



# Relationship between age at last delivery and age at menopause: The Korea National Health and Nutrition Examination Survey

Yeun Joo Shin<sup>1</sup>, Ji Yong Song<sup>1</sup>, Min Jeong Kim<sup>1</sup>, Jeong In Choi<sup>1</sup>, Kyung-Do Han<sup>2</sup>, Hae Nam Lee<sup>1</sup>

<sup>1</sup>Department of Obstetrics and Gynecology, Bucheon St. Mary's Hospital, the Catholic University of Korea College of Medicine, Bucheon; <sup>2</sup>Department of Biostatistics, the Catholic University of Korea College of Medicine, Seoul, Korea

## Objective

We used data from the 2010 to 2012 Korean National Health and Nutrition Examination Surveys to investigate whether the age at menopause is related to age at last delivery.

## Methods

This was a cross-sectional study of the data for 714 women who became menopausal within the 3 years preceding the Korean National Health and Nutrition Examination Survey.

## Results

Smoking, exercise, drink, educational level, and income were adjusted in model 1, and the mean ages at menopause were 50.5±0.3, 51.2±0.2, 51.2±0.3, and 50.2±0.4 years for women with <25, ≥25 and <30, ≥30 and <35, ≥35 years age at last delivery, respectively ( $P=0.049$ ). Smoking, exercise, drink, educational level, income, age at first delivery, age at last delivery, and gravidity were adjusted in model 2, and the respective mean ages at menopause were 50.5±0.5, 50.7±0.4, 50.3±0.4, and 49.2±0.5 years ( $P=0.03$ ). In both models, older age at last delivery showed higher age at menopause compared with women with younger age at last delivery.

## Conclusion

Korean women with older age at last delivery were associated with younger age at menopause. Increased number of pregnancies was related to older age at menopause.

**Keywords:** Korean National Health and Nutrition Examination Surveys; Last delivery; Menopause

## Introduction

Natural menopause is commonly defined as the time when a woman has experienced 12 consecutive months of amenorrhea that is not related to any surgical or drug treatment [1-3]. The average age at natural menopause has consistently been estimated at between 50 and 51 years [2,4,5]. Menopause increases the risk of many chronic health problems. An early decline in estrogen production can translate into a substantially greater risk of osteoporosis, obesity, cardiovascular disease, and earlier onset of Alzheimer's disease [6-9].

It is thought that genetic factors determine the age at menopause for about 50% of women [10]. However, in addition to genetic factors, many other factors have been investi-

gated in relation to the age of menopause, including obesity, parity, age at menarche, pattern of menstrual cycles, smok-

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Corresponding author: Hae Nam Lee

Department of Obstetrics and Gynecology, Bucheon St. Mary's

Hospital, 327 Sosa-ro, Wonmi-gu, Bucheon 14647, Korea

Tel: +82-32-340-7083 Fax: +82-32-340-2544

E-mail: leehaenam@catholic.ac.kr

<http://orcid.org/0000-0002-8861-508X>

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ing, socioeconomic level, alcohol intake, educational level, diet, marital state, and use of contraceptives [11-13]. The associations between these factors and age at menopause are inconsistent between studies [14]

For reproductive factors such as parity, age at first delivery and age at last delivery, fewer cumulative menstrual cycles in parous women may be associated with a larger reserve of oocytes and longer exposure to estrogen. However, some studies showed results agreed with such effects, others not. Regional, racial and cultural differences may be reasons for diverse results among studies. There are few studies for association of age at menopause with reproductive factors, especially age at last delivery. In this study, we evaluated the relationship between age at last delivery and age at menopause using the data from Korean National Health and Nutrition Examination Surveys (KNHANESs).

## Materials and methods

This study was based on data collected during the 2010 to 2012 KNHANES, which has been conducted since 1998 by the Division of Chronic Disease Surveillance under the Korea Centers for Disease Control and Prevention. KNHANES is a population-based cross-sectional survey designed to assess the health-related behavior, health condition, and nutritional state of Koreans (<http://knhanes.cdc.go.kr/>) [15]. A field survey team that included doctors and nurse examiners traveled with a mobile examination unit and performed interviews and physical examinations. The survey comprised a health interview, nutritional survey, and health examination survey. The survey collected data by household interviews and by direct standardized physical examinations conducted in specially equipped mobile examination centers. During 2011 to 2013, 25,534 noninstitutionalized South Korean people participated in KNHANES. Among the 25,534 participants, 13,918 were women and 4,546 of these female participants were in the menopausal state. We chose 714 women of the 4,354 menopausal women, minus 192 who did not complete the examination surveys, who had become menopausal within the preceding 3 years for blocking the bias from inaccurate memories.

