


ORIGINAL ARTICLE

Early menarche and adult major depressive disorder among Japanese women: The role of childhood traumatic experience and socioeconomic conditions in young adulthood

Maki Umeda MPH, PhD¹  | Norito Kawakami DMSc² | Haruki Shimoda PhD³ | Karin Miyamoto PhD⁴ | Hanako Ishikawa DMSc² | Hisateru Tachimori PhD⁵ | Tadashi Takeshima DMSc⁶

¹Research, Institute of Nursing Care for People and Community, University of Hyogo, Hyogo, Japan

²Department of Mental Health, The University of Tokyo Graduate School of Medicine, Tokyo, Japan

³Department of Hygiene and Preventive Medicine, Iwate Medical University, Iwate, Japan

⁴World Health Organization Rwanda, Kigali, Rwanda

⁵Department of Clinical Data Science, Clinical Research & Education Promotion Division, National Center of Neurology and Psychiatry, Tokyo, Japan

⁶Kawasaki City Inclusive Rehabilitation Center, Kanagawa, Japan

Correspondence

Maki Umeda, MPH, PhD, Research Institute of Nursing Care for People and Community, University of Hyogo, 13-71 Kitaoji-cho, Akashi, Hyogo 673-8588, Japan.
Email: makiumedatky@umin.ac.jp

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Abstract

Aim: The aim of this study is to examine the long-term impact of early menarche with adult depression, and to assess whether this association was explained by childhood traumatic experience and socioeconomic condition in early adulthood.

Methods: The data were derived from World Mental Health Survey Japan Second, a cross-sectional survey conducted among Japanese community residents between 2013 and 2015. We used the data of female respondents aged 20–75 years ($N = 1171$). Hazard ratio (HR) of the onset of major depression up to 40 years was calculated for an early-menarche group and a non-early-menarche group, respectively. Kaplan–Meier curve and log-rank statistics were used to examine the difference in failure. Cox proportional hazard models were administered for the association of major depression with early-menarche and early-life psychosocial factors.

Results: Risk for major depressive disorders were three to four times higher in an early-menarche group, and the differences in survival functions were significant ($p < 0.001$). HR of early menarche was 2.79 (95% CI = 1.29–6.02), and was slightly changed when childhood traumatic experience and socioeconomic conditions in young adulthood were added in the model (HR = 2.88, 95% CI = 1.30–6.38; HR = 3.19, 95% CI = 1.41–7.21).

Conclusion: Early menarche was significantly associated with increased risk for depression by the age of 40 years. Childhood trauma and socioeconomic hardship in

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early adulthood did not account for the association. Both physical and psychosocial risk factors in early life need to be addressed for preventing women's depression.

KEYWORDS

child adversities, depression, Japan, menarche, women

INTRODUCTION

The global burden of diseases caused by depressive disorders has been increasing, being ranked among the top 10 leading causes of disease burden in 2019, as well as fourth among those aged 10–24 years and sixth among those aged 25–49 years.¹ Considering the fact that depressive disorders pose a 1.5-times greater burden on women than they do on men,² gender-specific factors, either biological or psychosocial, may exist behind the onset of depression.³

Early menarche is defined as the onset of menarche before the standard age for menarche in that population. The age criteria for early menarche ranges from 10 to 14 years old in existing studies. Early menarche has been hypothesized to be a gender-specific risk factor of women's depression.^{4–9} A large-scale prospective study in the United States found that early menarche was associated with an increased risk for depressive symptoms up to the age of 27 years,⁴ while other studies found that the association became nonsignificant before they reached adulthood.^{6,8} The prolonged effect of early menarche by 40 years' old throughout women's reproductive ages has yet to be known.

One of most prominent theoretical explanations for the pathway between early menarche and later depression is the psychosocial stressors model. This model addresses childhood exposure to recurrent stressors in and around the family and their impact on pubertal timing.^{10–13} Psychosocial acceleration theory specifically addresses the fact that sexual maturation of children experiencing recurrent traumatic events are likely to be accelerated, resulting in early sexual initiation, unstable pair bonds, and internalizing and externalizing disorders in adolescence.^{10,11,14–16} This psychosocial vulnerability among adolescents could further lead them to socio-economic disadvantages, such as early pregnancy, educational underachievement and unstable jobs,¹¹ which could increase the risk for depression throughout their life.

