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Effects of Sleep Pattern, Stress, Menstrual Attitude, and Behavior That Reduces Exposure to Endocrine Disrupting Chemicals on Premenstrual Syndrome in Adolescents

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ABSTRACT

Purpose: The study aimed to examine the effects of sleep pattern, stress, and attitude towards menstruation, and behavior that causes a reduction in exposure to endocrine disrupting chemicals (EDCs) in the course of premenstrual syndrome (PMS) in female adolescents.

Method: In total, 200 girls attending middle school in K city were recruited via convenience sampling between December 11 and 31, 2018, and 192 subjects were selected for the analysis. Data were analyzed using descriptive statistics, an independent t-test, ANOVA, Pearson's correlation coefficient, and multiple regression.

Results: Overall, 9 (4.7%), 152 (79.2%), and 31 (16.1%) students had morning-, intermediate-, and evening-type sleep pattern, respectively. The mean scores for school-related stress were highest. Scores for stress regarding relationships with friends were the lowest. The mean score for attitudes toward menstruation was 72.33 out of 147. The mean score for behavior that led to a reduction in EDCs exposure was 56.57 out of 85. The mean scores for PMS severity were 25.30 and 38.39 out of 60. Analysis of factors affecting PMS revealed that severity of menstrual pain ($\beta=.28$), use of analgesics during menstruation ($\beta=.17$), family history of PMS ($\beta=-.16$), stress ($\beta=.19$), and behavior that reduces EDCs exposure ($\beta=-.17$) exerted significant effects on PMS. The explanatory power of these variables was 37%.

Conclusion: The findings propose the necessity of a health intervention program including educational information, which can reduce PMS in adolescents, induce the behaviors which can decrease exposure to EDCs, and activities for managing the stress levels.

Keywords: Adolescent; Premenstrual syndrome; Endocrine disruptors

INTRODUCTION

Premenstrual syndrome (PMS) is a menstrual disorder that occurs 2–10 days before menstruation. PMS involves a combination of physical, mental, and behavioral symptoms that resolve once menstruation begins [1]. Approximately 80% to 90% of women who have

menstruation experience varying degrees of PMS [2] and approximately 5% to 8% of women suffer from severe pain or functional impairment [3]. Of women who experience PMS, students, who undergo physical changes and rapid growth, are particularly hindered in their school lives and daily living because of PMS [4]. Therefore, it is necessary to identify the factors that influence PMS in students attending middle school, as this is generally the period that marks the beginning of puberty.

PMS is influenced by physiological factors, such as body mass index (BMI), age at menarche, family history, sleep pattern, dietary habits, and use of birth control pills [5], and psychosocial factors such as low self-esteem, depression, menstrual knowledge, attitudes toward menstruation, and stress [5,6]. Therefore, many studies have examined the effects of interventions for discomfort caused by PMS, which focused on controlling biological and psychosocial factors [7,8]; however, recent reports have suggested that environmental factors exacerbated PMS symptoms [9,10]. An array of environmental factors play a complex role in the body, and it is difficult to determine how and when they influence people. Furthermore, symptoms and PMS onset vary between individuals, and it is difficult to eliminate the effects of other variables, all of which limit research on the topic [11].

In particular, Korean adolescents are often deprived of sufficient sleep because of academic stress, internet gaming, and smartphone use and follow an irregular sleep pattern, whereby they go to sleep late on weeknights and sleep in on weekends to compensate for this [12,13]. Compared to their foreign counterparts, Korean adolescents experience more diverse types of stress, including that involving school, family, social life, finances, their looks, and friends [9]. It is therefore important to examine the correlation between stress and PMS in female students attending middle school—an age at which girls generally begin menstruation and puberty—to present foundational data for the development of PMS relief strategies.

Furthermore, individuals' thoughts and attitudes are known to influence physical symptoms [14]. A previous study [5] reported that students with strong negative attitudes toward menstruation experienced more severe menstrual symptoms, relative to those observed in students with positive attitudes.

