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Associations of Physical Activity and Smoking Status with Primary Dysmenorrhoea in Young Women: A Cross-Sectional Study

Genç Kadınlarda Primer Dismenore ile Fiziksel Aktivite ve Sigara Kullanım Durumu Arasındaki İlişkiler: Kesitsel Bir Çalışma

Buket Şeran[1], Onur Akman[2], Kamber Kaşali[3]

[1] Department of Coaching, Faculty of Sports Sciences, Erzurum Technical University, Erzurum, Türkiye
[2] Department of Recreation, Faculty of Sports Sciences, Gazi University, Ankara, Türkiye
[3] Department of Biostatistics and Medical Informatics, Faculty of Medicine, Atatürk University, Erzurum, Türkiye

ABSTRACT

Primary dysmenorrhoea is a common and important gynaecological complaint among women of reproductive age that may adversely affect daily activities and quality of life. This study aimed to investigate the associations of physical activity level and smoking status with menstrual pain severity among young women. This cross-sectional study included 177 women aged 18-30 years who had regular menstrual cycles (21-35 days, ±7 days) and no history of childbirth or miscarriage. Menstrual pain severity was assessed using a 10-cm Visual Analogue Scale (VAS), based on the maximum pain experienced during the previous three menstrual cycles. Physical activity level was determined using the International Physical Activity Questionnaire–Short Form (IPAQ-SF). Participants who reported smoking regularly for at least six months were classified as regular smokers. Women reporting higher physical activity levels had lower menstrual pain scores, and the difference across physical activity groups was statistically significant ($p < 0.001$). Although smokers had higher VAS scores than non-smokers across all physical activity groups, the difference reached statistical significance only in the moderate-physical-activity group (6.00 ± 1.00 vs. 5.00 ± 1.00; $p = 0.009$). The differences observed in the low- and high-physical-activity groups were not statistically significant ($p = 0.059$ and $p = 0.219$, respectively). The findings indicate an inverse cross-sectional association between self-reported physical activity level and menstrual pain severity. However, the association between smoking status and menstrual pain was not consistent across physical activity groups and should be interpreted cautiously.

Keywords: Primary dysmenorrhoea, menstrual pain, physical activity, smoking.

ÖZET

Primer dismenore, üreme çağındaki kadınlarda yaygın görülen ve günlük aktiviteler ile yaşam kalitesini olumsuz etkileyebilen önemli bir jinekolojik yakınmadır. Bu çalışma, genç kadınlarda fiziksel aktivite düzeyi ve sigara kullanım durumunun menstrüel ağrı şiddeti ile ilişkisini incelemeyi amaçlamıştır. Kesitsel olarak tasarlanan çalışmaya, düzenli menstrüel sikluslara sahip (21-35 days, ±7 gün), 18-30 yaş aralığında ve doğum veya düşük öyküsü bulunmayan toplam 177 kadın katılmıştır. Menstrüel ağrı şiddeti, önceki üç menstrüel siklusta yaşanan maksimum ağrı esas alınarak 10 cm'lik Görsel Analog Skala (VAS) ile değerlendirilmiştir. Fiziksel aktivite düzeyi, Uluslararası Fiziksel Aktivite Anketi Kısa Formu (IPAQ-SF) kullanılarak belirlenmiştir. En az altı ay boyunca düzenli olarak sigara kullandığını bildiren katılımcılar düzenli sigara içicisi olarak sınıflandırılmıştır. Daha yüksek fiziksel aktivite düzeyi bildiren kadınların menstrüel ağrı skorlarının daha düşük olduğu görülmüş ve fiziksel aktivite grupları arasındaki fark istatistiksel olarak anlamlı bulunmuştur ($p<0,001$). Sigara içen kadınların VAS skorları tüm fiziksel aktivite gruplarında sigara içmeyenlerden daha yüksek olmakla birlikte, bu farklılık yalnızca orta düzey fiziksel aktivite grubunda istatistiksel anlamlılığa ulaşmıştır (6,00 ± 1,00'a karşı 5,00 ± 1,00; $p<0,009$). Düşük ve yüksek fiziksel aktivite gruplarında gözlenen farklılıklar istatistiksel olarak anlamlı değildir (sırasıyla $p<0,059$ ve $p<0,219$). Bulgular, öz bildirime dayalı fiziksel aktivite düzeyi ile menstrüel ağrı şiddeti arasında ters yönlü kesitsel bir ilişki bulunduğunu göstermektedir. Sigara kullanım durumu ile menstrüel ağrı arasındaki ilişki ise fiziksel aktivite grupları arasında tutarlı değildir ve dikkatli yorumlanmalıdır.

Anahtar kelimeler: Primer dismenore, menstrüel ağrı, fiziksel aktivite, sigara kullanımı

Corresponding author: Onur AKMAN
Department of Recreation, Faculty of Sports Sciences, Gazi University, Ankara, Türkiye
E-mail: akman.onur@gazi.edu.tr **ORCID ID:** 0000-0001-5157-7430
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1. Introduction

Dysmenorrhea is defined as painful menstruation resulting from excessive uterine contractions caused by prostaglandins (Tyas et al., 2023), and when it occurs in the absence of any underlying pelvic pathology, it is referred to as primary dysmenorrhea (Dawood, 2006; Karout et al., 2021; Lee & Park, 2015). Dysmenorrhea is quite common among adolescent girls and women of reproductive age, with prevalence reported to range from 50% to 90% (Parra-Fernández et al., 2020; Ishikura et al., 2024; Kazama et al., 2015; Sultan et al., 2012). The pain is usually felt in the lower abdominal region, but it can also spread to the back and thighs (Daley, 2008). However, symptoms such as nausea, vomiting, headache, dizziness, fatigue, and diarrhoea may also accompany it (Fernández-Martínez et al., 2018). These symptoms can negatively impact work and school performance, as well as quality of life (Alonso & Coe, 2001; Ju et al., 2014; Karout et al., 2021; Qin et al., 2020). Furthermore, a meta-analysis found that 20.1% of individuals experiencing dysmenorrhea missed school or university, while 40.9% reported adverse effects on their academic performance and concentration (Armour et al., 2019).

