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Original Article

Direct and Indirect Effects of Stress and Self-Esteem on Primary Dysmenorrhea in Korean Adolescent Girls: A Cross-Sectional Survey Study

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Abstract

Background: Positive and negative emotions have recently revealed a link with primary dysmenorrhea in adults. Among them, roles of stress and self-esteem have been less studied specially in adolescents and the direction of causality has not been clearly established. Therefore, this study investigated whether stress and self-esteem independently affect primary dysmenorrhea after adjustment for the known risk factors in adolescents. Additionally, indirect effects of stress and self-esteem were determined using mediation analyses.

Methods: This survey was conducted in adolescent girls aged 15-18 yr in metropolitan regions in South Korea in 2021. The survey included general, menstrual, and lifestyle characteristics, menstrual pain and symptom, perceived stress, self-esteem, depression, and state-trait anxiety.

Results: Stress, depression, and anxiety were associated positively with menstrual pain and symptom (all $P<0.001$) in adolescent girls (n=519). Self-esteem was also associated inversely with negative emotions and dysmenorrhea (all $P<0.001$). Additionally, stress independently affected frequency and severity of menstrual symptom (both $P<0.05$), but not pain intensity after adjustment for covariates. Stress also had indirect effect through depression and anxiety on menstrual pain and symptom. Effect of self-esteem vanished after adjustment for covariates, but indirectly reduced menstrual pain and symptom through mediations of stress, depression, and anxiety.

Conclusion: Mental health such as stress and self-esteem are important for managing menstrual pain and symptom in adolescents. It should be considered in managing dysmenorrhea.

Keywords: Dysmenorrhea; Adolescents; Self-esteem; Stress; Anxiety; Depression

Introduction

Many adolescent girls experience pain and associated symptoms during the menstrual period (dysmenorrhea) (1). A recent meta-analysis study reported that the overall prevalence of dysmenorrhea was 72.5% in teenage girls (1). In the adolescent population, primary dysmenorrhea, which is developed without pelvic pathology, is more common compared to secondary dysmenorrhea, which occurs due to pathological disorders (i.e., endometriosis) (2,3). Pharmacological treatments, including painkillers, nonsteroidal anti-inflammatory drugs, and hormonal contraceptive

pills are the first-choice treatments (4). However, many women reported ineffectiveness of medications for dysmenorrhea (29.3%-49.9%) (5). Therapy and exercise were more effective than analgesics for pain relief in women with primary dysmenorrhea (6).

Several risk factors, including biological (e.g., family history of dysmenorrhea, early age of the menarche, long period time, and heavier menstrual flow), lifestyle, and psychosocial factors, have been reported to affect dysmenorrhea (2,7). Negative emotions and pain could influence each other and form a vicious circle (8). Recently, a few but a growing number of studies have reported that negative emotions like depression, anxiety, and stress are risk factors for primary dysmenorrhea in adults (3,7,9) although it is not clear whether negative emotions cause or exacerbate menstrual pain or vice versa (10).

In adolescents, very few studies have investigated the effects of negative emotions, especially the effect of stress on dysmenorrhea (10-13). Previous studies in adolescents had some limitations and did not evaluate the effect of stress on dysmenorrhea. The severity and frequency of menstrual symptoms are correlated with stress, depression, and anxiety in Chinese adolescents (12). Other studies simply reported higher perceived stress levels in adolescent girls with dysmenorrhea compared to those without dysmenorrhea (10) and a positive relationship between the severity of symptoms of posttraumatic stress disorder and severity of dysmenorrhea measured by an unclarified scale (13). Stress was the best predictor of menstrual distress in Korean middle-school girls, but they did not clarify the kind of stress scale used (11). Moreover, the stress effect on dysmenorrhea disappeared after controlling for other risk factors in women aged 15-25 years (14). Thus, more studies about the effect of stress on adolescent dysmenorrhea seem to be needed.

Young women with dysmenorrhea had lower self-esteem compared to those without dysmenorrhea (15). Level of self-esteem changes throughout the lifespan along with maturational changes and surrounding environments (16,17). The average level of self-esteem is high in childhood, dropped in adolescence, but then continues to rise from adolescence to middle adulthood (16,17). Therefore, it is plausible that self-esteem might be one of the psychological factors related to dysmenorrhea in adolescents. To the best of our knowledge, the relationship of self-esteem with dysmenorrhea and its effect on dysmenorrhea have not yet been investigated in children and adolescents. In addition, we hypothesized that self-esteem could indirectly affect dysmenorrhea through negative emotions. To maintain mental health, it is important to have healthy self-esteem (16). The buffering hypothesis suggests that high self-esteem attenuates the effects of negative emotion (18).

