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When and how do adolescent girls in Japan become aware of premenstrual symptoms from menarche? A cross-sectional study among senior high school students

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ABSTRACT

Objective To investigate the interval from menarche to the onset of premenstrual symptoms and its relationship with menarche age.

Design Cross-sectional school-based survey.

Setting Urban areas of Sendai, the largest city in northeastern Japan.

Participants 1422 female Japanese 10th–12th grade senior high school students participated in the survey.

Main outcome measures The time of awareness of premenstrual symptoms, and the interval from menarche to the onset of premenstrual symptoms.

Results 1290 students had menstruation and completed the whole survey. The median age at menarche was 12 years (IQR: 11–13 years). The prevalence of self-reported premenstrual symptoms was 49%. The median age at which students became aware of premenstrual symptoms was 15 years (IQR: 14–16 years). The median time from the onset of menarche to awareness of premenstrual symptoms was 2 years. This time was negatively correlated with menarche age ($\rho=-0.47$, p<0.001). A Cox proportional hazards regression analysis revealed that early menarche was significantly associated with a lower cumulative risk of developing premenstrual symptoms (OR: 0.73 (95% CI 0.58 to 0.91)).

Conclusions High school students in Japan began experiencing premenstrual symptoms at around 15 years old, and within 2 years of menarche. This study suggested that social factors other than hormonal factors, such as early menarche, might be associated with the onset of premenstrual symptoms.

INTRODUCTION

Premenstrual disorders (PMDs), including premenstrual syndrome (PMS) and premenstrual dysphoric disorder (PMDD), are characterised by emotional, behavioural and physical symptoms which are limited in the late luteal phase.[1 2] Epidemiological surveys have estimated that the frequency of premenstrual symptoms is relatively high (80%–90%).[3 4] In addition, the prevalence of PMS in menstruating women has been reported

Strengths and limitations of this study

► This is the first study to investigate when premenstrual symptoms begin in women and the interval from menarche to the onset of premenstrual symptoms.
► The data were obtained from a relatively general adolescent population in Japan.
► This study used self-reported retrospective data, which are susceptible to recall bias.
► This study was conducted only in Japan.

to be between 20% and 30%.[1] Other studies have reported that 1.2%–6.4% of women of reproductive age exhibit moderate-to-severe premenstrual symptoms that interfere with their daily activities.[1] This severe form of PMS is defined as PMDD in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)*.[5] Premenstrual symptoms begin during puberty, and, although the causes of these symptoms have not been clearly elucidated, it has been suggested that they include hormonal changes, neurotransmitters, diet, stress, and lifestyle.[6]

Menarche, the onset of menstruation, is an important developmental marker for girls in their transition from childhood to young adulthood. Menarche is thought to cause a period of puberty and dynamic hormonal changes to the body. In Japan, the mean age of menarche is 12.3±1.0 years.[7] Primary dysmenorrhoea characteristically begins when adolescents start to exhibit ovulatory cycles, typically within 6–12 months of menarche.[8] However, few global reports have examined when adolescents develop premenstrual symptoms after menarche. Only one review article in the past estimated that PMS would probably start at age 14.[9]

The general definition of early menarche is that occurring in girls under 12 years of age. Early menarche is associated with various negative sexual and reproductive health issues, including early pregnancy, sexually transmitted infections and sexual violence. Moreover, early menarche has been reported to be linked to depression and anxiety disorder.[10–13] Because negative life events and depression are closely related to premenstrual symptoms, examining the relationship between early menarche and premenstrual symptoms may provide valuable information. Although several previous studies have analysed the association between age at menarche and the incidence of premenstrual symptoms in young women, the results have been inconsistent.[14–17] Moreover, no previous studies have examined the association between the timing of menarche and the onset of premenstrual symptoms.

The aim of the current study was to investigate the timing of the onset of premenstrual symptoms and the interval between menarche and adolescents' awareness of premenstrual symptoms.

