related to age at menopause, women with early menarche may have a longer time interval between menarche and menopause than women with late or delayed menarche. This interval is often referred to as the woman's reproductive period. A long reproductive period implies high cumulative exposure to endogenous female sex hormones such as oestrogens and progestogens, and this period has consistently been associated with increased risk of hormone-related cancers, such as breast cancer and endometrial cancer (Bjelland *et al.*, 2018). Even though there is evidence of a secular trend in menarche, it is less certain whether a similar trend for menopause exists. However, some trends are available for European countries (Flint, 1978; Dratva *et al.* 2009) and Taiwan (Shen *et al.*, 2019).

India is a land of enormous genetic, cultural and linguistic diversity (Majumder, 2001). It has been pointed out that the Indian population comprises more than a billion people and consists of 4693 communities with several thousand endogamous groups (e.g. Singh, 2002). It is home to a large number of caste and tribal/indigenous populations. A considerable number of scientific papers are available on ages at menarche and menopause from individuals belonging to these ethnic communities/populations (e.g. Singh & Thapar, 1983; Tyagi *et al.*, 1983; Chakravarty, 1994; Bagga & Kulkarni, 2000; Purnungla & Sengupta, 2002; Sidhu, 2002; Dasgupta & Ray, 2009; Deb, 2009; Ahuja, 2016; Goyal *et al.*, 2016; Sharma & Bansal, 2018; Shukla *et al.*, 2018). The northern part of the state of West Bengal is popularly known as North Bengal and comprises the districts of Malda, Uttar Dinajpur, Dakshin Dinajpur, Darjeeling, Cooch Behar, Kalimpong, Alipurduar and Jalpaiguri. A number of indigenous (e.g. Lepcha, Rabha, Meche, Toto and Rajbanshi) and caste (e.g. Bengalee) populations reside in this region. A thorough literature search has shown that studies in menarche and menopause are scarce among these ethnic populations.

The Rajbanshi is the largest indigenous population of North Bengal. A thorough literature search yielded very few investigations on ages at menarche and natural menopause for this population. The age at menarche among Rajbanshi girls was observed to be 14.7 years by Chakravarty (1994). Only two studies were available in the domain of menopause among Rajbanshi women. The different socioeconomic factors affecting menopause among Rajbanshi women were reported by Sinha and Sen (2017). The effects of different confounding factors on overweight and obesity among Rajbanshi post-menopausal women were studied by Sinha *et al.* (2018).

It remains uncertain whether age at menarche is associated with age at natural menopause. Several research investigations have also confirmed the association of premature and/or early age at menarche with the risk of adverse health outcome in later life with early natural menopause among women (e.g. Mishra *et al.*, 2017; Andarini & Sujarwoto, 2018; Bjelland *et al.*, 2018). Apparently, women who experience late menarche can exhibit more significant effects on age at natural menopause than women who have an early menarche. Therefore, the age at menarche appears to be an important contributing factor to age at natural menopause. With these issues in mind, the present investigation aimed to determine the association between an early or later age at menarche with age at natural menopause, along with the effects of different demographic, socio-economic and lifestyle variables among married post-menopausal women belonging to the Rajbanshi population of North Bengal, India.