Empirical studies supported this view by demonstrating the association of early menarche with several indicators in early life: childhood social disadvantage,^{17–19} parental separation,²⁰ parental psychopathology,²¹ family conflict and abuse,^{21–23} early sexual initiation and pregnancy,^{9,22,24–26} health risk behaviors,^{25,26} externalizing and internalizing disorders,^{5,27} and antisocial behaviors.⁴ However, many of these studies were conducted among adolescents,^{5,17,19,20,24,25,27} and included a limited number of early-life indicators. Because early-life adversities often co-occurred and had a complex interweaving effect on later mental health,^{28,29} a wider range of childhood indicators need to be considered for a more rigorous assessment of the prolonged impact of early menarche.

This cross-sectional study aims at examining the association of early menarche with history of major depressive disorder by age 40 years and assessing whether this association is independent of the early-life psychosocial stressors of childhood traumatic experience and early-life socioeconomic conditions. We used the data from World Mental Health Japan Survey Second (WMHJ2) that provided representative data of Japanese community residents.³⁰ We expected that early menarche would have a significant association with adult depression and that the association would be partly explained by childhood traumatic experience and early socioeconomic conditions. We controlled the analytical models with parental mental disorders that were identified as being associated with both early menarche and later depression.²¹

METHODS

Study population

Analysis was conducted on the data from the WMHJ2,³⁰ which was a cross-sectional survey conducted from 2013 to 2015 in collaboration with the World Health Organization World Mental Health Survey.³¹ Survey participants were Japanese community residents aged 20–75 years, who were selected by a two-stage stratified random sampling method. The primary sampling unit was the survey area and the secondary unit was the survey participants. Respondents were excluded from participation if they were (1) deceased or institutionalized, (2) had moved from the survey site, or (3) could not speak Japanese. The final sample was 2450 (response rate 43.4%). We analyzed the data of female participants who responded to the item that asked the timing of menarche ($N = 1171$).

Survey instrument

Data were collected by face-to-face interviews using the computer-assisted personal interviews (CAPI) and a self-administered questionnaire. The questionnaire built in CAPI was the Japanese version of the World Mental Health (WMH) Survey Initiative version of the World Health Organization Composite International Diagnostic Interview (WMH-CIDI), a fully structured diagnostic interview that is to be conducted by trained interviewers.³² CIDI has demonstrated acceptable reliability and validity as a clinical assessment tool of common mental disorders.³³ A self-administered questionnaire was developed for use in the WMHJ2, which included a women's section that asked information related to reproductive health.

Measures

Major depressive disorder

Respondents' lifetime experience of major depressive disorder between 10 and 40 years' old was assessed based on the DSM-IV adopted in the WMH-CIDI.³² Depressive symptoms caused by illness, injury, and medication and that appeared only during the presence of other mental disorders were excluded. The age at which respondents experienced depressive symptoms that met diagnostic criteria for the first time was used to define the age of onset.

Early menarche

Timing of menarche was based on the following retrospective self-report that asked about the first occurrence of their menstruation: "How old were you when you had a first menstruation?" The onset of menstruation at the age of 10 or younger was coded as early menarche.¹⁶

Covariates

Childhood traumatic experience

Five types of life-threatening traumatic events during childhood were included in the analysis: physical abuse by parents or caretakers, sexual abuse, witnessing domestic violence between parents, neglect, and separation from parents. Respondents were asked how often they experienced the following acts of parents until they had grown up: (1) pushing, grabbing, or shoving; (2) throwing an object at each other; and (3) slapping, hitting, or punching.³⁴ Response options were *often*, *sometimes*, *rarely*, and *never*. Those who responded with *often* or *sometimes* to any of the three questions were coded as physically abused. A positive response to another dichotomous question that asked whether the respondent had been beaten up by parents or caretakers was also used to define physical abuse. Childhood sexual abuse was coded as positive, if the respondents had experienced repeated sexual assault, molestation, or rape during their childhood.³⁵ Witnessing interparental violence was defined as positive when respondents witnessed any of the following acts either *sometimes* or *often* between the parents or caretakers while growing up: slapping, hitting, pushing, grabbing, shoving, or throwing an object at each other. Neglect was assessed by questions about being made to do chores that were too difficult or dangerous, being left alone or unsupervised, and not being provided school supplies, meals, and or/medical treatment during one's childhood.³⁶ Those who responded *often* to any of these questions were coded as positive, while those who answered *sometimes*, *never*, or *rarely* were coded as negative.

