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# The Relationship between Endocrine Disruptor Exposure Behavior and Premenstrual Syndrome in Female College Students

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***Abstract***

*This study aimed to investigate the relationship between endocrine disruptor exposure behaviour and Premenstrual Syndrome (PMS) in female college students, focusing on the extent of exposure, demographic variations, and correlations between these variables. Endocrine disruptors, which interfere with hormonal balance, are present in various daily-use materials and have been linked to reproductive health issues. This study aimed to provide insights for health education programs by examining how exposure influences PMS symptoms. Data were collected from 160 female college students through a structured questionnaire, with 157 valid responses included in the analysis. A descriptive, cross-sectional design was utilized, and data were analyzed using SPSS 25.0, employing ANOVA and Pearson correlation techniques. Results showed that the mean scores for endocrine disruptor exposure behaviour and PMS were 2.72 and 2.08, respectively, indicating moderate exposure and mild PMS symptoms. A statistically significant positive correlation was identified between the two variables ($r = 0.196$, $p = 0.014$). Notably, PMS severity was higher among analgesic participants ($t = 2.243$, $p = 0.026$). These findings highlight that higher exposure to endocrine disruptors is associated with more severe PMS symptoms. The study underscores the importance of reducing exposure to endocrine disruptors through behavioural changes and incorporating this knowledge into reproductive health education. Such efforts could alleviate PMS discomfort, improve the quality of life, and raise awareness among young women in their childbearing years. Further research is recommended to validate these findings across diverse populations and regions.*

***Keywords:*** *Female college student, Premenstrual syndrome, Endocrine disruptor exposure behavior*

## 1. Introduction

Premenstrual syndrome refers to a combination of physical, emotional, or behavioural symptoms that can interfere with daily life, appearing about 2 to 10 days before menstruation (sulphur period after ovulation) and then disappearing just before or after menstruation. More than 150-200 known symptoms are reported, and 80% of fertile women experience premenstrual syndrome, 5-10% of which are reported to be severe enough to interfere with their daily lives [1]. Symptoms were found to be severe by age, followed by female college students, middle-aged women, and high school students [2]. Premenstrual Syndrome (PMS) in female college students reduces academic efficiency and causes personal and social

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problems such as cheating, crime, or suicide in schools [3]. It affects the quality of life of physical, mental, and social health and health awareness [4]. Female college students have a relatively longer menstrual life than older women and tend to tolerate their premenstrual symptoms rather than treatment due to prejudice against single women's visits to obstetrics. Therefore, managing and studying premenstrual symptoms is more important than any age group [5].

Endocrine disruptors are substances that interfere with the normal functioning of the endocrine system, also called environmental hormones. They are mainly known as bisphenols, Polychlorinated Biphenyls (PCB), dioxin from incinerators, alkylphenols, plasticizers, and Styrofoam by-products such as styrene dimers and trimmers used in cup noodle containers [6]. Some substances are known to cause reproductive dysfunction and deformities in wild animals or humans through natural food chains and are reported to cause cancer in the breast and reproductive organs of a girl, endometriosis, uterine fibroma, and fibrous cytoplasm in the breast [7]. Endocrine disruptors are introduced into the human body through various processes, such as food-containing substances, food packaging materials, and containers related to dietary habits. They can be considered an influential factor for premenstrual syndrome [8]. Endocrine disruptors are already deeply embedded in our lives, so it is quite challenging to fundamentally block human inflow, so efforts should be made to minimize exposure.

Therefore, this study aims to identify the degree of the endocrine disruptor’s exposure behaviour and pre-menstrual syndrome of female college students and the relationship between the two variables. It will provide essential data for developing health education programs to form healthy habits and ease the discomfort of female college students during menstrual periods.

The specific purpose of this study is as follows:

1) Identify the degree of the endocrine disruptor’s exposure behaviour and premenstrual syndrome of study participants.
2) Identify the differences in the endocrine disruptors' exposure behaviour and premenstrual syndrome of study participants according to general characteristics.
3) Identify the relationship between the endocrine disruptors' exposure behaviour and the premenstrual syndrome of study participants.