Methods

Area of study

This cross-sectional investigation was carried out from January 2015 till May 2015 among 510 post-menopausal Rajbanshi women aged between 45 and 55 years residing in different Rajbanshi-dominated villages located in Kharibari block in the district of Darjeeling, West Bengal, India. The selection of these villages was based on population strength, dominance of the Rajbanshi population and easy road connectivity and accessibility. The Rajbanshi population is chiefly distributed in the north-eastern part of India and mainly concentrated in the state of Assam and few districts in the state of West Bengal (Sanyal, 1965). In West Bengal they constitute the second largest percentage and number of the Scheduled Caste population. It is generally agreed that ethnically the Rajbanshi show resemblances with the Koch population of neighbouring state of Assam and it has been conjectured that they belong to a mixed race of Australasians/Dravidians and Mongolians (Risley, 1891). According to Dalton (1872), the Rajbanshi originally belonged to a Dravidian stock and later came into contact with the Mongoloid racial strain of Assam, Northeast India. A study on genetic markers has identified the Rajbanshi to be a semi-Hinduized caste group located in-between the clusters of Caucasoid caste populations and Mongoloid tribal populations (Kumar *et al.*, 2004). The Rajbanshi language is a mixture of Tibeto-Burman and Indo-Aryan language speaking families. These people reside in the plain regions and are primarily dependent on agricultural activities. Rice is the staple food for the majority of the population. However, their poor economic condition has created numerous social problems and Rajbanshi women have adopted lower skilled jobs in certain unorganized sectors.

Study sample

The participants (i.e. Rajbanshi women) were selected using a stratified random sampling method. At the initial level, Rajbanshi households in the villages were identified. Then, post-menopausal Rajbanshi women in the age group of 45–55 years were singled out. Subsequently, 530 women were approached to take part in the investigation. Details of the research investigation protocol were explained to them. Twenty of them had to be excluded from the investigation as either their age at menarche could not be recalled or they had not experienced natural menopause; rather, they experienced menopause as a result of hormonal therapy or surgery or removal of the uterus. The age at natural menopause was only recorded from those women who reported spontaneous cessation of menstruation for more than one year based on the WHO criterion (WHO, 1996).

Variables

A structured schedule was used to obtain data on age at menarche and age at natural menopause, along with the following demographic, socioeconomic and lifestyle variables: marital status, parity, education, age of first and last pregnancies (in years), duration of breastfeeding of last child (in months), use of oral contraceptives, health status, monthly occupation income and lifestyle factors such as smoking. Age at menarche was ascertained by asking the participants to recall when they experienced menstrual bleeding for the first time. Age at menopause was calculated by subtracting the year of the birth of women from the year of their final menstrual period. Ages at menarche and ages at menopause, along with years elapsed between recalled age at menopause and present age, were calculated in completed years. Face-to-face interviews were conducted to complete the structured schedule. The interviewer (IS) was familiar with the Rajbanshi language and expressions, and had prior field experience in collecting data on reproductive history. Prior to the canvassing of the schedules, the interviewer discussed issues such as sport, literature and movies with the participants to put them at ease and build rapport.

Anthropometric measurements

The anthropometric measurements of height and weight were recorded following standard procedures (Hall *et al.*, 2007). Height was measured to the nearest 0.10 cm using an anthropometer with the individual standing in erect position with the head oriented in the Frankfort Horizontal plane. Weight was recorded to the nearest 0.10 kg with the individual standing motionless on a portable weighing scale. The technical error measurement (TEM) was calculated to determine the accuracy of the anthropometric measurements using the standard method of Ulijaszek and Kerr (1999). To calculate the TEM, height and weight was measured from 50 women other than those covered in the present investigation by two of the authors (IS and PT). The TEM was calculated using the formula:

$$\text{TEM} = \sqrt{\left(\sum D^2/2N\right)}$$

where D is the difference between the measurements and N is the number of individuals measured.

The co-efficient of reliability (R) was subsequently calculated using TEM using the following equation:

$$R = \{1 - (\text{TEM})^2/\text{SD}^2\},$$

where SD is the standard deviation of the measurements.

The intra-observer and inter-observer TEMs were observed to be within the cut-off value ($R=0.95$) of Ulijaszek and Kerr (1999). Hence, the anthropometric measurements were recorded by both IS and PT were reliable and reproducible. All the anthropometric measurements in the course of the present investigation were subsequently recorded by one of the authors (IS).

