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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

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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, socioeconomic and lifestyle variables among married post-menopausal women belonging to the Rajbanshi population of North Bengal, India.

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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.

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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 place. 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.

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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

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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 1st 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*)

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Table 1. (*Continued*)

Variable	*N*	*β*	*p*-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	*N*	*β*	*p*-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 1st 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*)

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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

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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 *et al.* (1983)
Mundas of India	12.76*	Tyagi *et al.* (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 *et al.* (2016)
Korean girls	12.70*	Lee *et al.* (2016)
South Indian girls	13.00*	Omidvar *et al.* (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

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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 *et al.* (1994)
American women	51.00**	Kato *et al.* (1998)
Japanese women	51.40**	Gold *et al.* (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 *et al.* (2006)
French women	52.00**	Cassou *et al.* (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 *et al.* (2015)
Indian women	46.20*	Ahuja (2016)
Women from Himachal Pradesh	45.00**	Sharma & Bansal (2018)
Gujrati women	44.90*	Shukla *et al.* (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

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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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References

Ahuja M (2016) Age of menopause and determinants of menopause age: APAN India survey by IMS. *Journal of Mid-life Health* **7**(3), 126–131.

Akahoshi M, Soda M, Nakashima E, Tominaga T, Ichimaru S and Seto S *et al.* (2002) The effects of body mass index on age at menopause. *International Journal of Obesity and Related Metabolic Disorders* **26**(7), 961–968.

Al-Safi ZA and Polotsky AJ (2015) Obesity and menopause. *Best Practice & Research: Clinical Obstetrics & Gynaecology* **29**(4), 548–553.

Andarini S and Sujarwoto S (2018) Early menarche and premature natural menopause in Indonesia. *Annals of Human Biology* **45**(5), 419–427.

Atsma F, Bartelink ML, Grobbee DE and vander SYT (2006) Postmenopausal status and early menopause as independent risk factors for cardiovascular disease: a meta-analysis. *Menopause* **13**(6), 265–279.

Ayele E and Berhan Y (2013) Age at menarche among in-school adolescents in Sawla Town, South Ethiopia. *Ethiopian Journal of Health Sciences* **23**(3), 189–200.

Bae J, Park S and Kwon JW (2018) Factors associated with menstrual cycle irregularity and menopause. *BioMed Central Women's Health* **18**, 36.

Bagga A and Kulkarni S (2000) Age at menarche and secular trend in Maharashtrian (Indian) girls. *Acta Biologica Szegediensis* **44**(1–4), 53–57.

Beall CM (1983) Ages at menopause and menarche in a high-altitude Himalayan population. *Annals of Human Biology* **10**(4), 365–370.

Bjelland EK, Hofvind S, Byberg L and Eskild K (2018) The relation of age at menarche with age at natural menopause: a population study of 336788 women in Norway. *Human Reproduction* **33**(6), 1149–1157.

Bjelland EK, Wilkosz P, Tanbo T and Gand Eskild A (2014) Is unilateral oophorectomy associated with age at menopause? A population study (the HUNT2 Survey). *Human Reproduction* **29**(4), 835–841.

Boulet MJ, Oddens BJ, Lehert P, Vemer HM and Visser A (1994) Climacteric and menopause in seven South-east Asian countries. *Maturitas* **19**(3), 157–176.

Boynton-Jarrett R, Wright RJ, Putnam FW, Lividoti Hibert E, Michels KB and Forman MR *et al.* (2013) Childhood abuse and age at menarche. *Journal of Adolescent Health* **52**(2), 241–247.

Brand JS, Onland NC, Eijkemans MJ, Tjonneland A, Roswall N and Overvad K *et al.* (2015) Diabetes and onset of natural menopause: results from the European Prospective Investigation into Cancer and Nutrition. *Human Reproduction* **30**(6), 1491–1498.

Bromberger JT, Matthews KA and Kuller LH (1997) Prospective study of the determinants of age at menopause. *American Journal of Epidemiology* **145**(2), 124–133.