The primary purpose of this study was to investigate whether stress independently affects dysmenorrhea after controlling for other dysmenorrhea-related factors in adolescent girls. We also identified the indirect effects of stress on dysmenorrhea through depression and anxiety using mediation analyses. The secondary purpose of the study was to determine the effect of self-esteem on dysmenorrhea in adolescent girls. Likewise, we examined whether self-esteem has an independent effect on dysmenorrhea and whether the effect of self-esteem would be mediated by negative emotions.

Methods

Study Design

The survey was conducted at high schools in Gyeonggi-do South Korea in 2021, during which time lockdowns and restrictions were given due to the COVID-19 pandemic.

Ethical approval for this study was obtained from the Institutional Review Board of Kyonggi University (KGU-20210222-HR-065-03). All participants and their parents provided written informed consent.

Participants

Participants with or without primary dysmenorrhea aged 15 to 18 yr were recruited. Moreover, 600 questionnaires were distributed, and 549

questionnaires were returned. Participants were given chocolate ($2) for their time and effort. Participants were excluded for the following reasons: incomplete survey (n=42); missing data (n=26); having gynecologic and obstetric diseases and mental disorders (n=17) including polycystic ovary syndrome, endometrial polyp, retroflexion of the uterus, bacterial vaginosis, irregular bleeding, depression, psychiatry, thyroid disease, precocious puberty, and unidentified disease. Finally, 519 adolescent girls were included in the data analysis.

Measurement Instruments

Menstrual pain and symptom

The intensity of menstrual pain was measured by a visual analog scale (VAS). Frequency and severity of menstrual symptom experienced during the most recent menstruation were evaluated using the Korean version of Cox menstrual symptom scale (CMSS) (19).

General, menstrual, and lifestyle characteristics

General and menstrual characteristics are presented in Table 1. For the regression analysis, the following variables were recategorized: family history of dysmenorrhea (no history or unknown *vs.* having history); length of menstrual cycle (≤35 d vs. >35 d); volume of menstrual fluid (light-to-moderate vs. heavy); period length (≤ 7 d vs. >7 d).

Lifestyle characteristics included weekly frequency of caffeinated beverage consumption, days of breakfast eaten, smoking (current or past smoker *vs.* non-smoker), drinking (current drinker *vs.* non-drinker), number of sports clubs participated, moderate-to-vigorous exercise (moderate intensity more than 60 min or vigorous intensity more than 20 min), and weekly sedentary time (Table 1). For the regression analysis, sedentary time (≥25th percentile *vs.* <25th percentile) and eating breakfast (skipping breakfast *vs.* eating breakfast ≥1day) were recategorized.

Self-esteem

Self-esteem was measured using the Korean version of the Rosenberg self-esteem scale (20). The reliability and validity of the Korean version of the Rosenberg self-esteem scale were acceptable (21).

Stress

Stress level was measured using the Korean version of perceived stress scale (PSS) 10 items (22). The reliability and validity of the Korean version have been well-established (23).

Depression

Depression was assessed using the Korean version of Center for Epidemiologic Studies Depression Scale (CES-D) (24). The Korean version of the CES-D had good concurrent validity and construct validity and high internal consistency in Korean adolescents (25).

Anxiety

Anxiety was measured using the Korean version of the state-trait anxiety inventory (STAI) form Y. The STAI evaluates the current state of anxiety (state anxiety) and anxiety proneness as a relatively stable personality trait (trait anxiety) (26). The reliability and validity of the Korean version have been well-established (27).

Statistical Analyses

All data was analyzed using SPSS (ver. 24.0, IBM SPSS Statistics, Armonk, NY, USA). Statistical significance was set at $P<0.05$ for all analyses. To identify participant characteristics, participants were divided into 3 groups according to VAS: no pain (VAS=0), mild pain (0<VAS<3), moderate-to-severe pain (3≦VAS). The significance of difference among groups was tested by chi-square test and one-way analysis of variance (ANOVA) with Scheffé post-hoc tests. To assess the association between psychological variables and menstrual variables, Pearson correlation analyses were performed.