The women's Body Mass Index (BMI) was calculated using the WHO (1995) formula:

$$\text{BMI}(\text{kg}/\text{m}^2) = \text{Weight}(\text{kg})/\text{Height}^2(\text{m}^2)$$

Statistical analysis

The data were statistically analysed using SPSS version 17.0. For a better understanding of the association between age at menarche and age at menopause, the data set was divided into two groups, the first being those women whose menarcheal age was <12 years (i.e. early menarche), and the second comprising those whose menarcheal age was ≥ 12 years (i.e. later age at menarche), as per the classification proposed by Lakshman *et al.* (2009), Giles *et al.* (2010) and Otero *et al.* (2010). As the information on age at natural menopause was as only available in complete years, the median age at menopause was calculated to be 50 years. A discrete binary logistic regression (BLR) analysis was performed for all of the determinant variables that could be associated with early menarcheal age (<12 years), and the second comprising those whose menarcheal age was ≥ 12 years. The BLR analysis was fitted to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) so as to examine the effect on individual attained age at menopause (e.g. ≤ 50 years vs ≥ 51 years) and allowed the control of the determinant variables, separately. This BLR model allows for controlling the determinant variables by comparing with a reference category. The dependent variables were created by those women whose age at menopause was observed to be ≤ 50 years and ≥ 51 years and were coded into '0' and '1' in the BLR model, separately. The predictor variables of age, marital status, parity, education, smoking, health status, age at pregnancy, age at last pregnancy, time of breastfeeding, occupation, monthly income and BMI were entered into the regression models as a set of categorical variables, and results were obtained by comparing them with the reference categories. The p -values of <0.05 and <0.01 were considered to be statistically significant.

Results

The 510 women were divided into two categories based on their age of menarche: those with early menarche (<12 years) ($n=47$) and those with later age at menarche (≥ 12 years) ($n=463$).

Age at menarche <12 years

In the 47 women with an age at menarche of <12 years, the median age at menopause was 49 years. There was an increase in the median age at menopause with an increase in the age of the women. A BLR model was fitted to find out the odds for different socioeconomic, demographic and lifestyle variables that have the potential to be significantly associated with age at natural menopause (Table 1). The results showed that educational level and health status were not significantly associated with age at natural menopause ($p>0.05$), but age at first pregnancy was significantly associated with age at natural menopause ($p<0.05$). Women who were illiterate (odds: 2.50, 95% CI 0.21–29.25; $p>0.05$) exhibited a higher odds value than those with primary education (odds: 0.80, 95% CI: 0.07–8.75; $p>0.05$), but neither was statistically significant. The age at first pregnancy in the age group of 17–20 years (odds: 0.04, 95% CI: 0.03–0.78; $p<0.05$) was significantly associated with age at natural menopause, but health status with major illness (odds: 2.26; 95% CI: 0.292–17.57; $p>0.05$) and employed women (odds: 3.00; CI: 0.65–13.84; $p>0.05$) were not significantly associated with age at natural menopause. No significant association was observed among women in the age group of 45–50 years (odds: 1.62, 95% CI 0.29–8.97; $p>0.05$) with age at natural menopause ($p>0.05$) (Table 1). No statistically significant associations were observed between age, marital status, parity, age at first pregnancy, duration of breastfeeding, tobacco use or monthly income, BMI and age at menopause ($p>0.05$).