Numerous risk variables influence primary dysmenorrhea (Iacovides et al., 2015; Wang et al., 2022). In women, factors like a familial history of dysmenorrhoea, early menarche, irregular menstrual cycles, nulliparity, and psychological stress, anxiety, and depression elevate the risk of dysmenorrhoea (Fernández-Martínez et al., 2018; Hyun & Kim, 2025). Moreover, modifiable environmental lifestyle factors, including smoking, alcohol intake, dietary habits, and levels of physical activity, may also correlate with primary dysmenorrhea (Ju et al., 2014; Iacovides et al., 2015).

Physical activity, a significant environmental lifestyle factor, is recognized for elevating endorphin levels (Gleeson et al., 2011; Triwahyuningsih et al., 2024), modulating progesterone and estrogen synthesis, and promoting the production of endogenous anti-inflammatory agents (Steinberg & Sykes, 1985; Liguori et al., 2023; Tyas et al., 2023). This is believed to alleviate the intensity of menstruation discomfort by decreasing inflammation (Harber & Sutton, 1984). Consistent physical exercise may function as a non-specific analgesic by enhancing pelvic blood circulation and promoting the production of beta-endorphins (Tyas et al., 2023; Zheng et al., 2024). Recent years have witnessed a growing interest in the potential analgesic effects of physical activity on dysmenorrhea. Evidence indicates that inactive women endure more intense menstrual symptoms. Nevertheless, the findings in the literature are not quite consistent; certain studies indicate that low levels of physical activity correlate with more severe dysmenorrhea (Matthewman et al., 2018), whereas others report no such correlation (Hyun & Kim, 2025).

Smoking has been suggested as a potentially modifiable factor associated with primary dysmenorrhoea (Qin et al., 2020; Karout et al., 2021). Proposed biological mechanisms include nicotine-induced vasoconstriction, which may reduce uterine blood flow and increase myometrial contractions, potentially contributing to menstrual pain. However, the relationship between smoking and dysmenorrhoea remains inconsistent across studies (Qin et al., 2020).

Although physical activity level and smoking status have each been investigated in relation to primary dysmenorrhoea, evidence regarding their associations with menstrual pain across different physical activity levels remains limited. In particular, the potential adverse association between smoking and primary dysmenorrhoea has not been sufficiently examined according to physical activity level. Therefore, this study aimed to investigate the associations of physical activity level and smoking status with primary dysmenorrhoea severity and to compare menstrual pain scores between smokers and non-smokers across different physical activity levels.

2. Method

2.1. Research Model

This study adopted a cross-sectional, correlational quantitative research design to examine the associations of physical activity level and smoking status with menstrual pain severity and duration at a single time point, without any experimental intervention. Therefore, causal inferences cannot be drawn from the findings, and the observed relationships should be interpreted as associations rather than cause-and-effect relationships.

2.2. Samples

An a priori sample-size calculation was performed using G*Power 3.1 (Faul et al., 2009), based on the proportions reported by Chua et al. (2020). With expected proportions of 23% and 7% (effect size = 0.465), 80% power, and a two-sided significance level of 5%, the minimum required sample size was 172 participants. The final analysis included 177 women aged 18–30 years.

Participants were recruited from female students at a single university via convenience sampling, and data were collected through a self-administered online questionnaire created with Google Forms. Participants were eligible if they had regular menstrual cycles (21-35 days, with cycle-to-cycle variation of no more than seven days) (Masuda & Okada, 2023), had no history of childbirth or miscarriage, and provided written informed consent (Kirmizigil & Demiralp, 2020). Women who self-reported a history of endometriosis, adenomyosis, uterine fibroids, pelvic inflammatory disease, ovarian disorders, or any other gynaecological condition associated with secondary dysmenorrhoea were excluded from the study. Menstrual pain severity was assessed as an outcome, and participants were not selected according to the presence or severity of menstrual pain. Eligibility and gynaecological history were based on self-reported information; no clinical or ultrasonographic assessment was performed.

Before data collection, all participants were informed about the study's purpose and procedures, and written informed consent was obtained. Ethical approval was obtained from the Atatürk University Faculty of Sport Sciences Ethics Committee (Approval No. E-70400699-050.02.04-2400244758; 31 July 2024). The study was conducted in accordance with the principles of the 2013 Declaration of Helsinki.

2.3. Data Collection

Data were collected using a structured self-report questionnaire developed by the researchers, informed by the relevant literature. The questionnaire included items assessing participants' sociodemographic characteristics (e.g., age and smoking status), menstrual characteristics (e.g., age at menarche), and general health-related information.