Separation from parents was coded as positive if they responded *yes* to the following dichotomous items: parental death, parental divorce, and any other separation from one or both parents due to parent's absence (e.g., hospitalization and desertion) or respondent's absence (e.g., adoption, boarding school, foster care, and left home before age 16 years).

Disadvantageous socioeconomic conditions in young adulthood

Disadvantageous early socioeconomic conditions included the following three types: teenage pregnancy, lower educational attainment, and early employment. Teenage pregnancy was coded as positive if the first pregnancy was at the age of 19 years or younger. Lower educational attainment was defined as junior high school graduates or lower. Early employment was defined as the first employment at the age 17 years or younger.

Parental mental disorders during childhood

Parental mental disorder during childhood was measured by a modified version of the Family History Research Diagnostic Criteria Interview in the CIDI.³⁷ Major depressive disorder of a parent was coded as positive if she or he ever had been sad or depressed most of the time for more than 2 weeks AND if she or he had other symptoms, such as low energy, changes in sleep or appetite, and problems with concentration during that time. General anxiety disorder was coded as positive if she or he had ever been constantly nervous, edgy, or anxious AND if she or he had other symptoms, such as being restless, irritable, easily tired, and difficulty falling asleep during that time. Panic disorder was coded as positive if she or he had ever had an anxiety attack when she or he felt frightened, anxious, or panicky. Substance abuse was coded as positive if she or he had a problem with alcohol or drugs. The four types of mental disorders described above were assessed individually for the mother and father. Having any of the disorders was coded as "mother's mental disorders" and "father's mental disorders," respectively, and included in the analysis.

Age

All the models were adjusted by age. Age was arranged into three groups: 20–39, 40–59, and 60–75 years.

Analysis

First, a descriptive analysis was conducted to see the prevalence of major depressive disorder, childhood traumatic experience, socioeconomic conditions in young adulthood, and parental mental disorders in the total sample and those who had early menarche. The difference in the prevalence between early-menarche and non-early-menarche groups was examined by the Fisher's exact test.

We drew a Kaplan–Meier curve for the failure time from 10 to 40 years by the timing of menarche. The curve showed the cumulative probability of major depressive disorder. Log-rank statistics were calculated to test the difference in failure curve. Incidence of the onset of major depressive disorders by 5 years from 10 to 40 years old was calculated for the early-menarche and non-early-menarche groups, respectively. We also calculated incidence rate ratio (IRR) and the 95% confidence interval (95% CI) by the age interval to quantify the difference in incidence between the two groups.

Cox proportional hazard models were used to examine the association between the failure time for depressive disorders and early-menarche with the adjustment of early-life factors. As a basic model, we calculated the HR of early menarche (reference = not early

menarche) on the onset of depressive disorders adjusted by age (Model 1). Variables of childhood traumatic experience (Model 2), socioeconomic conditions in young adulthood (Model 3), and parental mental disorders (Model 4) were cumulatively added to the basic model to assess the effect of these early-life factors on the association between early-menarche and onset of depressive disorders. Analyses were performed using STATA (Version 15; Stat Corp.). Statistical significance was consistently tested at a 0.05 level, two-sided.

RESULTS

Sample characteristics

Table 1 shows the characteristics of the sample and the prevalence of early menarche. Among the 1171 respondents, 52 had early

menarche (4.4%). Early menarche was more prevalent in younger age groups ($p < 0.001$), from 9.4% in those aged 20–39 years to 0.3% in those aged 60–76 years. The prevalence of early menarche was significantly higher among those who experienced sexual abuse ($p = 0.011$) and among those who experienced major depressive disorder ($p = 0.002$) than in their counterparts. The timing of menarche did not differ by other childhood traumatic experience and socioeconomic conditions in young adulthood.