Materials and methods

Participants

We surveyed a total of 1422 female students in the 10th to 12th grade attending two senior high schools in Sendai city, the largest city in northeastern Japan, in December 2018. The students were asked to complete a self-administered questionnaire regarding the timing of menarche, their premenstrual symptoms and when they became aware of their symptoms. The study questionnaires were given to all female students at each school by their teachers, and were completed voluntarily in the class and collected. We excluded 123 students whose responses were incomplete and nine students who had not yet begun menstruating, leaving 1290 students who had menstrual cycles and completed the survey (figure 1). Regarding the minimum sample size for Cox regression analysis, an event to variable ratio of 10:1 is recommended.[18 19] Furthermore, one previous study recommended a sample size of 500 and above.[20] The sample size in the current study exceeded these minimum requirements.
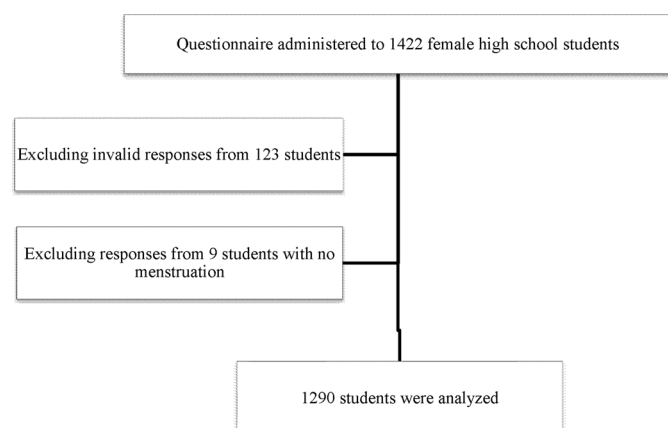

Figure 1 Flow diagram of study participants.

Questionnaire

We asked the participants if they had premenstrual symptoms, which we defined using the Premenstrual Symptoms Questionnaire (PSQ), which we developed in a previous study to screen for premenstrual symptoms.[21 22] The PSQ converts the *American Psychiatric Association: DSM, 4th edition* criteria into a rating scale with degrees of severity described in Japanese, and is, in essence, equivalent to the Premenstrual Symptoms Screening Tool.[23] The PSQ asked, 'Within the last three months, have you experienced the following premenstrual symptoms starting during the week before menses and remitting a few days after the onset of menses?'. The premenstrual symptoms listed for this item were: depressed mood; anxiety or tension; tearfulness; anger or irritability; decreased interest in work, home or social activities; difficulty concentrating; fatigue or lack of energy; overeating or food cravings; insomnia or hypersomnia; feeling overwhelmed; and physical symptoms such as tender breasts, feeling bloated, headache, joint or muscle pain, or weight gain. The PSQ also asked whether such premenstrual symptoms interfered with 'work efficiency or productivity, or home responsibilities,' 'social life activities' or 'relationships with coworkers or family'.

We asked participants if they had experienced these premenstrual symptoms, and, if so, when they first became aware of them. Additionally, we collected information about the participants' age, body weight, height, age at menarche, menstrual cycle and menstrual pain. Menstrual pain was assessed using a numerical rating scale. Pain was labelled from 0 to 10, with 0 indicating no pain and 10 indicating the worst pain possible.

Statistical analysis

We performed all statistical analyses except for the log-minus-log plot using JMP Pro V.15.1.0 (SAS). The log-minus-log plot was performed using the Excel add-in software BellCurve for Excel V.3.2.0 (Social Survey Research Information, Tokyo, Japan). Data are expressed as mean±SD or median with IQR as appropriate. Statistical significance was set at $p < 0.05$. We used Spearman's rank correlation coefficient to evaluate the association with age at menarche and the results of subtracting age at menarche from age at awareness of premenstrual symptoms. After adjusting for age, body mass index (BMI) and menstrual pain, we performed survival analyses using a Cox proportional hazards regression model to examine the association between the onset of premenstrual symptoms and early menarche. We selected these covariates because they were reported to be associated with PMS in previous studies.[17 24 25] The proportional hazards assumption was verified by the log-minus-log plot.

Patient and public involvement

No patients were involved.