Data regarding age, smoking history, exercise, place of residence, marital status, occupation, educational level, household income, number of pregnancies, duration of menopause,

age at menarche, and age at first and last delivery were collected during the health interview. During the physical examination, height, weight, and waist circumference were measured. Standing height was measured with the subject facing directly forward with the shoes off, feet together, arms by the sides, and the heels, buttocks, and upper back in contact with the wall. Waist circumference was measured to the nearest 0.1 cm at the midpoint between the iliac crest and the costal margin at the end of a normal expiration. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m<sup>2</sup>). Written informed consent was obtained from all participants before the survey, and approval for this study was obtained from the institutional review board of the Catholic University of Korea, Bucheon, Korea (HC 15QNME0089). Menopause was defined by health interview as having no menstruation during the past 12 months. Smoking history was categorized into the two groups: current or ex-smoker and nonsmoker.

The subjects were classified into three groups according to the amount of alcohol consumed per day in the month before the interview: nondrinkers, mild to moderate drinkers (<30 g/day), and heavy drinkers (≥30 g/day). Individuals with a household income in the lowest quartile were designated as the low-income group. The educational level was classified as low if the respondent did not finish education beyond middle school (i.e., beyond ninth grade). Regular exercise was defined as strenuous physical activity performed for at least 20 minutes at a time at least three times per week.

Statistical analyses were performed using the SAS ver. 9.3 (SAS Institute, Cary, NC, USA) to reflect the complex sampling design and sampling weights of the KNHANES, and to provide nationally representative prevalence estimates. The procedures included unequal probabilities of selection, oversampling, and nonresponse. Participant characteristics were described by using means±standard error for continuous variables, and percentages and standard error for categorical variables. For each variable, analysis of variance was used to analyze the association with age at menopause. Analysis of covariance was used to examine the association between reproductive factors (age at first delivery, age at last delivery, and gravidity) and age at menopause. We first adjusted for smoking, exercise, drink, educational level, and income (model 1), and then adjusted for smoking, exercise, drink, educational level, income, age at first delivery, age at last delivery, and gravidity (model 2). The *P*-values were two-tailed, and *P*<0.05 was considered significant.

## Results

The mean age of 714 menopausal women was  $52.6 \pm 0.1$  years, and 633 (84.6%) were older than 50 years. Mean menopausal age in this study population was 51.0 years. Two hundred thirty-two women (33.3%) had a BMI  $\geq 25$  and 339 (47.5%) had a waist circumference  $\geq 80$  cm. All of the women included in this study had experienced menopause within 3 years of the study, and the mean duration of menopause was  $1.52 \pm 0.05$  years. The baseline characteristics of the study population are shown in Table 1. An older age at menopause was related to a waist circumference  $\geq 80$  cm ( $P=0.044$ ) but not to BMI (Table 2). Women who worked had a younger age at menopause compared with those who did not work ( $P=0.031$ ). Women with a middle school or lower educational level ( $P<0.001$ ) and household income in the lowest quartile ( $P=0.002$ ) had an older age at menopause. More consumption of alcohol was related to earlier age at menopause ( $P=0.008$ ). Age at menopause was not related to smoking, exercise, place of residence, or living with one's spouse. Older age at last delivery was associated with younger age at menopause (Table 3). The difference of age at menopause between two groups were significant on both model 1 ( $P=0.049$ ) and model 2 ( $P=0.03$ ). Increased number of pregnancies was related to older age at menopause on both models (model 1,  $P=0.013$ ; model 2,  $P=0.001$ ). Age at first delivery was not related with age at menopause.

**Table 1.** Baseline characteristics of the study population (n=712)

Characteristics	Mean $\pm$ SE or % $\pm$ SE
Age (yr)	52.6 $\pm$ 0.1
Body mass index (kg/m <sup>2</sup> )	23.9 $\pm$ 0.1
Waist circumference (cm)	80 $\pm$ 0.4
Age at menarche (yr)	15.5 $\pm$ 0.1
Age at first delivery (yr)	24.9 $\pm$ 0.1
Duration of menopause (yr, %)	1.52 $\pm$ 0.05
0	19.4 $\pm$ 1.9
1	30.3 $\pm$ 2.2
2	28.9 $\pm$ 2
3	21.4 $\pm$ 1.9

SE, standard error.