Onset of major depressive disorder at age intervals by the timing of menarche

The Kaplan–Meier curve (Figure 1) shows the cumulative probability of major depressive disorder by the timing of menarche. The cumulative probability of early menarche exceeded that of the others at the age of 20 years and the difference enlarged as they

	Total sample (N = 1171)	Prevalence of early menarche by sample characteristics	
	N (%)	Early menarche ^a n = 52 (prevalence ^b , %)	Fisher's exact p value
Age (mean, SD)			>0.001***
20–39	340 (29.0)	32 (9.4)	
40–59	459 (39.2)	19 (4.1)	
60–75	372 (31.8)	1 (0.3)	
Childhood traumatic experience			
Physical abuse	102 (9.3)	3 (2.9)	0.471
Sexual abuse	4 (0.3)	2 (50.0)	0.011*
Witness of DV	64 (5.8)	2 (3.1)	0.764
Neglect	21 (1.8)	0 (0)	1
Separation from parents	55 (5.0)	2 (3.6)	1
Socioeconomic conditions in young adulthood			
Teen pregnancy	43 (3.7)	1 (2.3)	1
Junior high school or below	92 (7.9)	4 (4.4)	0.139
Employment at 17 or younger	196 (17.2)	7 (3.6)	0.703
Parental mental disorders			
Mother's mental disorders	24 (2.1)	3 (12.5)	0.087
Father's mental disorders	21 (1.8)	1 (4.8)	0.618
History of DSM-IV major depressive disorder by age 40	53 (4.5)	8 (15.1)	0.002**

TABLE 1 Sample characteristics and the prevalence of early menarche in WMHJ2

Abbreviation: WMHJ2, World Mental Health Japan Survey Second.

^aEarly menarche, having the first menstruation at the age of 10 years or younger.

^bPrevalence, percentage of responders who experienced early menarche to the total sample of each characteristics' variables.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

FIGURE 1 Kaplan–Meier curve for the occurrence of major depressive disorder from 10 to 40 years by the timing of menarche. Kaplan–Meier curves of an early menarche group (red) and the non-early-menarche group (blue) that show cumulative incidence rate of major depressive disorders between the age of 10 and 40 years.

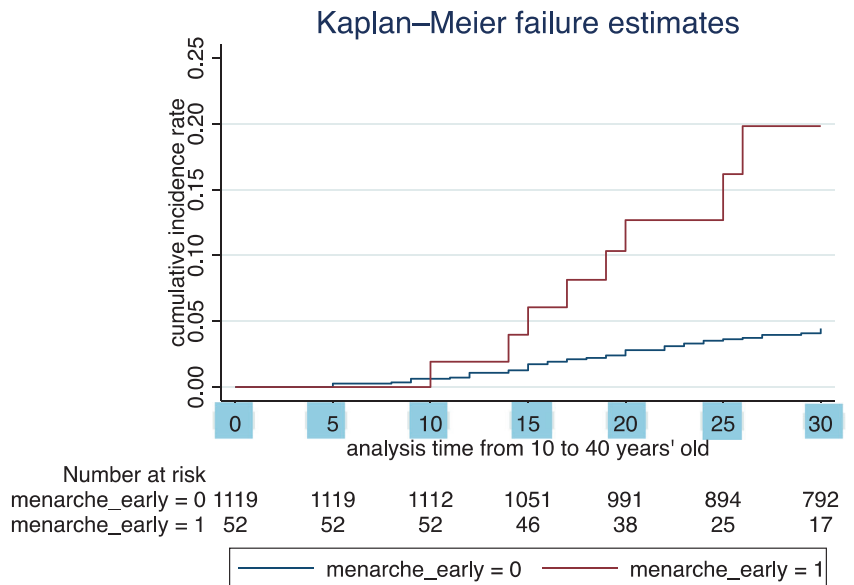


TABLE 2 Incidence rate and incidence rate ratio of the onset of DSM-IV major depressive disorder at each time interval among the early-menarche group and the non-early-menarche group (N = 1171)

	Early menarche (n = 52)				Others (n = 1119)					
	Person-year	MDD (n)	Incidence rate	95% CI	Person-year	MDD (n)	Incidence rate	95% CI	IRR	95% CI
10–15 years	260	0	–	–	5595	3	0.54	0.17–1.66	–	–
16–20 years	260	1	3.85	0.54–27.30	5575	4	0.72	0.27–1.91	3.13	0.06–31.58
21–25 years	241	2	8.30	2.08–33.18	5375	12	2.23	1.27–3.93	1.77	0.19–7.93
26–30 years	213	3	14.08	4.54–43.67	5076	11	2.17	1.20–3.91	1.38	0.25–5.23
31–35 years	144	1	6.94	0.98–49.30	4683	8	1.71	0.85–3.42	1.27	0.03–9.49
36–40 years	95	1	10.53	1.48–74.73	4182	7	1.67	0.80–3.51	5.58	0.12–43.41