Age at menarche ≥ 12 years

In the case of the 463 women who experienced menarche at ≥ 12 years of age, the median age at menopause was 51 years (Table 2). There was an increase in median age at menopause with an increase in the age of women. Highly significant statistical associations were observed between the age of the women (e.g. 45–50 years) and age at menopause ($p<0.001$). In addition, there was a significant association between health status and age at menopause ($p<0.05$). The results also indicated that women in the age group of 45–50 years (odds: 0.019; 95% CI: 0.00–0.06; $p<0.001$) were significantly associated with age at menarche than women aged 51–55 years. The results further showed that a lower monthly income (<Rs 4000) (odds: 1.95; 95% CI: 1.09–3.59; $p<0.05$), primary education (odds: 7.71; 95% CI: 1.82–23.52; $p<0.001$), marital status (odds: 9.87; 95% CI: 13.37–7.85; $p<0.001$), smoking use (odds: 7.40; 95% CI: 3.62–15.13; $p<0.001$), age at first pregnancy 17–20 years (odds: 10.73; 95% CI: 1.44–17.99; $p<0.05$), age at pregnancy ≥ 21 years (odds: 13.48; 95% CI: 1.79–10.02; $p<0.05$) age at last pregnancy (≥ 26 years) (odds: 5.77; 95% CI: 6.28–33.21; $p<0.001$), breastfeeding (odds: 4.74; 95% CI: 5.47–33.40; $p<0.001$) and health status with major illness (odds: 5.23; 95% CI: 5.41–7.67; $p<0.05$) had highly significant effects on the age at menopause. Unemployed women (odds: 30.28; 95% CI: 9.42–97.25; $p<0.001$) showed significantly higher odds than employed with age at menopause. Women with a lower (1–3) number of children or parity (odds: 24.67; 95% CI: 10.53–57.77; $p<0.001$) were more significantly associated with age at menarche than women with a higher number of children (≥ 4) (Table 2)

Discussion

The biological implications (i.e. mechanisms) and clinical implications (i.e. consequences) of the three possibilities for associations between the age at menarche and age at natural menopause (i.e. lack of association or direct association or inverse association) are different among different ethnic populations. The mean age at menarche in the present investigation among indigenous Indian

Table 1. Binary logistic regression analysis of association of socioeconomic, demographic and lifestyle variables with age at menopause among Rajbanshi menopausal women with <12 years age at menarche, $N = 47$

Variable	N	β	p -value	df	SE	Wald	Odds	95% CI
Age								
45–50 years	14	0.480	0.583	1	0.87	0.30	1.62	(0.29–8.97)
51–55 years (Ref.)	33							
Marital status								
Married	37	1.45	0.071	1	0.805	3.25	4.26	(0.27–22.61)
Other (Ref.)	10							
Parity								
1–3	17	–1.76	0.113	1	1.110	2.52	0.172	(0.02–1.52)
≥ 4 (Ref.)	30							
Education:								
Illiterate	12	0.92	0.465	1	1.23	0.53	2.50	(0.21–29.25)
Primary	29	–0.22	0.855	1	1.22	0.033	0.80	(0.07–8.75)
Secondary (Ref.)	6							
Smoking								
Yes	37	–0.22	0.855	1	0.88	0.064	0.80	(0.14–4.51)
No (Ref.)	10							
Health status								
Normal	20	0.348	0.678	1	0.84	0.172	1.42	(0.273–7.342)
Major illness	7	0.818	0.434	1	1.95	0.613	2.26	(0.292–17.57)
Minor illness (Ref.)	20							
Age at 1 st pregnancy								
17–20 years	22	–3.045	0.03	1	1.43	4.52	0.04*	(0.003–0.787)
≥ 21 years	21	–9.16	0.49	1	1.11	0.68	0.40	(0.045–3.527)
No pregnancy (Ref.)	4							
Age at last pregnancy								
20–25 years	4	–1.35	0.284	1	1.26	1.148	0.258	(0.022–3.06)
≥ 26 years	33	–0.63	0.455	1	0.84	0.558	0.530	(0.100–2.803)
No pregnancy (Ref.)	10							
Duration of breastfeeding								
26–34 months	24	–1.335	0.233	1	1.119	1.423	0.263	(0.029–2.36)
≥ 35 months	19	–2.14	0.087	1	1.249	2.930	0.118	(0.010–1.36)
No breastfeeding (Ref.)	4							
Occupation								
Employee	12	1.099	0.159	1	0.780	1.984	3.00	(0.650–13.84)
Housewife (Ref.)	35							

(Continued)

Table 1. (Continued)