Bubach S, Mola DCL, Hardy R, Dreyfus J, Santos AC and Horta BL (2018) Early menarche and blood pressure in adulthood: systematic review and meta-analysis. *Journal of Public Health* **40**(3), 476–484.

Cassou B, Mandereau L, Aegerter P, Touranchet A and Derriennic F (2007) Work-related factors associated with age at natural menopause in a generation of French gainfully employed women. *American Journal of Epidemiology* **166**(4), 429–438.

Ceylan B and Özerdoğan N (2014) Menopausal symptoms and quality of life in Turkish women in the climacteric period. *Climacteric* **17**(6), 705–712.

Chakravarty K (1994) Age at menarche among the Rajbanshi women of North Bengal. *Journal of Assam Science Society* **36**(1), 49–52.

Chang SH, Kim CS, Lee KS, Kim H, Yim SV and Lim YJ *et al.* (2007) Premenopausal factors influencing premature ovarian failure and early menopause. *Maturitas* **58**(1), 19–30.

Cooper GS, Sandler DP and Bohlig M (1999) Active and passive smoking and the occurrence of natural menopause. *Epidemiology* **10**(6), 771–773.

Cramer DW and Xu H (1996) Predicting age at menopause. *Maturitas* **23**(3), 319–326.

Dalton ET (1872) *The Descriptive Ethnology of Bengal*. Government Printing, Calcutta, India.

Dambhare DG, Wagh SV and Dudhe JY (2012) Age at menarche and menstrual cycle pattern among school adolescent girls in Central India. *Global Journal of Health Science* **4**(1), 105–111.

Dasgupta D, Pal B and Ray S (2015) Factors that discriminate age at menopause: a study of Bengali Hindu women of West Bengal. *American Journal of Human Biology* **27**(5), 710–715.

Dasgupta D and Ray S (2009) Menopausal problem: a study on the rural and urban women of Eastern India. *Journal of Social, Behavioral and Health Science* **3**(1), 20–23.

Dasgupta D and Ray S (2013) Attitude toward menopause and aging: a study on postmenopausal women of West Bengal. *Journal of Women & Aging* **25**(1), 66–79.

Deb R (2009) Variation in the age at menarche of the Assamese and Bengali girls of Guwahati, Assam. *Anthropologist* **11**(4), 259–264.

DiVall SA and Radovick S (2008) Pubertal development and menarche. *Annals of the New York Academy of Sciences* **1135**, 19–28.

Dorjgochoo T, Kallianpur A, Gao YT, Cai H, Yang G and Li H *et al.* (2008) Dietary and lifestyle predictors of age at natural menopause and reproductive span in the Shanghai Women's Health Study. *Menopause* **15**(5), 924–933.

Dratva J, Gómez Real F, Schindler C, Ackermann-Liebrich U, Gerbase MW and Probst-Hensch NM *et al.* (2009) Is age at menopause increasing across Europe? Results on age at menopause and determinants from two population-based studies. *Menopause* **16**(2), 385–394.

Eastell R (2005) Role of oestrogen in the regulation of bone turnover at the menarche. *Journal of Endocrinology* **185**(2), 223–234.

Elias SG, van Noord PA, Peeters PH, den Tonkelaar I and Grobbee DE (2003) Caloric restriction reduces age at menopause: the effect of the 1944–1945 Dutch famine. *Menopause* **10**(5), 399–405.

Ertunc D, Tok EC, Aytan H and Gozukara YM (2015) Passive smoking is associated with lower age at menopause. *Climacteric* **18**(1), 47–52.

Flint M (1978) Is there a secular trend in age of menopause? *Maturitas* **1**(2), 133–139.

Forman EJ, Hong KH and Ferry KM (2013) In vitro fertilization with single euploid blastocyst transfer: a randomized controlled trail. *Fertility and Sterility* **100**(1), 100–107.

Ghimire N, Dhakal P, Norrish D, Dangal G, Sharma D and Dhimal M *et al.* (2015) Menopausal health status of women of Kapilvastu District of Nepal. *Journal of Nepal Health Research Council* **13**(31), 182–187.