Abbreviations: IRR, incidence rate ratio; MDD, major depressive disorder.

grew older. As a result of the log-rank test, the survival function significantly differed between the two groups ($\chi^2 = 19.59$, $DF = 1$, $p < 0.001$). The hazard ratio from those aged 10 to 40 years was 4.47 (95% CI = 1.82–9.58). Incidence of major depressive disorder by the timing of menarche was presented at 5-year age intervals (Table 2). The IRR was the highest at the age-interval of 36–40 years' old (IRR = 5.58), although the wide 95% CI included 1.0 (95% CI = 0.12–43.41), possibly due to the small sample size.

Association of early-menarche with the onset of depressive disorders and its possible mechanisms

Table 3 shows the HRs of early menarche and other possible risk factors in early life as estimated by the Cox proportional-hazards model. HR of early menarche in the basic model was 2.79 (95% CI = 1.29–6.02) (Model 1), which did not change significantly with the

adjustment of childhood traumatic experience in Model 2 (HR = 2.88, 95% CI = 1.30–6.38). The HR slightly changed after adding socioeconomic conditions in young adulthood (HR = 3.19, 95% CI = 1.41–7.21) (Model 3) and parental mental disorders (HR = 3.23, 95% CI = 1.43–7.30) (Model 4).

DISCUSSION

Increased risk of major depressive disorder among those who had early menarche

The present study found that women with early menarche were at higher risk for major depressive disorder in later life by the age of 40 years. This result extends the existing evidence,^{4,9} highlighting the prolonged impact of early menarche throughout their reproductive age. Increased risk for major depressive disorder among those with early menarche emerged after 15 years of age,

TABLE 3 Hazard ratio of early menarche on the onset of DSM-IV major depressive disorder by age 40 estimated by Cox hazard model

	Model 1			Model 2			Model 3			Model 4		
	HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Early menarches	2.79	1.29–6.02	0.009 [*]	2.88	1.30–6.38	0.009 ^{**}	3.19	1.41–7.21	0.005 ^{**}	3.23	1.43–7.30	0.005 ^{**}
Traumatic experience				–			–			–		
Physical abuse				3.09	1.57–6.08	0.001 ^{**}	3.00	1.47–6.14	0.003 ^{**}	2.66	1.28–5.54	0.009 ^{**}
Sexual abuse				1.15	0.14–9.08	0.896	1.54	0.19–12.65	0.688	1.12	0.13–9.77	0.921
Witness DV				1.06	0.39–2.83	0.915	0.91	0.31–2.69	0.859	0.72	0.23–2.25	0.568
Neglect				2.38	0.68–8.28	0.172	2.72	0.77–9.60	0.121	2.88	0.79–10.44	0.108
Separation				2.18	0.83–5.70	0.112	1.58	0.52–4.76	0.418	1.58	0.52–4.74	0.418
Socioeconomic conditions							–			–		
Junior high school or below							0.29	0.06–1.35	0.114	0.32	0.07–1.51	0.152
Early employment							2.81	1.50–5.27	0.001 ^{**}	2.88	1.54–5.39	0.001 ^{**}
Teen pregnancy							1.13	0.34–3.73	0.840	1.13	0.34–3.76	0.841
Parental mental disorders												
Mother's disorders										2.67	1.00–7.17	0.051
Father's disorders										2.07	0.60–7.11	0.249

Notes: Model 1 was adjusted for age. $N = 1171$.

Model 2 was adjusted for age and childhood adversity. $N = 1100$.

Model 3 was adjusted for age, childhood adversity, and socioeconomic conditions in young adulthood. $N = 1070$.

Model 4 was adjusted for age, childhood adversity, socioeconomic conditions in young adulthood, and parental disorders. $N = 1070$.

Abbreviation: HR, hazard ratio.