Table 1: Participant characteristics

Variables	*Categories*	*No pain (N=32)* †	*Mild pain (N=90)* ‡	*Moderate/severe pain (N=397)*§	*P*
Age (yr)		16.1±0.9	16.2±0.8	16.2±0.8	0.993
Body mass index (kg/m²) ¶		19.4± 2.1	20.4±2.5	20.0±3.0	0.319
Intensity of menstrual pain		0.0±0.0***	1.6±0.9***	6.9±1.6***	0.000***
Severity of menstrual symptoms		2.5±3.0***	7.6±7.2*	19.6±10.1***	0.000***
Frequency of menstrual symptoms		3.3±3.1***	8.7±7.6	22.2±12.1***	0.000***
Menarcheal age	< 12 yr	6 (18.8)	27 (30.0)	114 (28.7)	0.449
	≥ 12 yr	26 (81.3)	63 (70.0)	283 (71.3)	
Period regularity	Regular	22 (68.8)	53 (58.9)	207 (52.1)	0.122
	Irregular	10 (31.3)	37 (41.1)	190 (45.7)	
Length of menstrual cycle	≤20 d	1 (3.1)	2 (2.2)	24 (6.0)	0.632
	21-35 d	28 (87.5)	78 (86.7)	330 (83.1)	
	> 35 d	3 (9.4)	10 (11.1)	43 (10.8)	
Volume of menstrual fluid	Light	6 (18.8)	23 (25.6)	27 (6.8)	0.000***
	Moderate	24 (75.0)	61 (65.7)	261 (66.7)	
	Heavy	2 (6.3)	6 (27.5)	109 (22.5)	
Period length	1-3 d	1 (3.1)	4 (4.4)	15 (3.8)	0.565
	4-7 d	24 (75.0)	77 (85.6)	329 (82.9)	
	> 7 d	7 (21.9)	9 (10.0)	53 (13.4)	
Family history of dysmenorrhea	No	13 (40.6)	36 (40.0)	144 (36.3)	0.355
	Yes	12 (37.5)	24 (26.7)	148 (37.3)	
	Unknown	7 (21.9)	30 (33.3)	105 (26.4)	
Smoking	No	30 (93.8)	87 (96.7)	373 (94.0)	0.591
	Yes	2 (6.3)	3 (3.3)	24 (6.0)	
Drinking	No	25 (78.1)	78 (86.7)	311 (78.3)	0.201
	Yes	7 (21.9)	12 (13.3)	86 (21.7)	
Eating breakfast	None	6 (18.8)	17 (18.9)	92 (23.2)	0.172
	1-3 d/wk	2 (6.3)	19 (21.1)	86 (21.7)	
	4-7 d/wk	24 (75.0)	54 (60.0)	219 (55.2)	
Caffeine consumption	None	20 (62.5)	36 (40.0)	147 (37.0)	0.017*
	≥1 time/wk	12 (37.5)	54 (60.0)	250 (63.0)	
Exercise	No	29 (90.6)	82 (91.1)	366 (92.2)	0.909
	Yes	3 (9.4)	8 (8.9)	31 (7.8)	
Participation in sports clubs	None	21 (65.6)	63 (70.0)	290 (73.0)	0.594
	≥1 club	11 (34.4)	27 (30.0)	107 (27.0)	
Sedentary time		83.7±25.7	79.7±23.7	80.2±21.7	0.671
≤ 65 hours per week		6 (18.8)	24 (26.7)	94 (23.7)	0.652
≥ 65 hours per week		26 (81.3)	66 (73.3)	303 (76.3)	
Perceived stress		16.7±5.8***	18.2±5.2	21.4±6.0***	0.000***
Self-esteem		22.2±5.8***	20.0±5.5	17.8±6.1**	0.000***
Depression		9.7±7.8***	14.2±7.1	19.14±10.6***	0.000***
State anxiety		36.1±11.5***	40.0±9.0	45.7±10.8***	0.000***
Trait anxiety		37.0±11.2***	42.3±8.5	47.5±11.0***	0.000***