Giles LC, Glonek GF, Moore VM, Davies MJ and Luszcz MA (2010) Lower age at menarche affects survival in older Australian women: results from the Australian Longitudinal Study of Ageing. *BioMed Central Public Health* **10**, 341.

Ginsberg J (1991) What determines the age at the menopause? *British Medical Journal* **302**(6788), 1288–1289.

Gold EB (2011) The timing of the age at which natural menopause occurs. *Obstetrics and Gynecology Clinics of North America* **38**(3), 425–440.

Gold EB, Bromberger J, Crawford S, Samuels S, Greendale GA and Harlow SD *et al.* (2001) Factors associated with age at natural menopause in a multiethnic sample of midlife women. *American Journal of Epidemiology* **153**(9), 865–874.

Goyal P, Singh Z and Sethi GK (2016) Association of age at menarche with anthropometric measures in Punjabi Bania girls. *Journal of Clinical and Diagnostic Research* **10**(11), IC01–IC05.

Graber JA, Seeley JR, Brooks-Gunn J and Lewinsohn PM (2004) Is pubertal timing associated with psycho pathology in young adulthood. *Journal of the American Academy of Childhood and Adolescents Psychiatry* **43**(6), 718–726.

Hall JG, Allanson JE, Gripp KW and Slavotinek AM (2007) *Handbook of Physical Measurements*. Oxford University Press, New York.

Hardy R and Kuh D (1999) Reproductive characteristics and the age at inception of the perimenopause in a British national cohort. *American Journal of Epidemiology* **149**(7), 612–620.

Hardy R and Kuh D (2005) Social and environmental conditions across the life course and age at menopause in a British birth cohort study. *British Journal of Obstetrics Gynaecology* **112**(3), 346–354.

Henderson KD, Bernstein L, Henderson B, Kolonel L and Pike MC (2008) Predictors of the timing of natural menopause in the Multiethnic Cohort Study. *American Journal of Epidemiology* **167**(11), 1287–1294.

Kato I, Toniolo P, Akhemedkhanov A, Koenig KL, Shore R and Zeleniuch-Jacquotte A (1998) Prospective study of factors influencing the onset of natural menopause. *Journal of Clinical Epidemiology* **51**(12), 1271–1276.

Khopkar S, Kulanthinal S, Virtanen SM and Saavala M (2015) Age at menarche and diet among adolescents in slums of Nashik, India. *International Journal of Adolescent Medicine and Health* **27**(4), 451–456.

Kim Y and Je Y (2019) Early menarche and risk of metabolic syndrome: a systematic review and meta analysis. *Journal of Women's Health* **28**(1), 77–86.

Koukouliata A, Nena A, Koutlaki N, Liberis V and Constantinidis TC (2017) Correlation of age at natural menopause with occupational status and other epidemiologic factors in women from Prefecture of Kavala, Greece. *Hippokratia* **21**(1), 32–37.

Kriplani A and Banerjee K (2005) An over view of age of onset of menopause in northern India. *Maturitas* **52**(3–4), 199–204.

Kritz SD and Barrett CE (1993) Early menopause, number of reproductive years, and bone mineral density in post menopausal women. *American Journal of Public Health* **83**(7), 983–988.

Ku SY, Kang JW, Kim H, Ku PS, Lee SH and Suh CS *et al.* (2004) Regional differences in age at menopause between Korean–Korean and Korean–Chinese. *Menopause* **11**(5), 569–574.

Kumar V, Basu D and Reddy BM (2004) Genetic heterogeneity in northeastern India: reflection of tribe–caste continuum in the genetic structure. *American Journal of Human Biology* **16**(3), 334–345.

Lakshman R, Forouhi NG, Sharp SJ, Luben R, Bingham SA and Khaw KT *et al.* (2009) Early age at menarche associated with cardiovascular disease. *Journal of Clinical Endocrinology and Metabolism* **94**(12), 4953–4960.

Lawn RB, Lawlor DA and Fraser A (2018) Associations between maternal prepregnancy body mass index and gestational weight gain and daughter's age at menarche: the Avon Longitudinal Study of Parents and Children. *American Journal of Epidemiology* **187**(4), 677–686.