Table 1 Characteristics of study participants (n=1290)

Characteristics	
Age (years), mean (SD)	16.7 (1.0)
Age at menarche (years), mean (SD)	12.3 (1.4)
BMI (kg/m²), mean (SD)	20.5 (2.3)
Menstrual pain intensity, mean (SD)	4.68 (2.6)/10
Abnormal menstrual cycle, n (%)	189 (14.7)
Premenstrual symptoms, n (%)	637 (49.4)

BMI, body mass index.

RESULTS

Participants' backgrounds are described in table 1. The participants' mean age was 16.7±1.0 years (range: 15–19 years), and their median age was 17 years. Table 2 shows the prevalence rates of each premenstrual symptom with varying degrees of severity. The students' median age at menarche was 12 years (range: 8–18 years; IQR: 11–13 years) (figure 2). The median age at which students reported being aware of premenstrual symptoms was 15 years (range: 9–18 years; IQR: 14–16 years) (figure 3A). The median period between menarche and awareness of premenstrual symptoms was 2 years, with an IQR of 2–4 years (figure 3B). Figure 4 shows the correlative relationship between age at menarche and age at onset of premenstrual symptoms. The value D shows the intervals from menarche to the onset of premenstrual symptoms. This age was negatively correlated with menarche age (ρ=−0.47, p<0.001) (Spearman's rank correlation coefficient).

Next, we used a Cox proportional hazards regression to examine the onset of premenstrual symptoms and early menarche (age at menarche ≤11), with duration from menarche as the time variable (table 3). Covariates included age, BMI and menstrual pain. In the Cox proportional hazards regression, early menarche was significantly associated with a lower cumulative risk of premenstrual symptom onset.

DISCUSSION

The current results revealed that the median age at which students became aware of premenstrual symptoms was 15 years, which was 2 years past menarche on average. Although age at menarche has been widely surveyed, data are scarce regarding the onset of premenstrual symptoms and the duration from menarche to symptom onset. According to the ACOG (American College of Obstetricians and Gynecologists) Committee on Adolescent Health Care in 2018, primary dysmenorrhoea characteristically begins when adolescents start to exhibit ovulatory cycles, typically within 6–12 months of menarche.[8] The pathophysiological basis for this difference between dysmenorrhoea and PMS may be helpful to elucidate.

Several previous studies have examined the relationship between early menarche and the incidence

Table 2 Prevalence rates of premenstrual symptoms with various degrees of severity (n=1290)

|	Not at all	Mild	Moderate	Severe	Missing
Tearful, n (%)	704 (54.5)	318 (24.7)	188 (14.6)	67 (5.2)	13 (1.0)
Anger or irritability, n (%)	449 (34.8)	457 (35.4)	295 (22.9)	80 (6.2)	9 (0.7)
Depressed mood, n (%)	670 (51.9)	311 (24.1)	213 (16.5)	86 (6.7)	10 (0.8)
Anxiety or tension, n (%)	457 (35.4)	457 (35.4)	296 (22.9)	71 (5.5)	9 (0.7)
Decreased interest in work, home or social activities, n (%)	775 (60.1)	351 (27.2)	117 (9.1)	37 (2.9)	10 (0.8)
Difficulty concentrating, n (%)	524 (40.6)	517 (40.1)	191 (14.8)	49 (3.8)	9 (0.7)
Fatigue or lack of energy, n (%)	407 (31.6)	493 (38.2)	295 (22.9)	84 (6.5)	11 (0.9)
Overeating or food cravings, n (%)	527 (40.9)	369 (28.6)	287 (22.2)	98 (7.6)	9 (0.7)
Insomnia or hypersomnia, n (%)	647 (50.2)	368 (28.5)	189 (14.7)	75 (5.8)	11 (0.9)
Feeling overwhelmed, n (%)	840 (65.1)	284 (22.0)	121 (9.4)	31 (2.4)	14 (1.1)
Physical symptoms, n (%)	620 (48.1)	396 (30.7)	210 (16.3)	54 (4.2)	10 (0.8)
Interference with work efficiency or productivity, home responsibility, n (%)	615 (47.7)	460 (35.7)	160 (12.4)	42 (3.3)	13 (1.0)
Interference with social life activities, n (%)	1019 (79.0)	191 (14.8)	45 (3.5)	24 (1.9)	11 (0.9)
Interference with relationships with coworkers or family, n (%)	1011 (78.4)	210 (16.3)	39 (3.0)	18 (1.4)	12 (0.9)
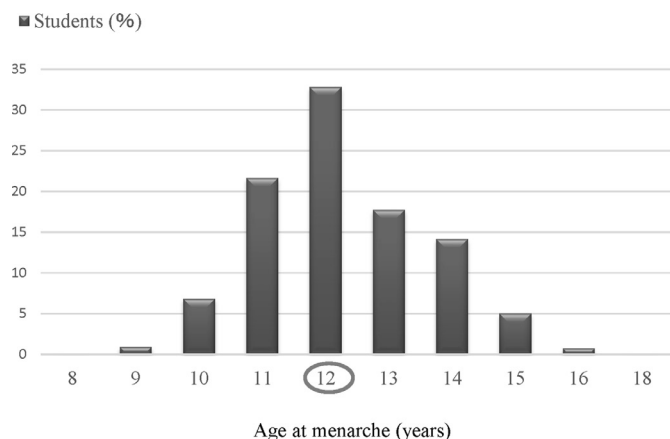
Figure 2 Age at menarche (n=1201). The median age of menarche was 12 years old. The IQR was 11–13 years old.