Variable	<i>N</i>	β	<i>p</i> -value	df	SE	Wald	Odds	95% CI
Monthly income (Rs)								
<4000	12	1.99	0.105	1	1.22	2.633	0.136	(0.01–1.51)
4000–8000	25	–1.25	0.138	1	0.84	2.197	0.286	(0.05–1.49)
≥8001 (Ref.)	10							
BMI (kg/m ²)								
≤23.0	31	–1.43	0.337	1	1.48	0.923	0.240	(0.01–4.41)
24.0–27.0	14	1.79	0.265	1	1.60	1.243	0.167	(0.07–3.89)
≥27.1 (Ref.)	2							

p*<0.05; *p*<0.01.**Table 2.** Binary logistic regression analysis and association of socioeconomic, demographic and lifestyle variables among Rajbanshi menopausal women with ≥12 years age at menarche with age at menopause, *N* = 463

Variable	<i>N</i>	β	<i>p</i> -value	df	SE	Wald	Odds	95% CI
Age								
45–50 years	221	–3.95	<0.001	1	0.59	4.01	0.019**	(0.006–0.06)
51–55 years (Ref.)	242							
Marital status								
Married	288	4.57	<0.001	1	1.01	20.48	9.87**	(13.37–37.88)
Other (Ref.)	175							
Parity								
1–3	222	3.20	<0.001	1	0.43	54.51	24.67**	(10.53–57.77)
≥4 (Ref.)	241							
Education								
Illiterate	95	1.37	0.07	1	0.77	3.11	3.93	(0.86–18.03)
Primary	324	2.04	<0.001	1	0.73	7.73	7.71**	(1.82–32.52)
Secondary (Ref.)	44							
Smoking								
Yes	91	2.00	<0.001	1	0.36	30.10	7.40**	(3.62–15.13)
No (Ref.)	372							
Health status								
Normal	163	1.24	0.05	1	0.23	27.41	3.47**	(2.18–5.53)
Major illness	8	3.82	0.05	1	1.08	12.39	5.23*	(5.41–7.67)
Minor illness (Ref.)	291							
Age at 1 st pregnancy								
17–20 years	249	2.37	0.02	1	1.02	5.36	10.73*	(1.44–17.99)
≥21 years	176	2.60	<0.001	1	1.08	6.40	13.48**	(1.79–10.02)
No pregnancy (Ref.)	38							

(Continued)

Table 2. (Continued)

Variable	N	β	p-value	df	SE	Wald	Odds	95% CI
Age at last pregnancy								
20–25 years	69	1.43	0.22	1	1.16	1.50	4.18	(0.42–41.09)
≥26 years	301	3.82	<0.001	1	1.01	14.25	5.77**	(6.28–33.21)
No pregnancy (Ref.)	93							
Duration of breastfeeding								
26–34 months	252	0.80	0.44	1	1.05	0.58	0.23	(0.28–17.49)
≥35 months	172	3.70	<0.001	1	1.02	13.09	4.74**	(5.47–30.49)
No breastfeeding (Ref.)	39							
Occupation								
Employee	173	3.41	<0.001	1	0.59	32.82	30.28**	(9.42–97.25)
Housewife (Ref.)	290							
Monthly income (Rs)								
<4000	96	−0.66	0.03	1	0.31	4.59	1.95*	(1.06–3.60)
4000–8000	206	−0.08	0.78	1	0.32	0.07	0.91	(0.49–1.72)
≥8001 (Ref.)	161							
BMI (kg/m ²)								
≤23.0	244	1.43	<0.001	1	0.25	12.29	4.19**	(2.56–6.87)
24.0–27.0	204	1.95	<0.001	1	0.55	0.91	7.03**	2.36–20.92)
≥27.0 (Ref.)	15							

* $p < 0.05$; ** $p < 0.01$.