In addition to physical and psychosocial factors that affect PMS, environmental factors, such as fine dust and endocrine disrupting chemicals (EDCs), have been identified in a number of studies worldwide [1,15,16]. Also, various chemicals synthesized to promote convenience for humans, which are known as environmental hormones, disrupt the endocrine system. EDCs are chemicals in environmental substances or within the environment; they enter the human body and have similar actions to those of endogenous hormones, thereby blocking normal hormonal action and interfering with the synthesis, transport, metabolism, and excretion of hormones. EDCs are not broken down easily and tend to accumulate in fat and tissue in the body [16], which results in a grave impact on growth during puberty [11]. However, few studies have examined the extent of behavior that reduces EDCs exposure or explored its association with PMS in female students attending middle school.

The study aimed to examine the effects of sleep pattern, stress, attitudes toward menstruation, and behavior that reduces EDCs exposure on PMS in female students attending middle school in order to provide foundational data for developing health educational strategies for PMS interventions. The specific objectives were as follows:

1. Examine the participants' general characteristics, menstruation-related characteristics,

- PMS, sleep pattern, stress levels, attitudes toward menstruation, and behavior that reduces EDCs exposure.
2. Identify differences in PMS according to participants' general and menstruation-related characteristics.
 3. Examine correlations between PMS and sleep pattern, stress levels, attitudes toward menstruation, and behavior that reduces EDCs exposure.
 4. Identify the factors that affect PMS.

METHODS

1. Study design

The study was a descriptive correlational study and examined the effects of sleep pattern, stress, attitudes toward menstruation, and behavior that reduces EDCs exposure on PMS in female adolescent.

2. Participants

Female students (grades 1st–3rd) attending a middle school in K city were recruited. The inclusion criteria were as follows: middle school attendance, menstruation, the completion of a written consent form by legal guardians, and the provision of informed consent to participate in the study. The sample size was calculated using G*power 3.1.9 software. The minimum sample size required for multiple regression analysis was 183 with statistical significance of $\alpha=.05$, power of $1-\beta=.90$, an effect size of 0.15, and 18 predictors [17]. Considering the dropout rate, questionnaires were distributed to 200 female middle school students; of these, 198 were retrieved, and 192 were included in the final analysis, with the exception of 6 questionnaires with unanswered questions.

3. Ethical considerations

The study was approved by the institutional review board at G University (GIRB-A18-Y-005). The survey was administered only to participants from whom we had received a written informed consent form from legal guardians and personal informed consent. Further, we explained that confidentiality would be ensured, no personally identifiable information would be exposed, all data would be used only for research purposes, and participants could withdraw their consent to participate at any time.

4. Instruments

1) Sleep pattern

Sleep pattern was measured using the Korean version of the Composite Scale (KtCS) morning-, intermediate-, and evening-type developed by Yoon et al. [18]. In this 13-item scale, three items are measured using a 5-point scale (1 to 5), and 10 items are measured using a 4-point scale (1 to 4). All items use different ranges of a 4- and 5-point scale such as the different sleep time for best feeling during daytime, length of sleep, and “1 = not at all” to “4 = very” for easiness, alertness, and tiredness. Total scores range from 13 to 55. Scores of ≥ 41 represent the morning-type pattern, scores of ≤ 26 represent the evening-type pattern, and scores of 27–40 represent the intermediate-type pattern. Lower scores indicate delayed sleep. Reliability was established using Cronbach's α , which were .78 at the time of scale development and .71 in the current study.

2) Stress

Stress was measured using a scale developed by Hong [9]. The scale consists of 27 items:

seven pertain to grade, homework, and college admission stress; seven pertain to family stress; four pertain to stress regarding looks; three pertain to socioeconomic stress (e.g., household income and insufficient allowance), and six pertain to stress regarding peer relationships. Items are measured using a 4-point scale ranging from 1 (not at all) to 4 (always true), and total scores range from 27 to 108. Higher scores indicate higher stress levels. Reliability was established using Cronbach's α , which were .91 at the time of scale development and .90 in the current study.