Lee MH, Kim SH, Oh M, Lee KW and Park MJ (2016) Age at menarche in Korean adolescents: trends and influencing factors. *Reproductive Health* **13**, 121.

Lehmann A and Scheffler C (2016) What does the mean menarcheal age mean? An analysis of temporal pattern in variability in a historical Swiss population from the 19th and 20th centuries. *American Journal of Human Biology* **28**(5), 705–713.

Li J, Eriksson M, Czene K, Hall P and Rodriguez-Wallberg KA (2016) Common diseases as determinants of menopausal age. *Human Reproduction* **31**(12), 2856–2864.

Luoto R, Kaprio J and Uutela A (1994) Age at natural menopause and sociodemographic status in Finland. *American Journal of Epidemiology* **139**(1), 64–76.

Majumder PP (2001) Ethnic populations of India as seen from an evolutionary perspective. *Journal of Biosciences* **26**(4), S533–S545.

Marván ML, Catillo-López RL, Alcalá-Herrera V and Callejo DD (2016) The decreasing age at menarche in Mexico. *Journal of Pediatric and Adolescent Gynecology* **29**(5), 454–457.

Matalliotakis M, Goulielmos GN, Matalliotaki C, Trivli A, Matalliotakis I and Arici A (2017) Endometriosis in adolescent and young girls: report on a series of 55 cases. *Journal of Pediatrics and Adolescence Gynecology* **30**(5), 568–570.

Mishra GD, Pandeya N, Dobson AJ, Chung HF, Anderson D and Kuh D *et al.* (2017) Early menarche, nulliparity and the risk for premature and early natural menopause. *Human Reproduction* **32**(3), 679–686.

Nagata C, Takatsuka N, Kawakami N and Shimizu H (2000) Association of diet with the onset of menopause in Japanese women. *American Journal of Epidemiology* **152**(9), 863–867.

Nagel G, Altenburg HP, Nieters A, Boffetta P and Linseisen J (2005) Reproductive and dietary determinants of the age at menopause in EPIC-Heidelberg. *Maturitas* **52**(3–4), 337–347.

Nichols HB, Trentham-Dietz A, Hampton JM, Titus-Ernstoff L, Egan KM and Willett WC *et al.* (2006) From menarche to menopause: trends among US women born from1912 to 1969. *American Journal of Epidemiology* **164**(10), 1003–1011.

Nikolaou D and Templeton A (2004) Early ovarian ageing. *European Journal of Obstetrics Gynecology and Reproductive Biology* **113**(2), 126–133.

Omidvar S, Amiri FN, Bakhtiari A and Begum K (2018) A study on menstruation of Indian adolescent girls in an urban area of South India. *Journal of Family Medicine and Primary Care* **7**(4), 698–702.

Osei-Hyiaman D, Satoshi T, Ueji M, Hideto T and Kano K (1998) Timing of menopause, reproductive years, and bone mineral density: a cross-sectional study of postmenopausal Japanese women. *American Journal of Epidemiology* **148**(11), 1055–1061.

Otero UB, Chor D, Carvalho MS, Faerstein E, Lopes CS and Werneck GL (2010) Lack of association between age at menarche and age at menopause: Pró-Saúde Study, Riode Janeiro, Brazil. *Maturitas* **67**(3), 245–250.

Ottolina J, Bartiromo L, Viganò P, Makieva S, Schimberni M and Candiani M (2018) Does endometriosis influence the age of menopause? *Minerva Ginecologica* **70**(2), 171–177.

Özdemir O and Coi M (2004) The age at menopause and associated factors at the health center area in Ankara, Turkey. *Maturitas* **49**(3), 211–219.

Pallikadavath S, Ogollah R, Singh A, Dean T, Dewey A and Stones W (2016) Natural menopause among women below 50 years in India: a population-based study. *Indian Journal of Medical Research* **144**(3), 366–377.

Parazzini F and Progetto, Menopausa Italia Study Group (2007) Determinants of age at menopause in women attending menopause clinics in Italy. *Maturitas* **56**(3), 280–287.