Rajbanshi women was 12.52 years, which is in the lower range when compared with those reported for other populations of India. The comparison of the mean age at menarche obtained in the present investigation with those reported for other Indian populations is shown in Table 3. The mean age at menarche among women from India reported in the existing literature ranged from 11.9 to 13.7 years (Tyagi *et al.* 1983; Sengupta *et al.*, 1996; Sidhu, 2002; Deb, 2009; Dambhare *et al.*, 2012; Khopkar *et al.*, 2015; Goyal *et al.*, 2016; Omidvar *et al.* 2018). It was observed to be 12.23 years among Brahmin girls from Assam (Sengupta *et al.*, 1996). Singh and Thapar (1983) reported the mean age at menarche to be 16.38 years among Bhootia girls from the Mana Valley of Uttar Pradesh. Tyagi *et al.* (1983) observed it to be 12.80 years and 12.76 years, respectively, among Oraon and Munda women, and Chakravarty (1994) observed it to be 14.7 years among the Rajbanshi of North-East India.

The influence of age at menarche on age at menopause has been a focus of research in various investigations. Several researchers have reported a direct association, with early menarche leading to early menopause (Cramer & Xu, 1996; Nichols *et al.*, 2006; Sioka *et al.*, 2009; Li *et al.*, 2016). This association causes a transition in the entire reproductive period in women towards an early span, but without necessarily shortening it, but the increases in mean age at menopause, with or without shortening of the fertile period, appear to increase the risk of diseases such as osteoporosis (Sioka *et al.*, 2009) and cardiovascular disease (Schmidt, 2017). The inverse association of an early age at menarche and a later age at menopause leads to a lengthening of the reproductive period, greater exposure to circulating endogenous hormones and a subsequent increase in the risk of diseases such as endometrial disease (e.g. endometriosis), cardiovascular disease, metabolic

Table 3. Age at menarche among different populations

Population	Age at menarche (years)	Study
Tibetan women	16.20*	Beall (1983)
Bhootia women	16.38*	Singh & Thapar (1983)
Oraon tribes of India	12.80*	Tyagi <i>et al.</i> (1983)
Mundas of India	12.76*	Tyagi <i>et al.</i> (1983)
Rajbanshi population of Assam	14.70*	Chakravarty (1994)
Aao Naga of Nagaland	15.00*	Purnungla & Sengupta (2002)
Punjabi girls of Punjab	12.51*	Sidhu (2002)
Bengali Brahmin girls of Assam	12.25*	Deb (2009)
Assamese girls of Assam	12.45*	Deb (2009)
Ethiopian girls	13.90*	Ayele & Berhan (2013)
Punjabi girls	12.30**	Goyal <i>et al.</i> (2016)
Korean girls	12.70*	Lee <i>et al.</i> (2016)
South Indian girls	13.00*	Omidvar <i>et al.</i> (2018)
Girls from Himachal Pradesh	14.00*	Sharma & Bansal (2018)
Rajbanshi population of North Bengal	12.52*	Present study

*Mean; **Median.

disorders and breast cancer (Nichols *et al.*, 2006; Schmidt, 2017). The present investigation also observed similar associations between ages at menarche and natural menopause among the Rajbanshi women. Similar results have been reported in the UK (Hardy & Kuh, 2005), United States (Nichols *et al.*, 2006), Europe (Stepaniak *et al.*, 2013) and India (Dasgupta *et al.*, 2015).