Physical activity level was assessed using the short form of the International Physical Activity Questionnaire (IPAQ-SF). The IPAQ-SF assessed self-reported physical activity over the previous 7 days. Total physical activity was calculated as metabolic equivalent minutes per week (MET-min/week) by multiplying the duration (minutes) and frequency (days) of each activity category using standard MET values (3.3 for walking, 4.0 for moderate-intensity activity, and 8.0 for vigorous-intensity activity), in accordance with the IPAQ scoring protocol and the Compendium of Physical Activities (Ainsworth et al., 2011). Based on total MET-minutes per week values, participants were classified into low, moderate, or high physical activity levels according to established IPAQ guidelines (IPAQ, 2005; Healey et al., 2020; Sağlam et al., 2010). The validity and reliability of the Turkish version of the IPAQ-SF were established by Sağlam et al. (2010).

Moderate physical activity was defined as: (a) vigorous-intensity activity for at least 20 minutes per day on three or more days; (b) moderate-intensity activity or walking for at least 30 minutes per day on five or more days; or (c) any combination of activities on five or more days achieving at

least 600 MET-min/week. High physical activity was defined as: (a) vigorous-intensity activity on at least three days achieving at least 1500 MET-min/week or (b) any combination of activities on seven or more days achieving at least 3000 MET-min/week. Participants who did not meet the criteria for the moderate or high categories were classified as having low physical activity.

Menstrual pain intensity was assessed using a 10-cm Visual Analogue Scale (VAS), ranging from 0 (no pain) to 10 (worst pain imaginable) (Kanda et al., 2002). Participants were asked to report the maximum level of pain experienced during their last three menstrual cycles to reflect habitual menstrual pain rather than momentary discomfort. In line with previous research, VAS scores were categorised as none-to-mild (0-3), moderate (4-6), or severe (7-10) menstrual pain (Aktaş, 2015; Parra-Fernández et al., 2020).

Smoking status was assessed via self-report, and participants were classified as regular smokers if they had been smoking consistently for at least six months prior to participation, consistent with previous studies (Chen et al., 2023; Kuo et al., 2025).

2.4. Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA). According to the variable type, data were presented as mean, standard deviation, median, minimum, maximum, frequency, and percentage. The normality of continuous variables was evaluated using the Shapiro–Wilk and Kolmogorov–Smirnov tests, together with Q–Q plots and skewness and kurtosis values. For comparisons between two independent groups, the independent-samples *t*-test was used for normally distributed data; otherwise, the Mann–Whitney U test was applied. Pearson's chi-square test was used for categorical data when the expected cell frequencies were greater than five. Yates' continuity-corrected chi-square test was used when the expected cell frequencies ranged between three and five, whereas Fisher's exact test was used when the expected cell frequencies were below three. The Fisher–Freeman–Halton test was used for categorical tables larger than 2 × 2 when the expected frequency in one or more cells was less than five. Analysis of covariance (ANCOVA) was used to examine differences in the dependent variables across physical activity levels, adjusting for age and age at menarche. All statistical tests were two-sided, and the level of statistical significance was set at $p < 0.05$.

3. Results

Categories	LLPA		MLPA		HLPA		Chi-Square	P	Effect Size (η^2, %95 CI)	Age (years) ANCOVA	Age at Menarche (years) ANCOVA
	$\bar{X}$ ± SD	Med (Min-Max)	$\bar{X}$ ± SD	Med (Min-Max)	$\bar{X}$ ± SD	Med (Min-Max)					
Age (years)	22±3.00	21(18-30)	23± 3.00	23(18-30)	23.00± 3.00	23(18-30)	9.0	0.011	0.039 (0.000-0.103)		
Age at Menarche (years)	12±1.00	12(11-15)	13± 1.00	13(11-19)	13.00± 1.00	13(11-19)	16.387	<0.003	0.085 (0.018-0.165)	<0.001	
Height (cm)	166±7.00	168(146-175)	165± 7.00	167(146-174)	165.00 ± 6.00	167(151-175)	1.565	0.457	0.004 (0.000-0.030)	0.824	0.634
Body Weight (kg)	55.00±9.00	55(45-90)	55± 7.00	56(44-80)	58.00± 9.00	56(45-90)	2.767	0.251	0.017 (0.000-0.065)	0.316	0.109

Categories	LLPA		MLPA		HLPA		Chi-Square	P	Effect Size (η^2, %95 CI)	Age (years) ANCOVA	Age at Menarche (years) ANCOVA
	$\bar{X}$ ± SD	Med (Min-Max)	$\bar{X}$ ± SD	Med (Min-Max)	$\bar{X}$ ± SD	Med (Min-Max)					
BMI (kg/m2)	20.26±3.53	19.84(15.57-33.87)	20.38±2.60	19.98(15.55-31.25)	21.31±3.53	20.30(15.3-33.87)	5.648	0.059	0.022 (0.000-0.074)	0.246	0.054
VAS Pain Score	8.00±1.00	8(3-10)	6.00±1.00	6(2-8)	3.00±1.00	3(0-6)	126.667	<0.001	0.713 (0.642-0.760)	<0.001	<0.001
Pain Duration (days)	3.00±1.00	3(1-4)	2.00±1.00	2(1-4)	2.00±1.00	2(1-3)	61.669	<0.002	0.227 (0.122-0.323)	<0.001	<0.001

LLPA: low level of physical activity; MLPA: moderate level of physical activity; HLPA: high level of physical activity; Chi-Square: χ^2=Kruskal Wallis Chi-Square test value; η^2: effect size; CI: confidence interval; ANCOVA: analysis of covariance; SD: standard deviation. Statistically significant at p < 0.05.