3) Attitudes toward menstruation

Attitudes toward menstruation were measured using the Attitude about Menstruation Scale (AMS) developed by Yang and Youn [19] which was modified for use in the current study. In the 21-item scale, items are measured using a 7-point scale ranging from 1 (not at all) to 7 (absolutely true), and total scores range from 21 to 147. Higher scores indicate attitudes of a more negative nature toward menstruation. Reliability was established using Cronbach's α , which were .83 at the time of scale development and .79 in the current study.

4) Behavior that reduces EDCs exposure

Behavior that reduces EDCs exposure was measured using a scale developed by Kang and Lee [20] and modified for use in the current study. In the 17-item scale, items are measured using a 5-point scale ranging from 1 (very true) to 5 (not at all), and total scores range from 17 to 85. Higher scores indicate greater frequency of the occurrence of behavior that reduces EDCs exposure. Reliability was established using Cronbach's α , which were .90 at the time of scale development and .70 in the current study.

5) PMS

PMS was measured using the Shortened Premenstrual Assessment Form (SPAF) developed by Allen et al. [21] and adopted by Lee et al. [22] In the 10-item scale, items were measured using a 6-point scale ranging from 1 for (no change) to 6 (very severe), and total scores range from 10 to 60. Higher scores indicate more severe PMS, and scores of ≥ 27 represent premenstrual dysphoric disorder (PMDD). Reliability was established using Cronbach's α , which were .95 at the time of scale development, .90 in the study conducted by Lee et al. [22], and .92 in the current study.

5. Data collection

Data were collected from December 11 to 30, 2018. Two hundred female students (grades 1st–3rd) attending a middle school in K city were recruited via convenience sampling. Survey completion took approximately 20 minutes, and surveys were retrieved from participants immediately after completion. Participants received a pen and drink as small gifts for participation.

6. Data analysis

The data were analyzed using SPSS 21 (IBM Corp., Armonk, NY, USA). WIN. General characteristics, menstruation-related characteristics, sleep pattern, stress, attitudes toward menstruation, behavior that reduces EDCs exposure, and PMS severity were analyzed via descriptive statistics, and differences in PMS according to general and menstruation-related characteristics were analyzed using independent t-test and one-way ANOVA, with Scheffé test performed post hoc. Correlations between sleep pattern, stress levels, attitudes toward menstruation, behavior that reduces EDCs exposure, and PMS were analyzed via Pearson's correlation coefficients, and the factors that affected PMS were analyzed using multiple regression.

RESULTS

1. Participants' general and menstruation-related characteristics

Participants' mean age was 13.9 years. In total, 66 participants were in the first grade (34.4%), 66 were in the second grade (34.4%), and 60 were in the third grade (31.2%). One hundred forty-eight students (77.1%) were nonreligious. 120 (62.5%) participants were normal weight, and 45 (23.4%) were underweight. In addition, 85 participants (44.3%) exercised for more than 30 minutes at least 3 times per week, while 107 (55.7%) did not (**Table 1**).

Participants' mean age at menarche was 11.8 years. Regarding the length of the menstrual cycle, 85 (44.3%) participants had a 21–28-day cycle, while 63 (32.8%) had a 29–35-day cycle. Of them, 138 (71.9%) participants reported a normal amount of menstrual blood. A total of 34.4% of the students answered their menstrual pain with a score of 7–10. Among the participants, 78 (40.6%) of them stated that they used analgesics during their periods, while 114 (59.4%) did not. Furthermore, 54 participants (28.1%) reported a family history of PMS, while 138 (71.9%) did not (**Table 1**).