Park CY, Lim JY and Park HY (2018) Age at natural menopause in Koreans: secular trends and influences there on. *Menopause* **25**(4), 423–429.

Pathak PK, Tripathi N and Subramanian SV (2014) Secular trends in menarcheal age in India evidence from the Indian human development survey. *PLoS One* **9**(11), e111027.

Peters SA and Woodward M. (2018) Women's reproductive factors and incident cardiovascular disease in the UK Biobank. *Heart* **104**(13), 1069–1075.

Purnungla S and Sengupta S (2002) Menarche and menopause among Ao Naga women of Nagaland, India. *Journal of Human Ecology* **13**(4), 327–328.

Qui C, Chen H, Wen J, Zhu P, Lin F, Huang B and Wu P *et al.* (2013) Associations between age at menarche and menopause with cardiovascular disease, diabetes, and osteoporosis in Chinese women. *Journal of Clinical Endocrinology Metabolic* **98**(4), 1612–1621.

Risley HH (1891) *Tribes and Castes of Bengal*. Firma Mukhopadhyay, Bengal Secretariat Press, Calcutta.

Rizvanovic M, Balic D, Begic Z, Babovic A, Bogadanovic G and Kameric L (2013) Parity and menarche as risk factors of time of menopause occurrence. *Medical Archives* **67**(5), 336–338.

Rumianowski B, Rotter I, Brodowska A, Adler G, Kowalski J and Karakiewicz B *et al.* (2016) Influence of selected reproductive factors and smoking on age at menopause. *Gesundheitswese* **78**(11), 749–751.

Ruth KS, Perry JR, Henley WE, Melzer D, Weedon MN and Murray A. (2016) Events in early life are associated with female reproductive ageing: a UK Biobank Study. *Scientific Report* **6**, 24710.

Ryu S, Chang Y, Choi Y, Kwon MJ, Yun KE and Jung HS *et al.* (2016) Age at menarche and gall stone disease in middle-aged women. *Reproductive Science* **23**(10), 1304–1314.

Santoro N, Brockwell S, Johnston J, Crawford SL, Gold EB and Harlow SD *et al.* (2007) Helping midlife women predict the onset of the final menses: SWAN, the Study of Women's Health Across the Nation. *Menopause* **14**(3), 415–424.

Sanyal CC (1965) *The Rajbansis of North Bengal (A study of Hindu Social group).* The Asiatic Society, Calcutta.

Sapre S and Thakur R (2014) Lifestyle and dietary factors determine age at natural menopause. *Journal of Midlife Health* **5**(1), 3–5.

Sasser AC, Rousculp MD, Birnbaum HG, Oster EF, Lufkin E and Mallet D (2005) Economic burden of osteoporosis, breast cancer, and cardiovascular disease among postmenopausal women in an employed population. *Women's Health Issues* **15**(3), 97–108.

Schmidt CW (2017) Age at menopause: do chemical exposures play a role? *Environmental Health Perspectives* **125**(6), 062001.

Sengupta S, Gogoi G and Chetry HB (1996) Variation in menarcheal age of Assamese girls. *Journal of Indian Medical Association* **94**(3), 88–90.

Sharma K and Bansal M (2018) Association of age at menopause with post-menopausal symptoms, menarche age and other reproductive factors among rural females in Shimla, Himachal Pradesh. *Journal of Biosocial Science* **50**(1), 19–25.

Shen TY, Chen HJ, Pan WH and Yu T. (2019) Secular trends and associated factors of age at natural menopause in Taiwanese women. *Menopause* **26**(5), 499–505.

Shukla R, Ganjiwale J and Patel R (2018) Prevalence of postmenopausal symptoms, its effect on quality of life and coping in rural couple. *Journal of Midlife Health* **9**(1), 14–20.

Shyamala TS and Sivakami M. (2005) Menopause: an emerging issue in India. *Economic and Political Weekly* **40**(47), 4923–4930.

Sidhu S (2002) Age at menarche among scheduled caste girls of Punjab. *Journal of Human Ecology* **13**(4), 327–328.

Sievert LL (2014) Anthropology and the study of menopause: evolutionary, developmental, and comparative perspectives. *Menopause* **21**(10), 1151–1159.