Figure 1. Menstrual pain severity and pain duration according to physical activity level. (A) Menstrual pain score assessed using the Visual Analogue Scale. (B) Number of painful days during menstruation.

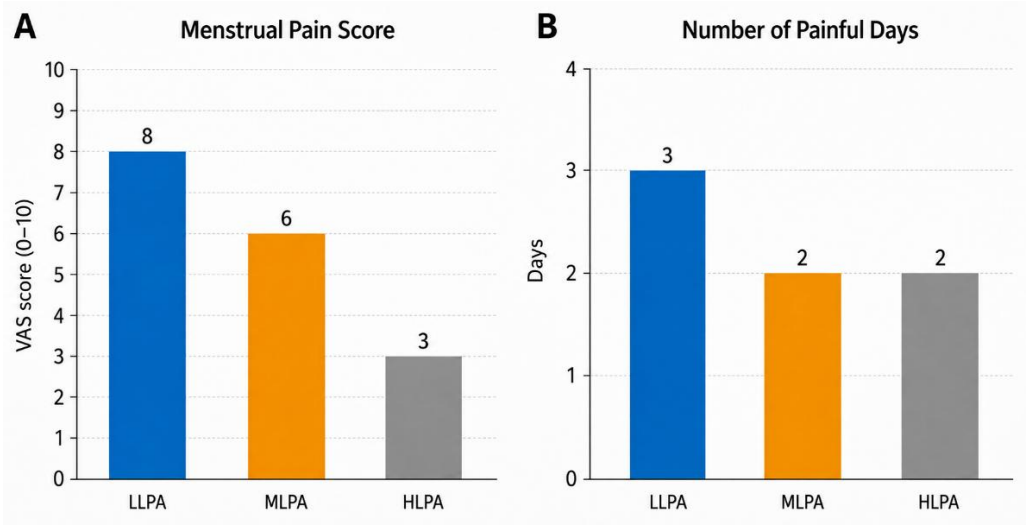


Table 2. Menstrual Pain Intensity (VAS Scores) by Smoking Status Within Physical Activity Levels

Categories	Smoking Status	$\bar{X}$ ± SD	Med (Min-Max)	p-value
LLPA	**Smokers (n=33)**	8.00 ± 1.00	8.00 (7.00-10.00)	0.059[U]
	Non-smokers (n=11)	7.00±2.00	7.00 (3.00- 10.00)	
MLPA	**Smokers (n=30)**	6.00 ±1.00	6.00 (3.00-8.00)	0.009 [U*]
	Non-smokers (n=37)	5.00 ±1.00	5.00 (2.00-7.00)	
HLPA	**Smokers (n=8)**	4.00 ±1.00	4.00 (2.00-6.00)	0.219[U]
	Non-smokers (n=58)	3.00 ±1.00	3.00 (0.00-6.00)	

*LLPA:low level of physical activity; MLPA: moderate level of physical activity; HLPA: high level of physical activity; U: Mann-Whitney U Test; SD: Standard deviation: *: Statistical significant p<0.05.*

When menstrual pain severity was compared between smokers and non-smokers within each

physical activity level, smokers in the low-physical-activity group had higher VAS scores than non-smokers (8.00 ± 1.00 vs. 7.00 ± 2.00); however, the difference was not statistically significant (p = 0.059). Among participants with moderate physical activity, smokers had significantly higher VAS scores than non-smokers (6.00 ± 1.00 vs. 5.00 ± 1.00; p = 0.009). Smokers in the high-physical-activity group also had higher VAS scores than non-smokers (4.00 ± 1.00 vs. 3.00 ± 1.00), but the difference was not statistically significant (p = 0.219).

Table 3. Menstrual Pain Duration by Smoking Status Within Physical Activity Levels

Categories	Smoking Status	$\bar{X}$ ± SD	Med (Min-Max)	p-value
LLPA	Smokers	3.00±0.48	3.00 (2.00-4.00)	0,013 U*
	Non-smokers	3.00±1.00	3.00 (1.00-4.00)	
MLPA	Smokers	3.00±1.00	3.0 (1.00-4.00)	0,411 U
	Non-smokers	2.00±1.00	2.0 (1.00-4.00)	
HLPA	Smokers	1.00±1.00	1.0 (1.00-3.00)	0,181 U
	Non-smokers	2.00±1.00	2.0 (1.00-3.00)	

*LLPA:low level of physical activity; MLPA: moderate level of physical activity; HLPA: high level of pysical activity; U: Mann-Whitney U Test; SD: Standard deviation: *: Statistical significant p<0.05.*

Among women with low physical activity, the distribution of pain duration differed significantly between smokers and non-smokers (p = 0.013), although both groups had the same mean and median pain duration. This finding should therefore be interpreted cautiously. No statistically significant differences were observed in the moderate- or high-physical-activity groups (p = 0.411 and p = 0.181, respectively).

Table 4. Distribution of Menstrual Pain Severity Categories by Physical Activity Level

Categories		LLPA N (%)	MLPA N (%)	HLPA N (%)	p-value
Dysmenorrhea	**None-to-mild**	2 (4.5%)	7 (10.4%)	61 (92.4%)	<0.001 χ^2*
	Moderate	2 (4.5%)	39 (58.2%)	5 (7.6%)	
	Severe	40(90.9%)	21 (31.3%)	0 (0.0%)	

Menstrual pain severity was classified based on Visual Analogue Scale (VAS) scores as none-to-mild (0–3), moderate (4–6), and severe (7–10). LLPA: low level of physical activity; MLPA: moderate level of physical activity; HLPA: high level of physical activity; χ^2: Pearson's chi-square test. Statistically significant at p<0.05.