Data are presented as n (%) or mean ± standard deviation. ¶No pain (n=27); Mild pain (n=79). Moderate/severe pain (n=349). †Significantly different from moderate-to-severe pain group, ‡significantly different from no-pain group, and §significantly different from mild-pain group. *P<0.05, **P<0.01, ***P<0.001

To identify a risk factor of dysmenorrhea, simple regression analyses were performed with VAS, CMSS frequency, and CMSS severity as the dependent variable, respectively. To find the best predictors for the dysmenorrhea, stepwise multiple regression analyses were conducted. Finally, mediation analyses with bootstrapping were carried out using the PROCESS macro (28) to test indirect effects of self-esteem and stress on dysmenorrhea through negative emotions (mediators). Schematic diagram of mediation model is presented in Fig. 1 (28).

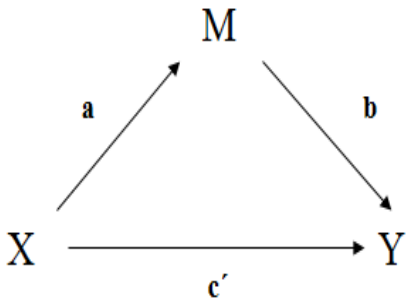

Fig. 1: Schematic diagram of mediating effects

If the 95% confidence interval (CI) of the bootstrapped estimate of the indirect effect does not include zero, indirect effect is significant indicating that mediation has occurred (28).

Mediation models use linear regression models to split the total effect, which an independent variable (X) has on a dependent variable (Y) into a direct effect, and an indirect effect via mediator (M); Total effect (c) = Direct effect (c′) + Indirect effect (a*b). The indirect effect is considered the mediating effect.

Results

As shown in Table 1, volume of menstrual fluid (P<0.001) and caffeine consumption (P<0.05) showed the significant group-difference. There were no group-differences in all other menstrual and lifestyle characteristics, age, and BMI. There were significant group-difference in VAS, CMSS, and psychological variables (all P<0.001).

State and trait anxiety, depression, and PSS exhibited positive correlations with VAS and CMSS (all P<0.001) indicating that participants with higher negative emotions had more severe menstrual pain and symptoms (Table 2). Self-esteem showed inverse correlations with dysmenorrhea (all P<0.001) showing that participants with higher self-esteem had less severe menstrual pain and symptoms.

Table 2: Bivariate correlation matrix of psychological and dysmenorrhea variables

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1. Frequency of menstrual symptoms	1	.875***	.587***	.357***	.420***	.307***	.322***	-.232***
2. Severity of menstrual symptoms		1	.607***	.379***	.479***	.351***	.382***	-.277***
3. Intensity of menstrual pain			1	.293***	.307***	.292***	.304***	-.218***
4. Perceived stress				1	.698***	.619***	.660***	-.552***
5. Depression					1	.724***	.753***	-.608***
6. State anxiety						1	.847***	-.642***
7. Trait anxiety							1	-.780***
8. Self-esteem								1

N = 519. ***P<0.001

The results of simple regression analyses showed that all psychological factors were significant predictors for VAS and CMSS (all $P<0.001$). Adolescent girls having irregular menstrual cycle ($P<0.05$) and heavy menstrual volume ($P<0.001$) and experienced menarche before 12 yr of age ($P<0.05$) had more severe menstrual pain. Family history, period length, menstrual cycle, and all lifestyle factors were not significant predictors of VAS. Period regularity, menstrual volume, menarcheal age, family history, caffeine consumption, skipping breakfast, and drinking were significant predictors for the CMSS frequency and severity ($P<0.05$, 0.01 or 0.001). Smoking was a significant predictor of the CMSS severity ($P<0.05$).

The best predictors by stepwise multiple regression analyses were presented in Table 3. Depression ($P<0.05$), trait anxiety ($P<0.01$), and menstrual volume ($P<0.001$) were significant predictors for VAS. Stress (both $P<0.05$) and depression (both $P<0.001$) significantly affect the CMSS frequency and severity after controlling for other significant factors.

Indirect effects of self-esteem and stress on dysmenorrhea through four negative emotions (mediators) were assessed using simple mediation analyses (Table 4). Partial indirect effects of self-esteem on the CMSS frequency and severity were significant when stress entered as a mediator indicating that self-esteem decreased stress, which in turn decreased the CMSS.