of PMDs.[14–17] One study indicates that the prevalence of PMS is significantly higher in early menarche[14] and the other study in late menarche,[15] while other studies reported no significant differences.[16 17] To the best of our knowledge, the current study is the first to reveal the interval from menarche to the onset of premenstrual
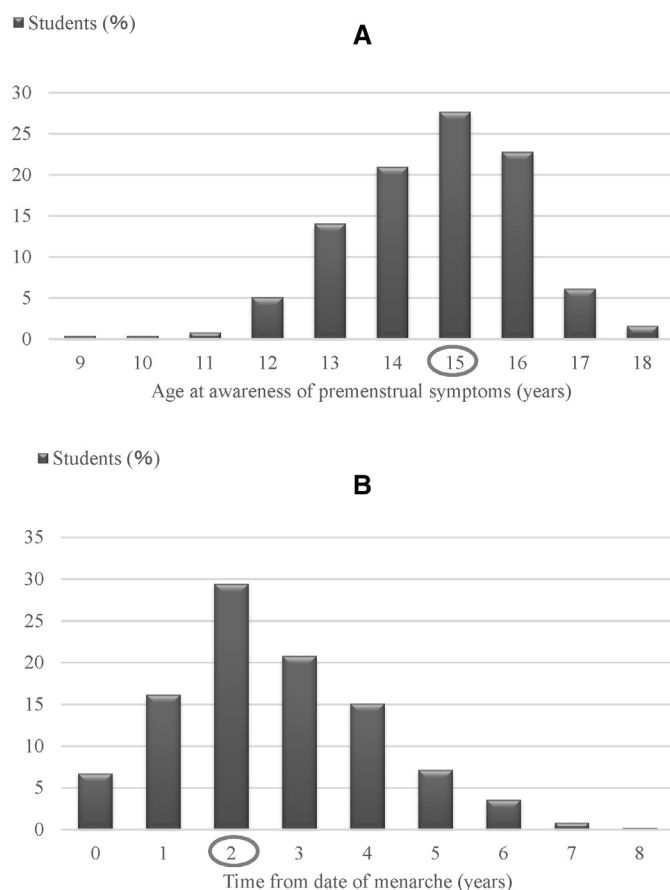

Figure 3 (A) The age at awareness of premenstrual symptoms (n=491). The median age was 15 years old. The IQR was 14–16 years old. (B) The result of subtracting age at menarche from age at first awareness of premenstrual symptoms (n=476). The median period was 2 years. The IQR was 2–4 years.
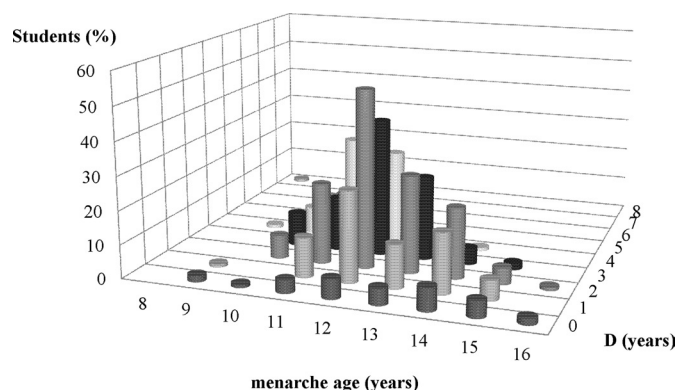