When the relationship between participants' physical activity levels and menstrual pain severity was evaluated, statistically significant differences were observed between the groups (p<0.001). Among women with low physical activity, 90.9% were classified as having severe menstrual pain, whereas only 4.5% were classified as having none-to-mild pain. Among women with moderate physical activity, the most common category was moderate menstrual pain (58.2%), while 31.3% were classified as having severe pain. In contrast, 92.4% of women with high physical activity were classified as having none-to-mild pain, and none were classified as having severe pain. Overall, higher physical activity levels were associated with lower menstrual pain severity.

4. Discussion

In our study, the relationships between physical activity level, smoking status, and menstrual pain were examined. The study found that women with higher physical activity levels had lower menstrual pain scores. In addition, smokers tended to report higher VAS scores than non-smokers across all physical activity categories; however, this difference was statistically significant only in the moderate physical activity group.

Engagement in physical exercise may stimulate the release of endorphins, which can elevate the pain threshold and hence diminish discomfort (Proctor & Farquhar, 2006; Bavil et al., 2016; Chua

et al., 2020). Studies investigating the correlation between exercise and menstrual discomfort yield inconsistent results (Armour et al., 2019). Some research indicated that exercise had no impact (Hyun & Kim, 2025), whilst others demonstrated a reduction in menstrual pain. A meta-analysis indicates that consistent physical activity markedly alleviates the intensity of menstrual pain (Matthewman et al., 2018). Ayhan's study (2024) revealed a statistically significant correlation between reduced physical activity and increased dysmenorrhoea severity before and during the pandemic. Triwahyuningsih et al. (2024) identified an association between physical activity levels and dysmenorrhoea pain intensity, noting that most young women with mild pain had elevated physical activity levels. Kim et al. (2022) reported that women with regular menstrual cycles engaged in greater physical activity during the postmenstrual phase, potentially linked to reduced dysmenorrhoea symptoms and accelerated recovery. A study indicated that women with dysmenorrhoea experienced depression 1.5 times more frequently than those without dysmenorrhoea (Titilayo et al., 2009). Physical activity may influence pain perception while alleviating negative emotional states, including anxiety and depression (Valois et al., 2004; Ortiz et al., 2015). Kawabe et al. (2022) found that young women with higher physical activity levels had less severe premenstrual symptoms. Hyun & Kim (2025) discovered no statistically significant difference in pain scores between physically active and inactive women over the last three menstrual cycles. The research conducted by Blakey et al. (2010) indicated that consistent exercise may offer a possible advantage in mitigating primary dysmenorrhoea and associated symptoms. Nevertheless, they did not observe a substantial change. The discrepancies in results may stem from variations in study design or the methodology employed to assess physical activity. Because physical activity and menstrual pain were assessed at the same time, the temporal direction of this relationship cannot be established. It is also possible that women experiencing more severe menstrual pain were less able or less willing to engage in physical activity.

Smoking in women has been linked to delays in fertilisation, alterations in hormone production, early menopause, menopausal hot flashes, and spontaneous abortion due to pathological processes (Oboni et al., 2016; Jenabi et al., 2019). Research indicates that nicotine, a primary component of tobacco, may induce vasoconstriction (Jenabi et al., 2019) and diminish uterine blood flow, potentially exacerbating menstrual pain by heightening uterine muscle contractions and reducing oxygen supply (Hornsby et al., 1998; Qin et al., 2020; Kuo et al., 2025). Our findings indicate that a statistically significant difference in VAS scores based on smoking status was detected solely within the moderate physical activity group, while the differences in the low and high physical activity groups were not statistically significant. Smokers reported higher VAS scores than non-smokers within all physical activity groups. Among women with low physical activity, the distribution of pain duration differed significantly between smokers and non-smokers, although both groups had the same mean and median pain duration. Therefore, this finding should be interpreted cautiously. No statistically significant differences in pain duration were observed in the moderate- or high-physical-activity groups. The research presents contradictory findings concerning smoking status. Research indicated that smokers reported markedly lower levels of dysmenorrhoea compared to non-smokers (Andersch & Milsom, 1982). Moreover, cramps endured by women who smoke persist for a longer duration (Harlow & Park, 1996). A meta-analysis assessed the correlation between smoking and dysmenorrhoea across fourteen distinct studies, revealing a strong positive association (Jenabi et al., 2019). A study in Türkiye indicated that the risk of dysmenorrhoea was 1.6 times greater among smokers compared to non-smokers (Ozerdogan et al., 2009). Parazzini et al. (1994) indicated that the risk of dysmenorrhoea escalated dramatically with prolonged smoking duration, reaching an increase of up to 3.4 times, particularly after 9 years or more. Karout et al. (2021) similarly identified no correlation between smoking status and primary dysmenorrhoea in their research. Smoking was generally associated with higher pain scores; however, this association was not statistically significant across all physical activity groups.

Because the subgroup comparisons were exploratory and no formal interaction analysis was conducted, these findings should not be interpreted as evidence that physical activity modifies the association between smoking and menstrual pain.