The present investigation reported the median ages at menopause among women who experienced menarche at <12 years and ≥ 12 years of age and their associations with different dependent and independent variables. In the case of menarche at age <12 years, the median age at menopause was 49 years, and for ≥ 12 years it was 51 years. This is on the higher side of the reported values from studies carried out in different countries, including India (e.g. Vehid *et al.*, 2006; Cassou *et al.*, 2007; Dasgupta & Ray, 2013). The reported median menopausal age among Lohar Ghadiy as from Madhya Pradesh was 46.34 years (Yadav *et al.*, 2002) and that of the Aao Nagas from Nagaland was 51.33 years (Purnungla & Sengupta, 2002). In West Bengal, the average menopausal age of Bengali Hindu women has been observed to be 46.14 years (Dasgupta & Ray, 2009) and 44.67 years (Dasgupta & Ray, 2013). The overall median age at natural menopause (i.e., 50 years) in the present investigation was close to the values observed in developed countries such as Finland (51 years) (Luoto *et al.*, 1994), United States (51 years) (Kato *et al.*, 1998), France (52 years) (Cassou *et al.*, 2007) and Italy (51.2 years) (Parazzini & Progetto Menopausa Italia Study Group, 2007). A population-specific comparison of the median age at menopause from different populations with the present investigation is shown in Table 4.

The median age at menopause was observed to be higher among women with early menarche (<12 years) than in those with later age at menarche (≥ 12 years). Therefore, there appeared to be some association between ages at menarche and menopause among these women. Women who experienced a later age at menarche (≥ 12 years) had more significant effects on age at natural menopause than women who experienced an early age at menarche (<12 years). Age of the

Table 4. Age at menopause among different populations

Population	Age at menopause (years)	Study
Tibetan women	46.80**	Beall (1983)
Finish women	51.00**	Luoto <i>et al.</i> (1994)
American women	51.00**	Kato <i>et al.</i> (1998)
Japanese women	51.40**	Gold <i>et al.</i> (2001)
Aao Naga women of Nagaland	51.33**	Purnungla & Sengupta (2002)
Turkish women	47.00*	Özdemir & Coi (2004)
English women	52.10**	Hardy & Kuh (2005)
North Indian women	48.00**	Kriplani & Banerjee (2005)
Turkish women	47.00**	Vehid <i>et al.</i> (2006)
French women	52.00**	Cassou <i>et al.</i> (2007)
Bengali women of West Bengal	45.00**	Dasgupta & Ray (2009)
Turkish women	46.40*	Ceylan & Özerdoğan (2014)
Nepali women of Nepal	47.00**	Ghimire <i>et al.</i> (2015)
Indian women	46.20*	Ahuja (2016)
Women from Himachal Pradesh	45.00**	Sharma & Bansal (2018)
Gujrati women	44.90*	Shukla <i>et al.</i> (2018)
Rajbanshi women West Bengal	50.00**	Present study

*Mean; **Median.

women appears to be an important factor related to age at menopause. Those aged 45–50 years exhibited greater significant effects on age at menopause than those aged 51–55 years. For parous women, age at natural menopause occurred significantly later compared with nulliparous women, concurring with the results of Bromberger *et al.* (1997). A trend of increasing age at menopause with increasing number of live births was observed, but the trend was not strongly monotonic, unlike that reported in a previous report (Hardy & Kuh, 1999). A study among Chinese women observed early menarche, younger age at first live birth, older age at last live birth and higher parity to be associated with late onset of menopause (Dorjgochoo *et al.*, 2008). Women who have given birth to at least one child have a larger reserve of oocytes and longer exposure to oestrogens (Nikolaou & Templeton, 2004; Santoro *et al.*, 2007). Thus, increasing parity may lead to slower depletion of ovarian follicles resulting in a later age at menopause (Ginsberg, 1991) because onset of menopause is theorized to be related to the rate of loss of oocytes and thus to the occurrence of ovulatory cycles.

The results of the present investigation add to a growing body of literature showing that regular and irregular smoking is significantly associated with an earlier age at menopause after adjustment for confounding factors. Some studies have reported that heavy smokers experience an earlier menopause than light smokers (Torgerson *et al.*, 1994; Parazzini & Progetto Menopausa Italia Study Group, 2007; Li *et al.*, 2016; Rumianowski *et al.*, 2016), while another investigation has shown that former smokers had no different, or only a slightly earlier, age at menopause than those who had never smoked (Cooper *et al.*, 1999). The effect of smoking may not be permanent – a finding inconsistent with a toxic effect leading to the atrophy of ovarian follicles. Polycyclic aromatic hydrocarbons in cigarette smoke are toxic to ovarian follicles and could result in their loss and thus lead to earlier menopause among smokers. An appreciable number of studies have

observed smoking to have a consistent association with menopausal age (e.g. Elias *et al.*, 2003; Sievert & Hautaniemi, 2003; Sapre & Thakur, 2014; Ertunc *et al.*, 2015).