Figure 4 Menarche age and the age of awareness of premenstrual symptoms (n=476). D is the result of subtracting menarche age from age of awareness of premenstrual syndrome. $\rho=-0.47$, p<0.001 (Spearman's rank correlation coefficient).

symptoms. Moreover, we examined the onset of premenstrual symptoms and early menarche. The current findings revealed that girls with later menarche have a shorter time to develop premenstrual symptoms than those with earlier menarche. The onset of premenstrual symptoms is delayed even when menstruation begins earlier.

In Japan, 15-year-old girls typically attend junior high school. Junior high school students can be under a great deal of stress from studying for high school entrance exams or participating in excessive club activities. For example, our previous data showed that the prevalence of sleep deficiency among Japanese high school students is extremely high, and significantly higher than among American high school girls.[26 27] Given this higher rate of sleep deficiency, the unique emotional changes of early adolescence are more likely to manifest. Considering the time lag between menarche and the onset of premenstrual symptoms, even when menarche occurs early, in addition to the hormonal factors brought about by the onset of puberty, cultural and social environmental factors associated with attending junior high school may affect the onset of premenstrual symptoms. These results may be related to the increased stress caused by students' entrance into junior high school.

The current study revealed that adolescent girls began to experience premenstrual symptoms at a median age of 15 years. The IQR was 14–16 years, meaning that most of the students who suffered from premenstrual symptoms

Table 3 The association between premenstrual syndrome and age at menarche

Cox proportional hazards model adjustment for age, BMI and menstrual pain			
		OR (95% CI)	P value
Age at menarche (years)	≤11	0.73 (0.58 to 0.91)	
	≥12	1	0.006

BMI, body mass index.

began experiencing symptoms at around 14 years old. Several previous studies have noted the beneficial effects of educational programmes on PMS, suggesting the need for PMS health education in junior high school.[28] In addition, cognitive behavioural therapy has been reported to have important beneficial effects in managing symptoms associated with PMS.[29] In light of the findings described earlier, educating students early about PMS may help to reduce its incidence. Unfortunately, this education is currently lacking in Japanese schools. The current findings may be particularly useful for school nurses considering introducing educational programmes about PMS at their schools. Further research, including studies examining the effects of educational intervention, is needed to clarify the relationship between the onset of menarche and premenstrual symptoms.

Our study involved several limitations that should be considered. The main limitation was that the study used self-reported retrospective data, which are susceptible to recall bias. However, because the onset of menstruation is a recent event for high school students, the data are likely to be accurate. A second limitation is that the study was conducted only in Japan. Japanese adolescents are under a substantial amount of stress due to the long hours of study required for the entrance examinations of high-ranking schools. From elementary school to senior high school, the provision of cram schools and preparatory schools that supplement children's studies has become a large industry. Similar conditions have been suggested to be present in Korea and China.[30 31] However, high levels of academic-related stress in high school students have also been reported in other developed countries,[32] indicating that the current findings may also be applicable in some other countries. A third limitation is that the past use of hormonal contraceptives was not examined in this study. However, because the rate of hormonal contraceptive use in Japan is very low (0.9%), this is unlikely to have been a problem.[33] Finally, we did not examine physical activity in this study. Although the evidence is inconclusive, physical exercise is recommended for improving PMS symptoms in the guidelines of the Royal College of Obstetricians and Gynaecologists, potentially having an impact on PMS.[34] This point should be considered in prospective studies in the future.

Despite these limitations, the current study had several strengths. To the best of our knowledge, the current study is the first to investigate when premenstrual symptoms begin in women and the interval from menarche to the onset of premenstrual symptoms. In addition, the schools included in this study were regular high schools, meaning that the data were obtained from a relatively general adolescent population in Japan.

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