## 2. Literature Review

Research on endocrine disruptor exposure and Premenstrual Syndrome (PMS) has expanded, focusing on this relationship's physiological, behavioural, and environmental dimensions. This review organizes relevant literature into three themes: endocrine disruptor exposure, PMS characterization, and their interrelationship.

Endocrine disruptors, including bisphenols, phthalates, and dioxins, are pervasive in consumer products and the environment, interfering with hormonal regulation [9]. Studies in the United States have demonstrated a strong correlation between higher exposure levels and reproductive health complications, such as hormonal imbalances and infertility [10]. Other research emphasizes behavioural factors influencing exposure, such as dietary habits and the use of plastic containers [11]. These findings underline the importance of raising awareness about reducing exposure, yet studies often overlook the unique vulnerabilities of young women during their reproductive years.

PMS encompasses a spectrum of physical, emotional, and behavioural symptoms that disrupt daily life, varying in severity across age groups. A U.K.-based study identified PMS as a significant factor affecting academic and social functioning among female students [12]. Theories such as the hormonal fluctuation hypothesis suggest that cyclic estrogen and progesterone changes trigger PMS symptoms [13]. However, gaps remain in understanding non-hormonal contributors, such as environmental toxins.

Emerging research connects endocrine disruptor exposure with heightened PMS severity. A Canadian study found elevated bisphenol A levels correspond to intensified PMS symptoms [14]. Similarly, data from Australian researchers reveal that endocrine disruptors may exacerbate symptoms through estrogenic and anti-estrogenic activity [15]. While these findings are compelling, they are limited by sample homogeneity, often excluding diverse demographic and regional contexts.

Methodologically, most studies utilize cross-sectional designs and self-reported measures, which provide valuable insights but may introduce bias [16]. Experimental approaches, such as bio-monitoring endocrine disruptor levels, could enhance validity but remain underexplored. Furthermore, longitudinal designs could better capture the long-term impact of exposure on PMS [17].

Despite growing evidence, significant gaps persist in the literature. Few studies examine the behavioural determinants of endocrine disruptor exposure specific to young women. Additionally, there is a limited exploration of how cultural and regional variations influence PMS severity. This study addresses these gaps by focusing on female college students, a demographic often overlooked but particularly susceptible to both endocrine disruptors and PMS. This research contributes to developing targeted health education programs by integrating behavioural and physiological data.

The reviewed literature underscores the relevance of examining the intersection of endocrine disruptor exposure and PMS severity. Although current research provides a strong foundation, further work is needed to explore diverse populations, apply advanced methodologies, and develop effective interventions. This study builds on these insights to inform health promotion efforts for young women in their reproductive years.

## 2. Materials and Methods

This study used a descriptive, cross-sectional design and self-reported questionnaire to identify the relationship between the endocrine disruptor's exposure behaviour and premenstrual syndrome among female college students. The subjects of this study were female students attending three universities located in Canada who agreed to participate voluntarily after hearing the explanation of the purpose and procedures of the study. To collect data, the researcher was required to prepare a structured questionnaire after explaining the purpose and method of research in the classroom and obtaining consent from students who wanted to participate in the study. The data collection period was from April 3, 2019, to April 20, 2019. One hundred fifty-seven out of 160 cases were used for the final analysis, except for three cases with uncertain responses.

The collected data was analyzed using the IBM SPSS (IBM Corp., Armonk, NY, USA) Statistics for Windows, version 25.0. The participants' general characteristics were analyzed using descriptive statistics, and the degree of exposure to endocrine disruptors and Premenstrual Syndrome (PMS) were analyzed using the average and standard deviation.

Differences in exposure behaviour and premenstrual syndrome according to the general characteristics were analyzed with one-way ANOVA and independent t-test. Pearson correlation analysis was performed to investigate the relationship between two variables.