Table 3: Best predictors for dysmenorrhea

Best predictors	***Dysmenorrhea variables***											
	Frequency of menstrual symptom				Severity of menstrual symptom				Intensity of menstrual pain			
	B	SE	β	*P*	B	SE	β	*P*	B	SE	β	*P*
Stress	0.29	0.11	0.14	0.011*	0.19	0.09	0.10	0.044*				
Depression	0.35	0.07	0.28	0.000***	0.37	0.06	0.35	0.000***	0.04	0.02	0.15	0.019*
Trait anxiety									0.05	0.02	0.18	0.004**
Menstrual fluid	5.74	1.19	0.19	0.000***	5.31	0.98	0.20	0.000***	1.49	0.28	0.22	0.000***
Family history	2.81	1.03	0.11	0.007**	2.81	0.85	0.12	0.001**				
Skipping breakfast	3.82	1.19	0.12	0.001**	2.97	0.98	0.11	0.003**				
Caffeine consumption	2.16	1.01	0.08	0.032*								
Drinking					2.27	1.02	0.08	0.026*				
	F (6, 512) = 30.045, $P<0.001$ Adjusted R^2 = 0.252				F (6, 512) = 38.574, $P<0.001$ Adjusted R^2 = 0.303				F (3, 515) = 31.045, $P<0.001$ Adjusted R^2 = 0.148			

The entered predictors for stepwise multiple regression analyses were as follow: self-esteem, stress, depression, state anxiety, trait anxiety, age, family history, length of menstrual cycle, menstrual volume, period length, caffeine consumption, skipping breakfast, smoking, drinking, participation in sports club, moderate-to-vigorous exercise, and sedentary time. N = 519. *$P<0.05$, **$P<0.01$, ***$P<0.001$

Table 4: Indirect effects of self-esteem and stress

Dependent variable (Y)	*Independent Variable (X)*	*Mediator (M)*	*Total effect (c)*	*Direct effect (c')*	*Indirect effect (a*b)*	*Confidence Interval of indirect effect*		*Mediation*
						Lower bound	Upper bound	
Frequency of menstrual symptom	Self-esteem	Stress	-0.490***	-0.107***	-0.383	-0.506	-0.260	Partial
		Depression	-0.490***	0.077	-0.567	-0.720	-0.424	Full
		State anxiety	-0.490***	-0.127	-0.363	-0.523	-0.216	Full
		Trait anxiety	-0.490***	0.098	-0.588	-0.807	-0.378	Full
	Stress	Self-esteem	0.754***	0.695***	0.059	-0.062	0.177	No
		Depression	0.754***	0.264*	0.491	0.316	0.679	Partial
		State anxiety	0.754***	0.573***	0.182	0.047	0.317	Partial
		Trait anxiety	0.754***	0.543***	0.212	0.058	0.369	Partial
Severity of menstrual symptom	Self-esteem	Stress	-0.500***	-0.177*	-0.323	-0.432	-0.222	Partial
		Depression	-0.500***	0.041	-0.540	-0.673	-0.132	Full
		State anxiety	-0.500***	-0.158	-0.342	-0.472	-0.219	Full
		Trait anxiety	-0.500***	0.094	-0.594	-0.782	-0.415	Full
	Stress	Self-esteem	0.684***	0.587***	0.098	-0.002	0.202	No
		Depression	0.684***	0.156	0.528	0.372	0.686	Full
		State anxiety	0.684***	0.472***	0.213	0.100	0.332	Partial
		Trait anxiety	0.684***	0.406***	0.278	0.144	0.416	Partial
Intensity of menstrual pain	Self-esteem	Stress	-0.102***	-0.038	-0.064	-0.09	-0.037	Full
		Depression	-0.102***	-0.024	-0.079	-0.107	-0.050	Full
		State anxiety	-0.102***	-0.026	-0.078	-0.113	-0.044	Full
		Trait anxiety	-0.102***	0.022	-0.125	-0.178	-0.073	Full
	Stress	Self-esteem	0.137***	0.116***	0.021	-0.005	0.047	No
		Depression	0.137***	0.072**	0.065	0.029	0.102	Partial
		State anxiety	0.137***	0.085**	0.052	0.023	0.083	Partial
		Trait anxiety	0.137***	0.077**	0.061	0.027	0.096	Partial

Note: $N = 519$. $^{*}P<0.05$, $^{**}P<0.01$, $^{***}P<0.001$

Stress completely mediated the relationship between self-esteem and VAS. Additionally, the effects of self-esteem on the CMSS and VAS were completely mediated by depression and anxiety. Stress had direct effect on dysmenorrhea and simultaneously indirectly affected dysmenorrhea through depression and anxiety. Interestingly, there were no indirect effects of stress on dysmenorrhea mediated by self-esteem.