5. Conclusion and Recommendations

Our study contributes by evaluating the associations of physical activity level and smoking status with menstrual pain in women. Women with higher physical activity levels reported lower menstrual pain intensity and shorter pain duration. It is particularly noteworthy that a large proportion of women with high physical activity were classified as having none-to-mild menstrual pain. Smokers reported higher VAS scores than non-smokers across all physical activity groups; however, the difference was statistically significant only in the moderate-physical-activity group. A significant difference in the distribution of pain duration was observed only in the low-physical-activity group and should be interpreted cautiously. In conclusion, higher physical activity levels were associated with lower menstrual pain severity, whereas smoking tended to be associated with less favourable pain outcomes. Because of the cross-sectional design, these findings should be interpreted as associations rather than causal effects.

6. Limitations

This study has several limitations. First, the cross-sectional design prevents causal inference. Second, physical activity levels were assessed using self-reported questionnaires, which may introduce recall bias. Future studies should incorporate objective measurement tools, such as accelerometers, to assess physical activity levels more accurately. Additionally, potential confounding factors, such as stress levels, sleep quality, and hormonal fluctuations, were not evaluated. Since only women with regular menstrual cycles and no history of childbirth were included, the generalisability of the findings may be limited. Smoking status was assessed as a binary self-reported variable, and information on smoking intensity, duration, cumulative exposure, former smoking, and the use of other tobacco products was unavailable. Therefore, potential dose–response relationships between smoking and menstrual pain could not be examined. Future longitudinal studies incorporating objective measurement methods are needed to clarify the temporal nature of the observed associations.

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REFERENCES

Aktaş, D. (2015). Prevalence and factors affecting dysmenorrhea in female university students: Effect on general comfort level. *Pain Management Nursing*, 16(4), 534-543.

Alonso, C., & Coe, C. L. (2001). Disruptions of social relationships accentuate the association between emotional distress and menstrual pain in young women. *Health Psychology, 20*(6), 411–416. https://doi.org/10.1037/0278-6133.20.6.411

Andersch, B., & Milsom, I. (1982). An epidemiologic study of young women with dysmenorrhea. *American Journal of Obstetrics and Gynecology, 144*(6), 655–660. https://doi.org/10.1016/0002-9378(82)90433-1

Armour, M., Smith, C. A., Steel, K. A., & Macmillan, F. (2019). The effectiveness of self-care and lifestyle interventions in primary dysmenorrhea: A systematic review and meta-analysis. *BMC Complementary and Alternative Medicine, 19*, Article 22. https://doi.org/10.1186/s12906-019-2433-8

Ayhan, T. Y., Bektaş, A., Büyükturan, G., Büyükturan, B., & Varol, S. (2024). Examination of the effect of the pandemic on physical activity and dysmenorrhea. *Turkish Journal of Health and Sport, 4*(1), 17–21. http://dx.doi.org/10.29228/tjhealthsport.64690

Bavil, D. A., Dolatian, M., Mahmoodi, Z., & Baghban, A. A. (2016). Comparison of lifestyles of young women with and without primary dysmenorrhea. *Electronic Physician, 8*(3), 2107–2114. https://doi.org/10.19082/2107

Blakey, H., Chisholm, C., Dear, F., Harris, B., Hartwell, R., Daley, A. J., & Jolly, K. (2010). Is exercise associated with primary dysmenorrhoea in young women? *BJOG: An International Journal of Obstetrics & Gynaecology, 117*(2), 222–224. https://doi.org/10.1111/j.1471-0528.2009.02220.x

Chen, S. J., Lu, M. Y., Lai, J. C. Y., Bair, M. J., & Cheng, H. Y. (2023). Sex and age disparities in the influence of tobacco smoking on depression: Evidence from the Taiwan Biobank. *Tobacco Induced Diseases, 21*, Article 155. https://doi.org/10.18332/tid/174643

Chua, H. N., Rajkumar Krishnan, V., & Yughdtheswari, M. (2020). A study on the prevalence of dysmenorrhea and its relationship with physical activity among young adults. *International Journal of Health Sciences and Research, 10*(10).

Critchley, H. O. D., Babayev, E., Bulun, S. E., Clark-Bilodeau, C., Foster, I. C., Goldberg, J. M., Halder, S. K., Jabbour, H. N., Knight, M. M., Kouides, P. A., Maybin, J. A., Monteleone, P. A., Praveen, A. S., Slayden, O. D., Taylor, H. S., Vollenhoven, B., & Griffith, L. G. (2020). Menstruation: Science and society. *American Journal of Obstetrics and Gynecology, 223*(5), 624–664. https://doi.org/10.1016/j.ajog.2020.06.004

Daley, A. J. (2008). Exercise and primary dysmenorrhoea: A comprehensive and critical review of the literature. *Sports Medicine, 38*(8), 659–670. https://doi.org/10.2165/00007256-200838080-00004

Dawood, M. Y. (2006). Primary dysmenorrhea: Advances in pathogenesis and management. *Obstetrics & Gynecology, 108*(2), 428–441. https://doi.org/10.1097/01.AOG.0000230214.26638.0c

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. B*ehavior Research Methods*, 41(4), 1149-1160.