Endocrine disruptor exposure behaviour was measured using behavioural tools to reduce exposure to environmental hormones that Kim Mi-ra and Kim Hyo-Jung developed. The scale consists of a 23-item questionnaire scored using a Likert scale ranging from 1 (never) to 5 (always). All questions were reversed except for questions 17 and 22; the higher the scores indicated, the more the endocrine disruptors were exposed. Endocrine disruptor exposure behaviour was divided into high risk for 5 and 4 points (70 to 115 points), medium risk for 3 points (47 to 69 points), and low risk for 1 point and 2 points (23 to 46 points). The Cronbach's α for this study was .778. MDQ (Menstrual Discomfort Questionnaire), developed by Moss (1968), was used. MDQs are questionnaires that classify premenstrual symptoms and indicate 47 negative symptoms that can measure each degree. Pain (6 questions), concentration (8 questions), behaviour change (5 questions), autonomic reaction (4 questions), water retention (5 questions), negative affect (8 questions), arousal (5 questions), and control (6 questions) make up a total of 47 questions in 8 areas. The symptoms were measured at “Not at all” 1 point, “Not weak” 2 points, “There are symptoms, but there is no disruption to activity,” 3 points, “It interferes with activity.” 4 points and ‘is not active.’ 5points. A higher score indicated a severe level of premenstrual symptoms. The risk classification of premenstrual syndrome was classified as low-risk groups for 1 to 94 points, medium-risk groups for 95 to 141 points, and high-risk groups for 142 points or more. The Cronbach's α for this study was .971.

## 3. Results

### 3.1. General characteristics

Table 1. General and menstrual-related characteristics (N=157)

| | | N(%) or Mean(±SD) |
|---|---|---|
| | | 21.44 ±3.65 |
| Age | ≤ 20 | 47(29.7) |
| | ≥ 21 | 111(70.3) |
| | 1st | 50(31.8) |
| | 2nd | 48(30.6) |
| Grade | | |
| | 3rd | 14(8.9) |
| | 4th | 45(28.7) |
| Menarche Age | | 13.29±1.297 |
| | ≤24days | 13(8.3) |
| | 25~35days | 25~35days |
| Menstrual cycle | | |
| | ≥36days | 4(2.5) |
| | irregular | 44(28.7) |
| | ≤3days | 6(4.0) |
| | 4~6days | 122(77.0) |
| Menstrual Period | | |
| | ≥7days | 26(16.0) |
| | etc | 3(3.0) |
| | Yes | 36(22.9) |
| Use of analgesics | | |
| | No | 121(77.1) |

Table 1 shows the general characteristics and subjects related to menstruation. The average age of the subjects was 21.44 years old, followed by 50 in the first grade (31.8%), 45 in the fourth grade (28.7%), 48 in the second grade (30.6%), and 14 in the third grade (8.9%). The average age of menarche was 13.3 years old, and the period of the menstrual cycle was the most with 94 (60.5%) on the 25th to 35th days, the least with 4 days (2.5%) on the 36th day, and the duration of menstruation was 122 with 4-6th days (77.0%), 26 (16.0%) over 7 days, and 6 (4. 0%) within 3 days. 121 people (77%) answered that they did not take the drug when asked if they would take pain medications during menstruation.

### 3.2. Mean score of the endocrine disruptor exposure behaviour and premenstrual syndrome

The average endocrine disruptor exposure behaviour score was 2.72 and the risk was 3.28 in the high-risk group, 2.59 in the normal group, and 1.95 in the low-risk group. The average score for the premenstrual syndrome was 2.08 points presented in Table 2.