Discussion

Although both negative and positive emotions are known to be associated with dysmenorrhea in adults (3,7,9,15), it has been less studied in adolescents. Among them, stress and self-esteem may play important roles on adolescent dysmenorrhea, but their roles are unclear. Furthermore, compared to other lifespans, adolescents have high stress and low self-esteem (16,17,29). It led us to investigate the effects of stress and self-esteem on adolescent dysmenorrhea. For a better understanding, our study examined the effects of stress and self-esteem on adolescent dysmenorrhea using multi-perspective approaches, including correlation analysis, multiple regression analysis controlling for other dysmenorrhea-related factors to determine their independent effects, and mediation analysis to find out indirect effects through other psychological factors.

This study aimed to determine whether stress affected dysmenorrhea (i.e., VAS and the CMSS frequency and severity) after controlling for covariates and whether stress indirectly affected dysmenorrhea through depression and anxiety. The majority of the previous studies have reported that depression, anxiety, and stress are correlated with dysmenorrhea although conflicting evidences exist (9). The main limitation of previous studies in terms of determining psychological risk factors of dysmenorrhea is the lack of focus on the causal effect of negative emotions on dysmenorrhea. Correlation does not determine causality and correlation between X and Y could mean that its direction of causality is bidirectional (18).

Our results of multiple regression analyses showed that stress independently affected the CMSS frequency and severity but not VAS after controlling for other risk factors. The strongest predictor of menstrual symptom was depression. Menstrual volume was the strongest predictor of the VAS followed by trait anxiety and depression. According to mediation analyses, stress had indirect effects on dysmenorrhea through state-trait anxiety and depression. Stress increases anxiety and depression and then aggravates menstrual pain and symptom.

Increases in depression and anxiety are known to lead to increased perception of pain (30). Stress is known to be associated with depression and anxiety (31,32). Similarly, in our results depression and anxiety were correlated with stress. Depression and anxiety acted as mediators in the relationship between stress and dysmenorrhea.

Besides the effect of stress on dysmenorrhea, we examined the effect of self-esteem on adolescent dysmenorrhea while simultaneously accounting for other dysmenorrhea-related factors (i.e., negative emotions, menstrual factors, and lifestyle factors). Our results revealed that self-esteem had a significant effect on dysmenorrhea showing the inverse association. However, after controlling for other factors of dysmenorrhea, effect of self-esteem vanished. Our results of mediation analyses showed that self-esteem decreases depression and anxiety, which in turn reduces menstrual pain and symptom. Similarly, stress was also the mediator in the causal pathway between self-esteem and dysmenorrhea.

Our results imply that self-esteem acts as a buffer against negative emotions and thus ameliorates dysmenorrhea. Indeed, high self-esteem operates as a buffer against stress (18). BarciKowska et al (15) recently reported that young Polish women with dysmenorrhea had lower self-esteem compared women without dysmenorrhea. They pointed out a need for further research about the impact of self-esteem on dysmenorrhea (15). To the best of our knowledge, our study is the first study to investigate the role of self-esteem on adolescent dysmenorrhea.

The limitation of this study is related to the cross-sectional study design, which makes causal inference complex (33). Further cohort and longitudinal studies are needed to verify our findings.

Implications for Policy and/or Practice

Negative and positive emotions can affect dysmenorrhea, interventions for psychological fac-

tors such as stress and self-esteem should be considered to manage menstrual pain and symptom. In addition, adolescent girls with dysmenorrhea should be aware of the importance of managing their mental health to reduce dysmenorrhea.

Conclusion

Self-esteem, stress, depression, and anxiety are associated with adolescent dysmenorrhea. Additionally, stress can independently aggravate menstrual symptoms and has indirect effect through depression and anxiety on menstrual pain and symptom. Self-esteem indirectly lessens dysmenorrhea by affecting stress, depression, and anxiety.

Journalism Ethics Considerations

Ethical issues (Including plagiarism, informed-consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interests.

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