Fernández-Martínez, E., Onieva-Zafra, M. D., & Parra-Fernández, M. L. (2018). Lifestyle and prevalence of dysmenorrhea among Spanish female university students. *PLOS ONE, 13*(8), Article e0201894. https://doi.org/10.1371/journal.pone.0201894

Frey-Law, L. A., Lee, J. E., Wittry, A. M., & Melyon, M. (2014). Pain rating schema: Three distinct subgroups of individuals emerge when rating mild, moderate, and severe pain. *Journal of Pain Research, 7*, 13–23. https://doi.org/10.2147/JPR.S52556

Gleeson, M., Bishop, N. C., Stensel, D. J., Lindley, M. R., Mastana, S. S., & Nimmo, M. A. (2011). The anti-inflammatory effects of exercise: Mechanisms and implications for the prevention and treatment of disease. *Nature Reviews Immunology, 11*(9), 607–615. https://doi.org/10.1038/nri3041

Harber, V. J., & Sutton, J. R. (1984). Endorphins and exercise. *Sports Medicine, 1*(2), 154–171. https://doi.org/10.2165/00007256-198401020-00004

Harlow, S. D., & Park, M. (1996). Risk factors for menstrual cramps. *British Journal of Obstetrics and Gynaecology, 103*(11), 1134–1142. https://doi.org/10.1111/j.1471-0528.1996.tb09597.x

Healey, E. L., Allen, K. D., Bennell, K. L., Bowden, J. L., Quicke, J. G., & Smith, R. (2020). Self-report measures of physical activity. *Arthritis Care & Research*, 72(5), 717–730. https://doi.org/10.1002/acr.24211

Hornsby, P. P., Wilcox, A. J., & Weinberg, C. R. (1998). Cigarette smoking and disturbance of menstrual function. *Epidemiology, 9*(2), 193–198. https://doi.org/10.1097/00001648-199803000-00016

Hyun, M., & Kim, J. (2025). Sedentary behavior and dysmenorrhea. *Healthcare, 13*(10), 1098. https://doi.org/10.3390/healthcare13101098

Iacovides, S., Avidon, I., & Baker, F. C. (2015). What we know about primary dysmenorrhoea today: A critical review. *Human Reproduction Update, 21*(6), 762–778. https://doi.org/10.1093/humupd/dmv039

International Physical Activity Questionnaire (IPAQ). (2005). *Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ)*

Ishikura, I. A., da Silva Vallim, J. R., Fernandes, G. L., Moysés-Oliveira, M., Hachul, H., Tufik, S., & Andersen, M. L. (2024). Altered sleep and diurnal consequences in women with dysmenorrhea: study from the EPISONO database. *Archives of Gynecology and Obstetrics*, 310(3), 1659-1667.

Jenabi, E., Khazaei, S., & Veisani, Y. (2019). The relationship between smoking and dysmenorrhea: A meta-analysis. *Women & Health, 59*(5), 524–533. https://doi.org/10.1080/03630242.2018.1508541

Ju, H., Jones, M., & Mishra, G. (2014). The prevalence and risk factors of dysmenorrhea. *Epidemiologic Reviews, 36*(1), 104–113. https://doi.org/10.1093/epirev/mxt009

Kanda, M., Matsuhashi, M., Sawamoto, N., Oga, T., Mima, T., Nagamine, T., & Shibasaki, H. (2002). Cortical potentials related to assessment of pain intensity with visual analogue scale (VAS). *Clinical Neurophysiology, 113*(7), 1013–1024. https://doi.org/10.1016/S1388-2457(02)00125-6

Karout, S., Soubra, L., Rahme, D., Karout, L., Khojah, H. M. J., & Itani, R. (2021). Prevalence, risk factors, and management practices of primary dysmenorrhea among university students in Lebanon. *BMC Women's Health, 21*, Article 392. https://doi.org/10.1186/s12905-021-01532-w

Kazama, M., Maruyama, K., & Nakamura, K. (2015). Prevalence of dysmenorrhea and its correlating lifestyle factors in Japanese female junior high school students. *The Tohoku Journal of Experimental Medicine*, 236(2), 107-113.

Kawabe, R., Sato, Y., Moriguchi, S., & Shiroshima, A. (2022). The relationship between high physical activity and premenstrual syndrome in Japanese female college students. *BMC Sports Science, Medicine and Rehabilitation, 14*, Article 175. https://doi.org/10.1186/s13102-022-00569-0

Kim, B. R., Kang, S., & Jeong, W.-S. (2022). The association of menstruation and leisure-time physical activity among Korean female university students: A preliminary study. *International Journal of Environmental Research and Public Health, 19*(12), 7492. https://doi.org/10.3390/ijerph19127492

Kirmizigil, B., & Demiralp, C. (2020). Functional exercise and dysmenorrhea. *Archives of Gynecology and Obstetrics, 302*(1), 153–163. https://doi.org/10.1007/s00404-020-05579-2

Kuo, C.-S., Wang, K.-T., Lai, J. C.-Y., & Chen, S.-J. (2025). Influence of tobacco smoking and alcohol drinking

on dysmenorrhoea: A cross-sectional analysis of data from the Taiwan Biobank. *BMJ Open, 15*(2), Article e088537. https://doi.org/10.1136/bmjopen-2024-088537

Lee, J. W., & Park, H. S. (2015). Menstrual pain factors. *Journal of Exercise Rehabilitation, 11*(2), 108–111. https://doi.org/10.12965/jer.150188

Liguori, F., Saraiello, E., & Calella, P. (2023). Premenstrual syndrome and premenstrual dysphoric disorder's impact on quality of life, and the role of physical activity. *Medicina, 59*(11), Article 2044. https://doi.org/10.3390/medicina59112044

Masuda, H., & Okada, S. (2023). Sleep and menstruation. *Frontiers in Global Women's Health, 4*, 1260645. https://doi.org/10.3389/fgwh.2023.1260645

