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Multidimensional Insights into the Role of Stress, Nutrition and Physical Activity in Modulating Dysmenorrheal Pathophysiology

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Abstract

Background: Dysmenorrhea, a common gynaecological condition, affects the quality of life among young women, with its severity influenced by various lifestyle factors such as stress, diet, physical activity, and hydration.

Materials and methods: A cross-sectional study involving 608 female students from various academic disciplines was carried out to examine lifestyle factors associated with dysmenorrhea. Validated questionnaires were used to evaluate dietary habits, physical activity, and stress levels. Statistical analyses, including chi-square tests, were employed to identify significant correlations between these variables and the severity of dysmenorrhea.

Results: The study found that pain was highest in students aged 18-22 years (53.45%, p = 0.409**)**, while stress worsened symptoms in 65.46% (p = 0.041)**,** mainly due to exams (18.09%) and personal issues (30.10%)**.** Exercise reduced pain (p = 0.039), especially cardio (21.38%) and flexibility training (18.09%), with short workouts (<15 min) providing the most relief (46.05%, p = 0.035)**.** Whole grains (46.76%, p = 0.043), dairy (56.87%, p = 0.041), and hydration (>2L/day, 23.03%, p = 0.038) helped alleviate symptoms**,** while high sugar intake worsened pain (39.47%, p = 0.037)**.**

Conclusion: The research has provided compelling evidence on the role of lifestyle factors in dysmenorrhoea severity, particularly stressing diet, hydration, and physical activity. Interventions such as stress management, sufficient water intake, and regular moderate exercise may help alleviate symptoms. Incorporating physical activity, balanced nutrition, and effective stress-reduction strategies could serve as practical approaches for managing dysmenorrhea among college students.

Keywords: Dysmenorrhea, Menstrual Pain, Stress, Exercise, Diet, Hydration, Academic Stress.

Introduction

Dysmenorrhea is a common gynaecological condition characterized by painful menstruation in both younger and adult women (1). The term originates from Greek, meaning "bad monthly bleeding" (2). The pain associated with dysmenorrhea is typically localized in the lower abdomen and may radiate to the inner thighs and back. As one of the most frequently reported menstrual disorders, dysmenorrhea significantly impacts daily activities, emotional well-being, and overall quality of life. There are two primary types of dysmenorrhea: primary dysmenorrhea and secondary dysmenorrhea (1). Dysmenorrhea is the leading menstrual complaint among individuals in their reproductive years and can lead to severe emotional, psychological, and health-related consequences (3). Understanding the symptoms, etiology, and management strategies for dysmenorrhea is crucial for improving the quality of life of affected individuals. Dysmenorrhea presents with a wide range of physical and psychological

symptoms. Physical symptoms include lethargy, sleep disturbances, breast tenderness, generalized body pains, appetite changes, nausea, vomiting, constipation or diarrhoea, and increased urination. Psychological symptoms primarily involve mood disturbances such as anxiety, depression, and irritability (4). Several factors contribute to the development of dysmenorrhea, including age (more common in individuals under 30 years old), attempts to lose weight, depression, longer menstrual cycles, younger age at menarche, and prolonged or heavy menstrual flow (1). Primary dysmenorrhea typically begins within two years after menarche and is most frequently diagnosed in adolescents and young adults (1). Prostaglandins (PGs) play a major role in the pathophysiology of dysmenorrhea by causing uterine contractions that lead to tissue hypoxia and ischemia, which in turn cause pain and associated symptoms such as nausea and diarrhea (5). Secondary dysmenorrhea is caused by an underlying medical condition, disorder, or structural abnormality within or outside the uterus (6). It may develop at any stage after menarche and is often associated with conditions such as endometriosis, adenomyosis, fibroids, endometrial polyps, cesarean scar niches, and intrauterine contraceptive devices (1, 5, 10, and 11). Up to 29% of individuals with dysmenorrhea may have endometriosis, and approximately 3.8% of young women exhibit reproductive tract anomalies contributing to secondary dysmenorrhea (1). The primary cause of secondary dysmenorrhea is excessive PG secretion, which increases intrauterine pressure and painful uterine contractions. Additional contributing factors include impaired uterine perfusion, ischemia, hypoxia, and metabolic byproducts from anaerobic metabolism (7). Hormonal fluctuations during menstruation also play a key role in dysmenorrhea. Decreased progesterone and estradiol levels trigger the breakdown of endometrial tissues, releasing phospholipids that are converted into arachidonic acid. The cyclooxygenase pathway converts this precursor into prostacyclins, PGs, and thromboxane-2a (8). PGF-2α and PGE2 increase uterine tone, resulting in strong contractions and increased pain sensitivity (9). Among premenopausal individuals, endometriosis and adenomyosis are leading causes of secondary dysmenorrhea (10). Additionally, chronic stress influences dysmenorrhea through activation of the hypothalamic-pituitary-adrenal (HPA) axis. Prolonged stress elevates cortisol levels, disrupting reproductive hormone balance and exacerbating menstrual pain (11). Chronic stress also heightens psychological distress and alters central pain processing, increasing pain sensitivity (12). Nutritional intake plays a significant role in managing dysmenorrhea. Vitamin E reduces uterine contractions and eases menstrual pain by blocking the release of arachidonic acid and its conversion into prostaglandins (13). Omega-3 fatty acids possess anti-inflammatory properties that reduce the production of pro-inflammatory prostaglandins, reducing menstrual cramps (14). Calcium and Vitamin D intake, particularly through dairy consumption, has been linked to a lower severity of menstrual pain. Increased consumption of fruits and vegetables, which are rich in vitamins and minerals, has been associated with decreased menstrual pain, particularly beta-carotene-rich foods (15). In contrast, diets high in fat and sugar have been correlated with increased dysmenorrhea risk due to their role in promoting inflammation and hormonal imbalances (16). Additionally, skipping breakfast and irregular meal patterns have been linked to menstrual disturbances, including dysmenorrhea, as they can affect hormonal regulation and energy balance (17). Regular physical activity serves as an effective intervention for dysmenorrhea management. Exercise stimulates endorphin release, which functions as the body's natural pain reliever, modulating pain perception and alleviating menstrual pain. Improved blood circulation through physical activity reduces uterine muscle contractions, easing cramping. Additionally, stress and anxiety reduction achieved through regular exercise indirectly mitigates menstrual pain by lowering psychological distress levels (18). Dysmenorrhea is a multifactorial condition influenced by hormonal, physiological, and lifestyle factors. A comprehensive approach incorporating dietary modifications, physical activity, and stress management is essential for effectively managing menstrual pain and enhancing the well-being of affected individuals.