The results of the present investigation showed that ages at first (i.e. ≥ 21 years) and last pregnancy (e.g. ≥ 26 years) had more significant associations with age at natural menopause among women who experienced later age at menarche (i.e. ≥ 12 years) than those with an early age at menarche (i.e. < 12 years) ($p < 0.001$). These results partially corroborate the finding from Indian national-level data, which have shown that women who begin and end childbearing at an earlier stage of their reproductive life reach menopause earlier (Shyamala & Sivakami, 2005). Several studies have also shown menarcheal age, duration of breastfeeding and ages at first and last pregnancies to be significantly associated with the onset of menopause (e.g. Gold *et al.*, 2001; Chang *et al.*, 2007; Parazzini & Progetto Menopausa Italia Study Group, 2007; Dorjgochoo *et al.*, 2008), suggesting a role for these variables in influencing the ovarian store of the body. It has been suggested that an increased duration of breastfeeding may prevent follicle depletion and preserve ovarian function, thereby delaying the onset of menopause (Chang *et al.*, 2007).

The results showed that women with a higher level of education and employment were significantly associated with an earlier age at menopause as compared with women with a lower level of education and unemployment. Several research studies found that lower educational attainment and/or socioeconomic status, often determined by occupational status of the woman or her husband, were associated with an earlier age at menopause (Torgerson *et al.*, 1994; Vehid *et al.*, 2006; Parazzini & Progetto Menopausa Italia Study Group, 2007; Koukouliata *et al.*, 2017). Social and physical stresses are associated with amenorrhoea and reproductive dysfunction, and low socioeconomic status or low educational level may be markers for elevated stress. In the present investigation, BMI was observed to be significantly associated with age at menopause. Some studies have observed that women with lower BMI experienced an earlier natural menopause (e.g. Willett *et al.*, 1983; Al-Safi & Polotsky, 2015), as documented in the present investigation. In humans, caloric restriction and nutritional deficiencies are associated with amenorrhoea. The production of oestrogens in adipose tissue, which is greater in more-obese women, may result in higher levels of circulating oestrogens, which may contribute to longer reproductive functioning. However, some studies have also argued that body composition had no relationship with menopausal age (e.g. Akahoshi *et al.*, 2002; Ku *et al.*, 2004).

The present investigation has its limitations. A major limitation is that it was cross-sectional in nature and did not focus on the reproductive health of the Rajbanshi women. Memory bias could have affected the results as the data were retrospective in nature. There was also a lack of information on the duration and regularity of the women's menstrual cycles. The other limitations include lack of information on diet and body composition measures (like waist-hip ratio) prior to menopause and total duration of breastfeeding (for all children).

In conclusion, this investigation observed that among Rajbanshi women from North Bengal, India, the median age of menopause among women who experienced menarche at < 12 years of age was higher (≤ 49 years) in comparison to that of women who attained menarche at ≥ 12 years of age (≥ 50 years). There appears to be an indirect association between different variables and age at menarche and natural age at menopause. Factors such as marital status, parity, educational status, tobacco use, duration of breastfeeding of the last child and age at first pregnancy discriminate the menopausal age of women. Duration of breastfeeding and age at first pregnancy are essentially culturally determined behaviours and are not uniform across ethnic groups/populations. Age at menarche, despite being largely controlled by biological processes, varies from one population to another. As India is a multi-ethnic country, it would be interesting to conduct similar investigations in order to identify how these factors discriminate the age of menopause for other ethnic populations.

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