Matthewman, G., Lee, A., Kaur, J. G., & Daley, A. J. (2018). *Physical activity for primary dysmenorrhea: A systematic review and meta-analysis of randomized controlled trials*. *American Journal of Obstetrics and Gynecology, 219*(3), 255.e1–255.e20. https://doi.org/10.1016/j.ajog.2018.04.001

Oboni, J. B., Marques-Vidal, P., Bastardot, F., Vollenweider, P., & Waeber, G. (2016). Impact of smoking on fertility and age of menopause: A population-based assessment. *BMJ Open, 6*(11), Article e012015. https://doi.org/10.1136/bmjopen-2016-012015

Ortiz, M. I., Cortés-Márquez, S. K., Romero-Quezada, L. C., Murguía-Cánovas, G., & Jaramillo-Díaz, A. P. (2015). Effect of a physiotherapy program in women with primary dysmenorrhea. *European Journal of Obstetrics & Gynecology and Reproductive Biology, 194*, 24–29. https://doi.org/10.1016/j.ejogrb.2015.08.008

Ozerdogan, N., Sayiner, D., Ayranci, U., Unsal, A., & Giray, S. (2009). Prevalence and predictors of dysmenorrhea among students at a university in Turkey. *International Journal of Gynecology & Obstetrics, 107*(1), 39–43. https://doi.org/10.1016/j.ijgo.2009.05.009

Parazzini, F., Tozzi, L., Mezzopane, R., Luchini, L., Marchini, M., & Fedele, L. (1994). Cigarette smoking, alcohol consumption, and risk of primary dysmenorrhea. *Epidemiology, 5*(4), 469–472. https://doi.org/10.1097/00001648-199407000-00016

Parra-Fernández, M. L., Onieva-Zafra, M. D., Abreu-Sánchez, A., Ramos-Pichardo, J. D., Iglesias-López, M. T., & Fernández-Martínez, E. (2020). Management of primary dysmenorrhea among university students in the South of Spain and family ınfluence. *International Journal of Environmental Research and Public Health*, 17(15), 5570. https://doi.org/10.3390/ijerph17155570

Proctor, M., & Farquhar, C. (2006). Dysmenorrhoea management. *BMJ, 332*(7550), 1134–1138. https://doi.org/10.1136/bmj.332.7550.1134

Qin, L. L., Hu, Z., Kaminga, A. C., Luo, B. A., Xu, H. L., Feng, X. L., & Liu, J. H. (2020). Association between cigarette smoking and the risk of dysmenorrhea: A meta-analysis of observational studies. *PLOS ONE, 15*(4), Article e0231201. https://doi.org/10.1371/journal.pone.0231201

Sağlam, M., Arıkan, H., Savcı, S., İnce, D. İ., Boşnak Güçlü, M., & Karabulut, E. (2010). International physical activity questionnaire: Reliability and validity of the Turkish version. *Perceptual and Motor Skills*, 111(1), 278–284. https://doi.org/10.2466/06.08.PMS.111.4.278-284.

Steinberg, H., & Sykes, E. A. (1985). Endorphins review. *Pharmacology Biochemistry and Behavior, 23*(5), 857–862. https://doi.org/10.1016/0091-3057(85)90083-0

Sultan, C., Gaspari, L., Paris, F. (2012). Adolescent dysmenorrhea. *Endocr Dev.,* 22, 171-180. doi: 10.1159/000331775. Epub 2012 Jul 25. PMID: 22846528.

Titilayo, A., Agunbiade, O. M., Banjo, O., & Lawani, A. (2009). Menstrual discomfort and its influence on daily academic activities and psychosocial relationship among undergraduate female students in Nigeria. *Tanzania Journal of Health Research, 11*(4), 181–188. https://doi.org/10.4314/thrb.v11i4.50173

Triwahyuningsih, R. Y., Rahfiludin, M. Z., Sulistiyani, S., & Widjanarko, B. (2024). Role of stress and physical

activity on primary dysmenorrhea: A cross-sectional study. *Narra Journal, 4*(1), Article e685. https://doi.org/10.52225/narra.v4i1.685

Tyas, E. S., Hartono, S., Wahyuni, E. S., Muhammad, H. N., Prasetya, F. I., & Sasmito, P. (2023). The effect of abdominal stretching, yoga, and dysmenorrhea exercises on prostaglandin levels and pain. *International Journal of Public Health Excellence, 3*(1), 442–449. https://doi.org/10.55299/ijphe.v3i1.734

Unsal, A., Ayranci, U., Tozun, M., Arslan, G., & Calik, E. (2010). Prevalence of dysmenorrhea and its effect on quality of life among a group of female university students. *Upsala Journal of Medical Sciences, 115*(2), 138–145. https://doi.org/10.3109/03009730903457218

Valois, R. F., Zullig, K. J., Huebner, E. S., & Drane, J. W. (2004). Physical activity behaviors and perceived life satisfaction among public high school adolescents. *Journal of School Health, 74*(2), 59–65. https://doi.org/10.1111/j.1746-1561.2004.tb04201.x

Wang, L., Yan, Y., Qiu, H., Xu, D., Zhu, J., Liu, J., & Li, H. (2022). Prevalence and risk factors of primary dysmenorrhea in students: A meta-analysis. *Value in Health, 25*(10), 1678–1684. https://doi.org/10.1016/j.jval.2022.03.023

Zheng, Q., Huang, G., Cao, W., & Zhao, Y. (2024). Comparative effectiveness of exercise interventions for primary dysmenorrhea: A systematic review and network meta-analysis. *BMC Women's Health, 24*, 610. https://doi.org/10.1186/s12905-024-03453-w