Table 1. Different in General and Menstruation Related Characteristics of PMS

(N=192)

Variables	Characteristics	Categories	n(%)	M±SD	PMS		
					M±SD	t or F	p
General characteristics	Age (year)			13.92±0.80			
	Grade	First	66 (34.4)		22.90±10.86	2.13	.121
		Second	66 (34.4)		25.89±12.19		
		Third	60 (31.2)		27.28±13.56		
	Religion	Yes	44 (22.9)		25.37±12.38	0.14	.885
		No	148 (77.1)		25.06±12.11		
	BMI	Underweight	45 (23.4)		23.82±10.49	0.53	.590
		Normal group	120 (62.5)		25.53±12.20		
		Overweight	27 (14.1)		26.74±15.32		
	Exercise	Yes	85 (44.3)		25.18±12.26	-0.11	.909
	No	107 (55.7)		25.39±12.36			
Menstruation related characteristics	Menarche age (year)	9–10	10 (5.2)	11.89±0.94	28.20±15.92	0.36	.900
		11	53 (27.6)		25.83±11.65		
		12	83 (43.3)		25.55±12.92		
		13	40 (20.8)		23.72±11.50		
		14–15	6 (3.1)		22.83±8.95		
	Menstrual cycle (day)	<21 ^a	26 (13.5)		28.46±13.06	3.49	.017 [†] (a,b>c)
		21–28 ^b	85 (44.3)		26.81±12.39		
		29–35	63 (32.8)		24.06±12.34		
		≥36 ^c	18 (9.4)		17.94±6.43		
	Amount of menstrual bleeding	Low	10 (5.2)		24.40±11.76	7.26	.001 [†] (a<b)
		Medium ^a	138 (71.9)		23.45±11.12		
		Heavy ^b	44 (22.9)		31.29±14.13		
	Severity of menstrual pain (VAS)	0–3 ^a	77 (40.1)	4.66±2.824	19.12±8.96	37.19	<.001 [†] (a<b<c)
		4–6 ^b	49 (25.5)		23.26±9.59		
		7–10 ^c	66 (34.4)		34.01±12.51		
Use of analgesics during menstruation	No ^a	114 (59.4)		21.20±9.90	-6.09	<.001 [†] (a<b)	
	Yes ^b	78 (40.6)		31.29±13.01			
Family history of PMS	Yes ^a	54 (28.1)		31.05±13.42	4.23	<.001 [†] (a>b)	
	No ^b	138 (71.9)		23.05±11.07			

M±SD=mean±standard deviation; PMS=premenstrual syndrome; BMI=body mass index; VAS=visual analogue scale.

[†]Scheffé test.

2. Participants' sleep pattern, stress, attitudes toward menstruation, behavior that reduces EDCs exposure, and PMS

In total, 9 (4.7%), 152 (79.2%), and 31 (16.1%) students had morning-, intermediate-, and evening-type sleep pattern. Lower scores indicate delayed sleep, and the mean with standard deviation of sleep score was 31.50 ± 5.46 out of 55 (**Table 2**).

The mean scores for school related stress were highest (1.90 ± 0.60), followed by those for stress regarding family (1.75 ± 0.60) and appearance (1.75 ± 0.66). Scores for stress regarding friend relationships were lowest (1.21 ± 0.38), and the mean stress score was 44.21 ± 11.42 out of 108 (**Table 2**). The mean score for attitudes toward menstruation were 72.33 ± 14.67 out of 147. The mean score for behavior that reduces EDCs exposure was 56.57 ± 7.65 out of 85. The mean scores for PMS were 25.30 ± 12.28 out of 60 for the non-PMDD ($n=118$, 61.5%) and PMDD ($n=74$, 38.5%) groups (**Table 2**).