Table 2. The mean score of endocrine disruptor exposure behaviour and premenstrual syndrome (N=157)

| Variables | N(%) | Mean±SD | Minimum value | Maximum value |
|---|---|---|---|---|
| endocrine disruptive exposure behaviour | | 2.72±.43 | 1.83 | 3.78 |
| High (≥ 70 score) | 40(25.5) | 3.28±.21 | 3.04 | 3.78 |
| Medium (47 ~ 69 score) | 107(68.2) | 2.59±.27 | 2.04 | 3.00 |
| Low (≤ 46 score) | 10(3.3) | 1.95±.04 | 1.83 | 2.00 |
| premenstrual syndrome | | 2.08±.76 | 1.00 | 4.23 |

### 3.3. Differences in endocrine disruptor exposure behaviour and premenstrual syndrome of endocrine disorders according to general and menstrual-related characteristics

Table 3. Differences in research variables according to general characteristics (N=157)

| endocrine disruptive exposure | | | | premenstrual syndrome | |
|---|---|---|---|---|---|
| | | M±SD | F(p) /t(p) | M±SD | M±SD |
| Age | ≤ 20 | 2.70±.39 | -.400 | 1.98± .70 | -.970 |
| | ≥ 21 | 2.73±.45 | (.689) | 2.11± .79 | (.333) |
| | 1st | 2.74±.39 | | 2.06±.74 | |
| Grade | 2nd | 2.72±.44 | .097 | 2.07± .81 | .409 |
| | 3rd | 2.76±.46 | (.962) | 1.89± .73 | (.747) |
| | 4th | 2.70±.47 | | 2.14± .76 | |
| | 24↓ | 2.57±.51 | | 2.26± .98 | |
| Menstrual cycle | 25-35 | 2.72±.42 | 1.202 | 2.09± .73 | .619 |
| | 36↑ | 2.50±.72 | (.311) | 1.80± .77 | (.604) |
| | irregular | 2.79±.42 | | 1.99± .78 | |
| | 3↓ | 2.50±.66 | | 1.77± .77 | |
| Menstrual Period | 4-6 | 2.73±.41 | 1.261 | 2.04± .74 | .986 |
| | 7 | 2.70±.46 | (.986) | 2.26± .78 | (.401) |
| | irregular | 3.10±.43 | | 2.29± 1.45 | |
| Medication | Yes | 2.79±.47 | 1.065 | 2.32± .80 | 2.243 |
| | No | 2.70±.42 | (.289) | 2.00± .74 | (.026) |

There was no statistically significant difference in the endocrine disruptor exposure behaviour according to the subjects' general characteristics and the menstrual-related characteristics. In the case of premenstrual syndrome, there was a statistically significant difference in the presence or absence of analgesics (t=2.243, p=.026) shown in Table 3.

### 3.4. Relationship between endocrine disruptor exposure behaviour and premenstrual syndrome

There was a statistically significant difference in premenstrual syndrome according to the risk of exposure behaviour of endocrine disruptors (F=5.273, p=.006) as seen in table 4. Also, as a result of correlation analysis between the exposure behaviour of endocrine disruptors and premenstrual syndrome, there was a statistically significant statistical correlation (r=.234, p=.003). The correlation was shown in Table 5.

Table 4. Differences in premenstrual syndrome according to risk of endocrine disruptive exposure (N=157)

| endocrine disruptive exposure | | | | |
|---|---|---|---|---|
| premenstrual syndrome | High risk | Medium risk | Low risk | F(p) |
| | M±SD | M±SD | M±SD | |
| premenstrual syndrome | 2.40±.89 | 1.96±.69 | 1.93±.63 | 5.23(.006) |

Table 5. Relation of endocrine disruptor exposure behaviors and premenstrual syndrome (N=157)

| | premenstrual syndrome |
|---|---|
| endocrine disruptor exposure behaviour | .234<br>(.003) |

## 4. Discussion

The mean score of exposure behaviour of the endocrine disruptors in this study was 2.72 on average. It was found to be higher than 2.68 in Khan et al study [18] for college students and lower than 3.22 in Buckley et al study [8] and 2.81 points in the study by Abousoliman and Ibrahim [6], which surveyed nursing students. This result was supported by Halbreich et al study [19], which reported that female college students had a significantly higher risk of exposure to disorders than female high school students (X2=32.978, p<.001). This is due to the increased awareness of environmental hormones, but the possibility of exposure to environmental hormones has increased due to changes in lifestyle in modern society. Agrochemicals, dioxins, bisphenol A, alkylphenols, phthalates, styrene, and other endocrine disruptors come deep into our lives through various foods, incinerators, furniture, electronic products, plastic containers, receipts, synthetic detergent cup ramen containers, etc. Therefore, it is time to be alert to these harmful substances.