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

which echoes existing evidence that the effect of early menarche on depression was detectable after 12 years old with the time lag from the first menstruation of the early developers.⁵

Mechanisms of the association between early menarche and major depressive disorder

Our results did not support the hypothesis that childhood traumatic experience and early socioeconomic conditions contributed to the higher risk for adult depression among women with early menarche. A previous study among adolescent girls in the United States found that 6.2% of the association between childhood trauma and depression was explained by early menarche.³⁸ However, the link between childhood trauma and early menarche was not observed in our Japanese sample. The contradictory results suggest that the association between early menarche and psychosocial stressors in early life have a sociocultural variation. In a cultural group, where risky behaviors in reproductive health were suppressed or controlled, the link between early menarche and childhood psychosocial stressors may not be evident.²⁴

An alternative pathway between early menarche and adult major depressive disorder is biological. Existing studies addressed that gonadal steroid hormone could have direct effect on the central nervous system especially during puberty, which can affect psychopathology in later life.^{5,12} In addition, the fact that a gender gap in the occurrence of

depression became observable around the age of 13 years indicated that gonadal hormone plays a critical role in increased risk of depression.³ The long-term mental health effect of gonadal steroid hormone and its mechanism has yet to be examined in relation to early menarche.

Limitations

Our study had the following limitations. First, the data were derived from a cross-sectional study, and the participants' age ranged from 20 to 75 years. An historical trend of acceleration of menarche timing¹² was also observed in our sample, which implied different cutoff points for early menarche between the younger and the older. In addition, self-assessment of psychosocial stressors may vary as they grew older, which could obscure the association between early menarche and psychosocial stressors. Although the accuracy of self-report on the timing of menarche was reported as acceptable,³⁹ recall bias may occur depending on educational level and factors associated with reproductive health.⁴⁰ Second, the sample size may not be sufficient for examining the effect of sexual abuse. Childhood abuse, especially sexual abuse, has been consistently a significant risk factor for early menarche in many studies.^{12,21,41} Lack of association in our study may be due to the small sample size, as we have only four respondents who reported having been sexually abused. A large-scale cohort data would mitigate these biases. Third,

psychosocial stressors directly resulted from early menarche, such as physical-maturity gap and social experience of being “off-time,”^{10,12} was not examined in this study. Although the limited mediating effect of these stressors was reported in the literature,¹⁴ negative self-image and stressful social interaction caused in adolescence might be associated with later depression.

CONCLUSION

We found that women who had menarche at an earlier age were at higher risk for depression by the age of 40 years. Psychosocial stressors in early life, such as childhood trauma and socioeconomic hardship in early adulthood, did not account for the association. Biological factors that affect the central nerve system during early puberty may be a potential mediator between early menarche and adult depression. Cultural variation for the effect of early menarche is worth investigating with the use of a larger cohort sample from other countries. Although biological factors during adolescence have not attracted much attention in predicting adult psychopathology, our findings suggest that early menarche serves as a robust predictor for adult depression. These results suggest that preventive efforts for women's depression start from the early stage of their lives, and the assessment of both physical and psychosocial risk factors is essential.

AUTHOR CONTRIBUTIONS

All the authors have read and contributed to the manuscript preparation. All the authors took part in study design and project administration. Maki Umeda and Norito Kawakami conceptualized the study. Maki Umeda conducted the analysis and prepared the first draft. Norito Kawakami, Hisateru Tachimori, Tadashi Takehisa, Haruki Shimoda, Miyamoto Karin, and Hanako Ishikawa provided critical review and added important intellectual contents for interpretation of results. All the authors agreed with the final manuscript and the submission to this journal.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DISCLOSURE STATEMENT

The funding sources had no role in any process of the research design, data collection, data analysis and interpretation, and submission of the manuscript.

DATA AVAILABILITY STATEMENT

The data for this study are not publicly available due to privacy and ethical restrictions, and will be available on request from the corresponding author. When a reasonable request is received, the data will be made available after approval by the ethics committee of the University of Tokyo.

ETHICS APPROVAL STATEMENT

The contents and procedure of this study were approved by the Research Ethics Committees of Graduate School of Medicine/Faculty of Medicine, The University of Tokyo (10131- (2), (3), and (4)). This research met the ethical standards laid down in the Declaration of Helsinki and ethical guidelines for epidemiological studies.

PATIENT CONSENT STATEMENT

All participants gave their written informed consent prior to their participation. The participation in this study was completely voluntary and confidentiality was assured.

ORCID

Maki Umeda  <http://orcid.org/0000-0002-0859-0477>

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