3. Differences in PMS according to general and menstruation-related characteristics

There were significant differences in PMS according to the length of the menstrual cycle ($F=3.49$, $p=.017$), the amount of menstrual bleeding ($F=7.26$, $p=.001$), the severity of menstrual pain ($F=37.19$, $p<.001$), use of analgesics during menstruation ($t=-6.09$, $p<.001$), and a family history of PMS ($t=4.23$, $p<.001$). PMS was more severe when the length of the menstrual cycle was <21 days or 21–28 days long, relative to that observed when it was ≥ 36 days. Further, PMS was more severe in girls with heavy menstrual bleeding, relative to that observed in girls with normal menstrual bleeding. PMS was most severe for those with menstrual pain scores of 7–10, followed by those of 4–6 and 0–3. In addition, PMS was more severe for those who used analgesics during menstruation and those who reported a family history of PMS (**Table 1**).

4. Correlations between sleep pattern, stress, attitudes toward menstruation, behavior that reduces EDCs exposure, and PMS

PMS was significantly negatively correlated with sleep pattern ($r=-.15$, $p=.037$) and behavior that reduces EDCs exposure ($r=-.26$, $p<.001$) but was positively correlated with stress ($r=.24$, $p=.001$). In other words, girls experienced more severe PMS with lower amounts of sleep, less frequent occurrence of behavior that reduces EDCs exposure, and higher levels of stress (**Table 3**).

Table 2. Degree of Sleep Pattern, Stress, Attitudes toward Menstruation, Behavior That Reduces EDCs Exposure and PMS

(N=192)

Variables	Sub categories	n(%)	Possible range	Min–Max	M±SD	Item M±SD
Sleep pattern	Morning	9 (4.7)	41–55			
	Intermittent	152 (79.2)	27–40			
	Evening	31 (16.1)	13–26			
	Total		13–55	16–50	31.50±5.46	
Stress	School-related stress		7–28	7–25	13.30±4.23	1.90±0.60
	Family-related stress		7–28	7–27	12.27±4.22	1.75±0.60
	Appearance related stress		4–16	4–16	7.01±2.65	1.75±0.66
	Economic stress		3–12	3–11	4.31±1.75	1.43±0.58
	Friends related stress		6–24	6–21	7.31±2.32	1.21±0.38
	Total		27–108	27–83	44.21±11.42	1.57±0.49
Attitudes toward menstruation			21–147	36–122	72.33±14.67	3.01±1.29
Behavior that reduces EDCs exposure			17–85	33–79	56.57±7.65	3.35±0.82
PMS	Non-PMDD	118 (61.5)	10–26	10–26	17.09±5.06	1.41±0.55
	PMDD	74 (38.5)	27–60	27–57	38.39±8.45	3.83±0.84
	Total		10–60	10–57	25.30±12.28	2.45±1.53

M±SD=mean±standard deviation; EDC=endocrine disrupting chemical; PMS=premenstrual syndrome; PMDD=premenstrual dysphoric disorder.

Factors Affecting Premenstrual Syndrome in Adolescents

Table 3. Correlation of Variables

(N=192)

Variables	Sleep pattern	Stress	Attitudes toward menstruation	Behavior that reduces EDCs exposure	PMS
	r (p)	r (p)	r (p)	r (p)	r (p)
Sleep pattern	1				
Stress	-.20 (.004)	1			
Attitudes toward menstruation	-.11 (.106)	.20 (.005)	1		
Behavior that reduces EDCs exposure	.31 (<.001)	-.14 (.039)	-.23 (.001)	1	
PMS	-.15 (.037)	.24 (.001)	-.03 (.619)	-.26 (<.001)	1

EDC=endocrine disrupting chemical; PMS=premenstrual syndrome.