It is known that the endocrine disruptors affect the reproductive system, the thyroid gland, and the pituitary gland, thus acting like estrogen or acting as anti-estrogen and affecting genital health. The average score of premenstrual syndrome experienced by the subjects in this study was 2.08 points, compared to 2.67 points from Jung, et al [20] using the same MDQ scale, and 2.75 points from Kim Hyun-young and Kim Sang-nam [21]. It was low, and it was higher than the score of 1.7, which was the result of Chomiock and Mi [22]. In the sub-area, behavioural change was the highest, with 2.70 points, and the arousal area was the lowest, with 1.49 points, consistent with the findings of Chrisler et al [23]. In the studies of Jung, Oh, Choi [20] and Chomiock et al [22], the scores for the areas of pollination and pain

were high, which is different from the results of this study. This is because the symptoms of premenstrual syndrome are a very subjective experience, so different results may appear in situations where it is challenging to ensure homogeneity between the study subject and the study method. As a result of verifying the difference in premenstrual syndrome according to general characteristics and menstrual-related characteristics, there was a difference in the use of analgesics, and the group taking the drug was found to experience more symptoms of premenstrual syndrome. As a result of examining the relationship between exposure behaviours of endocrine disruptors and premenstrual syndrome, we showed statistically significant differences in premenstrual syndrome according to the risk of endocrine disruptor exposure behaviour. Also, there was a significant positive correlation between endocrine disruptor exposure behaviour and premenstrual syndrome. This was consistent with the findings of Halbreich et al., [19], who reported that premenstrual syndrome scores increased as exposure behaviours increased. It was found to support the results of Sung-hee Lee et al., [24], who revealed that endocrine disruptor exposure behaviour influences premenstrual syndrome in female college students.

## 5. Conclusion

This study explored the relationship between endocrine disruptor exposure behaviour and Premenstrual Syndrome (PMS) among female college students, addressing an important yet underexplored aspect of women's health. The findings demonstrated a significant positive correlation between the degree of endocrine disruptor exposure and the severity of PMS symptoms, with participants experiencing greater exposure reporting more pronounced discomfort. This underscores the role of environmental factors, alongside hormonal changes, in influencing PMS symptoms.

By examining behavioural determinants of exposure to endocrine disruptors, the study highlights the importance of awareness and education in mitigating health risks associated with these substances. These insights contribute to the development of targeted health education programs aimed at young women, who represent a vulnerable group due to their higher lifetime exposure to hormonal fluctuations. This study is a foundation for promoting preventive strategies and healthier behavioural patterns, particularly in managing PMS symptoms and improving reproductive health outcomes.

However, the research faced limitations, including the use of self-reported data, which may introduce recall or social desirability bias, and a cross-sectional design that limits causal interpretations. Additionally, the sample was geographically confined to universities in Busan, which may restrict the generalizability of the findings to broader or more diverse populations. Future research should employ longitudinal studies to examine long-term exposure effects, integrate bio-monitoring methods for more precise exposure measurement, and investigate cultural and regional variations in exposure and PMS severity.

The study highlights the urgent need for interdisciplinary efforts involving healthcare providers, educators, and policymakers to address the pervasive influence of endocrine disruptors. It is possible to mitigate their impact on reproductive health by fostering awareness and encouraging proactive behavioural changes. As endocrine disruptors continue to infiltrate daily life, a collective commitment to reducing exposure is essential to ensure healthier futures for young women and future generations.

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