## Discussion

A few studies have evaluated the relationship between the age at last delivery and the age at menopause. In the most of studies, older age at last delivery was related to older age at menopause [16-18]. In the Shanghai Women's Health Study of Dorjgochoo et al. [16] (n=33,054), mean age at menopause of women with <25, 25–29, 30–34, and  $\geq 35$  years age at last live birth were  $49.2 \pm 3.7$ ,  $49.1 \pm 3.7$ ,  $49.2 \pm 3.7$ , and  $49.6 \pm 3.7$  years ( $P<0.01$ ). The study by Abdollahi et al. [17] of 804 menopausal women in Iran reported mean age at menopause of women with <30, 30–40, and >40 years age at last pregnancy were  $46.95 \pm 4.65$ ,  $47.96 \pm 4.2$ , and  $50.78 \pm 2.79$  years ( $P<0.01$ ). Ayatollahi et al. [18] also presented younger age at last pregnancy was associated with younger age at menopause. They reported <25, 25–29, 30–34, and  $\geq 35$  years age at last pregnancy were related to  $46.0 \pm 8.5$ ,  $47.6 \pm 6.3$ ,  $47.9 \pm 5.3$ , and  $48.9 \pm 4.6$  years mean age at menopause ( $P=0.001$ ). Unlike our study, in above three studies,  $\geq 35$  or >40 years age at last delivery showed older age at menopause compared with women with younger age at last delivery. To our knowledge, there was not any study with same result with our study. Our findings probably differ from those of previous studies because of differences in ethnicity, climate, region and cultural determinants. Mean menopausal age, family income and BMI of population in previous studies differed from those of our study. Difference in delivery method (vaginal delivery or caesarean section delivery), blood loss amount during delivery may be factors influence on age at menopause. However, most of studies including ours did not analyze delivery method and blood loss amount during delivery. Further well-designed research concerning the relationship of age at last delivery and age at menopause is needed.

We showed increased number of pregnancy was related with older age at menopause. Unlike our study, Mckinlay et al. [19] reported the effect of number of children was not significant to age at menopause and they showed median age at menopause of women with 0–2, 3–5, and  $\geq 6$  children were 51.21, 51.47, and 51.42 years. However, most of studies presented increased number of pregnancy or delivery was associated with older age at menopause [13,16-22]. For relationship between age at first delivery and age at menopause, there was not any significance in our study. Abdollahi et al. [17] reported similar results with our data. In their study, mean age at menopause of women with <18, >18 and <30,  $\geq 30$

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**Table 2.** Analysis of factors potentially associated with age at menopause

Parameter	Unweighted (n=712)	Age at menopause (yr)	P-value
Age (yr)			<0.001
<50	81 (15.4)	46.6±0.2	
≥50	633 (84.6)	51.8±0.1	
BMI (kg/m <sup>2</sup> )			NS
<25	482 (76.7)	50.9±0.2	
≥25	232 (33.3)	51.4±0.3	
Waist circumference (cm)			0.044
<80	374 (52.5)	50.8±0.2	
≥80	339 (47.5)	51.4±0.3	
Smoker (ex or current)			NS
No	676 (93)	51.1±0.1	
Yes	33 (7)	50.8±0.5	
Regular exercise			NS
No	567 (80.3)	51.1±0.2	
Yes	147 (19.7)	50.6±0.3	
Residential location			NS
Rural	152 (23.6)	51.3±0.3	
Urban	562 (76.4)	51±0.2	
Living with spouse			NS
No	92 (13.4)	51.4±0.3	
Yes	622 (86.6)	51.0±0.1	
Occupation			0.031
No	303 (40.4)	51.4±0.2	
Yes	411 (59.6)	50.8±0.2	
Education			<0.001
Up to middle school	338 (52.2)	51.7±0.2	
Beyond high school	376 (47.8)	50.3±0.2	
Income			0.002
Lowest quartile	63 (9.3)	52.2±0.4	
Other	643 (90.7)	50.9±0.1	
Alcohol drinking habit			0.008
Abstainer	271 (36.0)	51.6±0.2	
Mild to moderate drinker	426 (61.1)	50.7±0.2	
Heavy drinker	17 (2.9)	50.6±0.5	

Values are presented as number (%) or mean±standard error; The P-values were calculated by analysis of variance.