Table 4. Factors Influencing PMS

(N=192)

Variables	B	SE	β	t	p	R ²	Adj. R ²	F (p)
(Constant)	29.75	7.90	-	3.76	<.001			
Severity of menstrual pain	7.44	1.87	.28	3.96	<.001			
Use of analgesics during menstruation [†]	4.41	1.73	.17	2.55	.011	.40	.37	15.48 (<.001)
PMS family history [†]	-4.42	1.66	-.16	-2.66	.008			
Stress	0.20	0.06	.19	3.11	.002			
Behavior that reduces EDCs exposure	-0.27	0.09	-.17	-2.83	.005			

PMS=premenstrual syndrome; B=unstandardized coefficients; SE=standard error; β =standardized coefficients; Adj. R²=adjusted coefficient of determination R²; EDC=endocrine disrupting chemical.[†]Dummy (Yes=1, No=0).

5. Factors affecting PMS

The results of the multiple regression analysis to determine factors affecting PMS, with variables confirmed in the univariate analysis (i.e., menstrual cycle, amount of menstrual bleeding, use of analgesics during menstruation, menstrual pain, family history of PMS, sleep pattern, stress, and behavior that reduces EDCs exposure) as independent variables. The results showed that severity of menstrual pain ($\beta=.28$), use of analgesics during menstruation ($\beta=.17$), family history of PMS ($\beta=-.16$), stress ($\beta=.19$), and behavior that reduces EDCs exposure ($\beta=-.17$) exerted significant effects on PMS. The data met the assumption of normality and equality of variance, and multicollinearity was not an issue, with tolerance of 0.615–0.878 and a variation inflation factor of 1.138–1.626. The regression model for PMS was significant ($F=15.48$, $p<.001$), and these variables explained 37% of the total variance (Table 4).

DISCUSSION

This study aimed to examine the relationships between sleep pattern, stress, attitudes toward menstruation, and behaviors that reduces EDCs exposure in Korean girls attending middle school and factors that affect PMS. Participants' mean age was 13.9 years, and their mean age at menarche was 11.8 years, which was similar to that observed in a previous study [23]. The most common length of the menstrual cycle, which differed significantly according to PMS, was 21–28 days (44.3%), followed by 29–35 days (32.8%), and <21 days (13.5%). These were similar to cycles reported in a previous study [24] and PMS severity increased with decreasing cycle length. Approximately 71.9% of participants reported normal menstrual bleeding, while 22.9% reported heavy menstrual bleeding, and girls with heavy bleeding experienced more severe PMS. These results were similar to those of some previous studies [25] but contradictory to those of other studies that reported that PMS was more severe in girls with light or normal menstrual bleeding [12]. Further, PMS was more severe in girls with a family history of PMS, as shown in a previous study [5]. Approximately 59.9% of the girls reported moderate-to-severe menstrual pain; this proportion was slightly higher relative to that of

girls attending middle school who experienced moderate-to-severe pain (50.6%) in a recent study [26]. Because more than half of girls attending middle school experience moderate-to-severe PMS, relevant interventions should be developed and administered.

Similar to the findings of a previous study involving high school students [27], sleep quality was moderate, with 79.2% of participants showing the intermediate-type of sleep pattern and a mean score of 31.5 (range: 13–55). However, Korean adolescents begin school earlier each day and sleep later at night as they advance in grade, relative to their foreign counterparts [13], and they are likely to lack sufficient sleep and experience poor sleep quality.

Unlike adolescents in other countries, Korean adolescents were most stressed by school grades, homework, and college admission. These were followed by family stress and stress regarding their looks. These results were similar to those of previous findings involving high school girls [9]. Fierce competition for college admission and rampant obsession with appearance induces severe stress in Korean adolescents, necessitating programs that relieve these factors. Thus, the specific programs are needed to reduce the study related stress for adolescents with severe PMS.

The mean score for behavior that reduces EDCs exposure was 56.5, which was high, as in previous studies [20]. However, a previous study examining awareness of and behavior related to EDCs in Korean students attending middle school [10] reported that the students obtained information regarding EDCs from the public media and perceived them as hazardous substances. Moreover, students with higher grades possessed greater knowledge concerning EDCs, relative to that of students with lower grades, and behavior that reduces EDCs exposure was strongly correlated with knowledge scores. Therefore, it is necessary to develop intervention programs to engage students' behaviors that reduces EDCs exposure by providing accurate knowledge for PMS prevention.