Sievert LL and Hautaniemi SI (2003) Age at menopause in Puebla, Mexico. *Human Biological Review* **75**(2), 205–226.

Silva HP and Padez C (2006) Secular trends in age at menarche among Caboclo populations from Pará, Amazonia, Brazil: 1930–1980. *American Journal of Human Biology* **18**(1), 83–92.

Singh KS (2002) *People of India: Introduction National Series.* Anthropological Survey of India, Oxford University Press, New Delhi, India.

Singh L and Thapar M (1983) Age at menarche among the Bhotias of Mana Valley. *Anthropolosicher Anzeiger* **41**(4), 259–262.

Sinha I, Mondal N and Sen J (2018) Effects of socio-economic, demographic and lifestyle variables on overweight and obesity among rural Rajbanshi post-menopausal women of India. *Anthropologischer Anzeiger* **75**(3), 251–262.

Sinha I and Sen J (2017) Factors affecting menopause among Rajbanshi women of North Bengal. *Human Biology Review* **6**(4), 387–402.

Sioka C, Fotopoulos A, Georgiou A, Xourgia X, Panadopoulos A and Kalef-Ezra JA (2009) Age at menarche, age at menopause and duration of fertility as risk factors for osteoporosis. *Climateric* **13**(1), 63–71.

Stepaniak U, Szafraniec K, Kubinova R, Malyutina S, Peasey A and Pikhart H *et al.* (2013) Age at natural menopause in three central and eastern European urban populations: the HAPIEE study. *Maturitas* **75**(1), 87–93.

Torgerson DJ, Avenell A, Russell IT and Reid DM (1994) Factors associated with onset of menopause in women aged 45–49. *Maturitas* **19**(2), 83–92.

Tyagi D, Pal G and Tewari PK (1983) Menarcheal age among Oraon and Munda girls of Ranchi. *Journal of the Indian Medical Association* **80**(9–10), 133–134.

Ulijaszek SJ, and Kerr DA (1999) Anthropometric measurement error and the assessment of nutritional status. *British Journal of Nutrition* **82**(3), 165–177.

vanKeep PA, Brand PC and Lehert P (1979) Factors affecting the age at menopause. *Journal of Biosocial Science* **6**(1), S37–S55.

Vehid S, Aran SN, Köksal S, Işiloglu H and Senocak M (2006) The prevalence and the age at the onset of menopause in Turkish women in rural area. *Saudi Medical Journal* **27**(9), 1381–1386.

Werneck AO, Coelho-E-Silva MJ, Padilha CS, Ronque ERV, Cyrino FS and Szwarcwald CL *et al.* (2018) Age at menarche and cancer risk at adulthood. *Annals of Human Biology* **45**(4), 369–372.

WHO (1995) Physical Status: The Use and Interpretation of Anthropometry. Technical Report Series No. 854. World Health Organization, Geneva.

WHO (1996) Report of WHO Scientific Group on Menopause in 1990s. WHO Technical Report Series 866. World Health Organization, Geneva, pp.12–13.

Willett W, Stampfer MJ and Bain C (1983) Cigarette smoking, relative weight, and menopause. *American Journal of Epidemiology* **117**(6), 651–658.

Yadav A, Jain A and Sharma AN (2002) Menarche and menopause among seminomadic Lohar Gadhiyas of Malthon Town of Sagar District, Madhya Pradesh. *Journal of Human Ecology* **13**(4), 325–326.

Yermachenko A and Dvornyk V (2014) Nongenetic determinants of age at menarche: a systematic review. *BioMed Research International* **2014**, 371583.

Yi KH, Hwang JS, Lim SW, Lee JA, Kim DH and Lim JS (2017) Early menarche is associated with non-alcoholic fatty liver disease in adulthood. *Pediatrics International* **59**(12), 1270–1275.

Zsakai A, Mascie-Taylor N and Bodzsar E (2015) Relationship between some indicators of reproductive history, body fatness and the menopausal transition in Hungarian women. *Journal of Physiological Anthropology* **34**, 35.

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