BMI, body mass index; NS, not significant.

years age at first pregnancy were 47.65±4.73, 47.48±4.07, and 47.81±2.85 years and there was not significant difference among groups. However, Dorjgochoo et al. [16] presented older age at first live birth was related with younger age at menopause. Mean age at menopause of women with

<20, 20–24, 25–29, and ≥30 years age at first live birth were 49.3±3.9, 49.2±3.6, 49.1±3.6, and 49.0±3.5 years (P<0.01).

Mean menopausal age of participants in our study was 51.0 years. This age is similar to that of several western countries. Median age at menopause of western countries such as the

**Table 3.** The relationship between age at delivery and age at menopause

Parameter	n (%)	Model 1		Model 2	
		Age at menopause (yr)	P-value	Age at menopause (yr)	P-value
Age at first delivery (yr)			NS		NS
<20	18 (2.7)	51.3±1.0		49.8±1.0	
<25	297 (44.1)	50.8±0.2		49.9±0.4	
<30	347 (45.5)	51.3±0.2		50.6±0.3	
≥30	52 (7.7)	50.2±0.4		50.4±0.5	
Age at last delivery (yr)			0.049		0.03
<25	68 (9.6)	50.5±0.3		50.5±0.5	
<30	393 (55.1)	51.2±0.2		50.7±0.4	
<35	180 (24.1)	51.2±0.3		50.3±0.4	
≥35	73 (11.2)	50.2±0.4		49.2±0.5	
Gravidity (n)			0.013		0.001
0	3 (0.3)	49.4±0.9		48.9±1.0	
1	70 (9.8)	50.5±0.3		49.9±0.5	
2	460 (63.0)	50.9±0.2		50.4±0.3	
3	181 (26.9)	51.5±0.3		51.5±0.3	

Values are presented as mean±standard error unless otherwise indicated; The P-values were calculated by analysis of covariance; Model 1 was adjusted for smoking, exercise, alcohol consumption, education level, and income; Model 2 was adjusted for smoking, exercise, alcohol drinking, education level, income, age at first delivery, age at last delivery, and gravidity.

SE, standard error; NS, not significant.

United States, Netherlands, England, New Zealand, Sweden and Germany were 50.0 to 51.5 years [19]. In the several studies for Iranian, mean age of menopause were 47.4 to 48.3 years [17,18,23]. Dorjgochoo et al. [16] study for Chinese showed mean age of menopause of 49.2 years.

Women who consumed alcohol in our study had a younger age at menopause, and higher alcohol consumption was related to a younger age at menopause. However, many studies found alcohol consumption had a positive correlation with age at menopause or was not associated with age at menopause [16,20-22,24,25]. One of the strongest and most clearly demonstrated risk factors for early menopause is cigarette smoking. In most studies of smoking, age at menopause is consistently inversely related to smoking [16,21,26]. Dorjgochoo et al. [16] reported that the mean age at natural menopause was significantly younger for current smokers (n=1,167; 48.4±4.1 years) than for never-smokers (n=31,615; 49.2±3.7 years) (P<0.01). In the Kaczmarek [21] analysis, the median age at menopause was 1.2 years earlier for current smokers compared with nonsmokers and 0.3 years earlier compared with past smokers (P for trend=0.00007). However,

in our study, age at menopause was not related to smoking. The number of smokers was small, only 33 (7%), and this was too small for a precise analysis. The study by Abdollahi et al. [17] also found no significant association between smoking and age at menopause and only four of the women (0.5%) were smokers. Most studies of the associations between age at menopause and household income and educational level have showed inconsistent results. We found that older age at menopause was related to low household income and educational level. Some investigators have found that age at menopause was not associated with income or educational level [17,20,23], whereas others have reported an association between younger age at menopause and low educational level [21,25].

The main strength of the present study lies in the nationally representative sample of Koreans and the sufficient power to investigate these relationships. Another strength is the availability of data about relevant confounding factors. There are also a few limitations in this study. First, to obtain more precise information about the age at menopause of the participants, we chose only women who had experienced meno-

pause within the past 3 years. This reduced the number of participants and weakened the power of our study. Second, the present study was cross sectional. An obvious problem with cross-sectional studies is that exposure and outcome are measured at the same time and that their interrelated sequences are unknown. Many studies have shown a relationship between age at menopause and various factors. However, most have been purely observational. There have been insufficient analyses of mechanisms by which these factors are associated with age at menopause. Future studies should focus on identifying these mechanisms, and may help control the health problems related to menopause and the age at which it occurs.

This study has demonstrated women with older age at last delivery were associated with younger age at menopause and showed increased number of pregnancy was related with older age at menopause.

## Conflict of interest

No potential conflict of interest relevant to this article was reported.

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