The mean PMS score was 25.30 (range: 10–60). Approximately 38.5% of participants were in the PMDD group, for which the mean PMS score was 38.39, which was similar to that shown in a previous Korean study [12]. PMDD is often neglected because its origin is uncertain and treatment is challenging. However, relevant education and support should be provided to prevent progression to PMDD and reduce discomfort.

In the current study, menstrual pain, use of analgesics during menstruation, a family history of PMS, stress levels, and behavior that reduces EDCs exposure influenced PMS. In a study involving 1,688 Korean high school girls [5], those with menstrual pain and a family history of PMS experienced PMS more frequently relative to other girls. In addition, a study involving female college students and adults [28] reported that menstrual pain and family history affected PMS, as in the current study. The association between menstrual pain and PMS has been documented extensively in the literature; therefore, effective PMS management could reduce the adverse effects of menstrual pain and discomfort on school works and daily lives in girls attending middle school. Further, as girls with a family history of PMS experienced more severe PMS, relative to those without such a history, schools should provide special management for students with this family history. A study involving 1,087 Korean students attending middle and high school [25] and a study involving female college students and adults showed that stress influenced PMS [28]. Therefore, PMS interventions for girls attending middle school should be designed in reflection of the different stressors involved. Behavior that reduces EDCs exposure also influenced PMS; this finding was similar to those

of a study involving female Korean college students [27]. EDCs vary widely in type and mechanism, and although prenatal exposure to EDCs was reported to exert a strong impact in foreign studies, studies examining the association between EDCs exposure and PMS are scarce. Further, studies examining factors related to EDCs are required in Korea, and researchers should explore the relationship between PMS and EDCs in large, diverse samples. In the current study, PMS severity increased as stress levels increased and the occurrence of behavior that reduces EDCs exposure decreased. Therefore, intervention programs that reduce PMS in Korean girls attending middle school are required.

The current study was meaningful, in that it presented the association between PMS and behavior that reduces EDCs exposure in Korean girls attending middle school. However, the findings could not be generalized to other groups, as the sample consisted of girls attending a middle school in a single region, and future studies should recruit more diverse samples to identify the factors that affect PMS including behavior that reduces EDCs exposure. Furthermore, numerous scales that measure behavior related to EDCs exposure were developed for use with adults; therefore, tools that are appropriate for adolescents should be developed. Moreover, based on these findings, additional studies should be required to develop intervention programs that reduce stress and behavior that EDCs exposure in Korean girls attending middle school.

CONCLUSION

This was a descriptive correlational study that aimed to examine the effects of sleep pattern, stress, attitudes toward menstruation, and behavior that reduces EDCs exposure on PMS in female students attending middle school. The results showed that severity of menstrual pain exerted the strongest effect on PMS, followed by use of analgesics during menstruation, a family history of PMS, stress, and behavior that reduces EDCs exposure. These variables explained 37% of the total variance. Based on the findings, we recommend that health intervention program is developed to prevent PMS for adolescents including educational information and activities for managing their stress and promoting the behaviors that reduces EDCs exposure.

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SUMMARY STATEMENT

- **What is already known about this topic?**

Previous studies stated that premenstrual syndrome (PMS) was affected by menarche age, menstruation pain, family history, attitudes toward menstruation, stress, and anxiety.

- **What this paper adds?**

In this study, it was found that behavior that reduces exposure to endocrine disrupting chemicals (EDCs) was the influencing factor in the course of adolescents' PMS.

- **Implications for practice, education, and/or policy**

The health intervention program should be developed to relieve adolescents' PMS by managing their school-related stress, providing accurate knowledge for EDCs, and promoting behavioral changes. Moreover, future researches are needed to confirm health problems related to EDCs in order to efficiently manage EDCs.