Materials And Methods

To investigate the connections between nutritional intake, physical activity, and psychophysiological stress in the pathophysiology of dysmenorrhea in female college students, a six-month cross-sectional observational study was carried out across several educational institutions. The study involved 608 participants, ensuring statistical reliability in assessing lifestyle factors influencing menstrual pain. Data was gathered using a structured questionnaire that included validated scales, such as the International Physical Activity Questionnaire (IPAQ) for physical activity levels, the Food Frequency Questionnaire (FFQ) for dietary habits, and the Depression, Anxiety, and Stress Scale (DASS-21) for stress assessment. Participants included female students aged 18-30 years who experienced primary dysmenorrhea without any known gynaecological pathology and were willing to provide

informed consent. The exclusion criteria included people with gynaecological conditions like endometriosis or fibroids, people receiving hormonal contraception therapy or self-medicating for menstrual symptoms, people with chronic illnesses that affected lifestyle choices, and people who did not want to take part (19).

The study was conducted in three phases: Phase I involved defining the study scope, conducting an extensive literature review, and developing the questionnaire. Phase II included obtaining institutional permissions, recruiting participants, collecting socio-demographic data, and assessing dysmenorrhea severity along with lifestyle factors such as stress levels, dietary habits, and physical activity. Awareness sessions on stress management, nutrition, and exercise were also conducted. Phase III focused on statistical analysis and interpretation of results to establish correlations between stress, nutrition, physical activity, and dysmenorrhea severity. Statistical analysis was performed using GraphPad Prism and SPSS software, employing Chi-Square tests to assess categorical relationships, correlation analysis to determine associations between variables, and multivariate regression to identify significant predictors of dysmenorrhea risk. Ethical considerations ensured participant confidentiality and voluntary participation, and the findings were compiled into a research report with recommendations for lifestyle-based dysmenorrhea management (20).

Result

TABLE 1: EXAMINATION OF DEMOGRAPHIC VALUES AND ACADEMIC DISCIPLINES

DEMOGRAPHIC VALUE	CATEGORY	NO OF STUDENTS N = 608		STATISTS P VALUE
		MITIGATING PAIN (REDUCING PAIN	EXACERBATING PAIN (INCREASING PAIN)	
Age	Below 18	16 (2.63%)	35 (5.75%)	0.4090
	18 - 22	165(27.13%)	325(53.45%)	
	22 - 25	15 (2.46%)	46 (7.56%)	
	Above 25	3 (0.49%)	3 (0.49%)	
Academic Discipline	Medical Science	83(13.65%)	174(28.61)	0.8544
	Arts & Science	103 (16.94%)	205 (33.71%)	
	Engineering	9(1.48%)	24 (3.94%)	
	Others	4(0.65%)	6 (0.98%)	

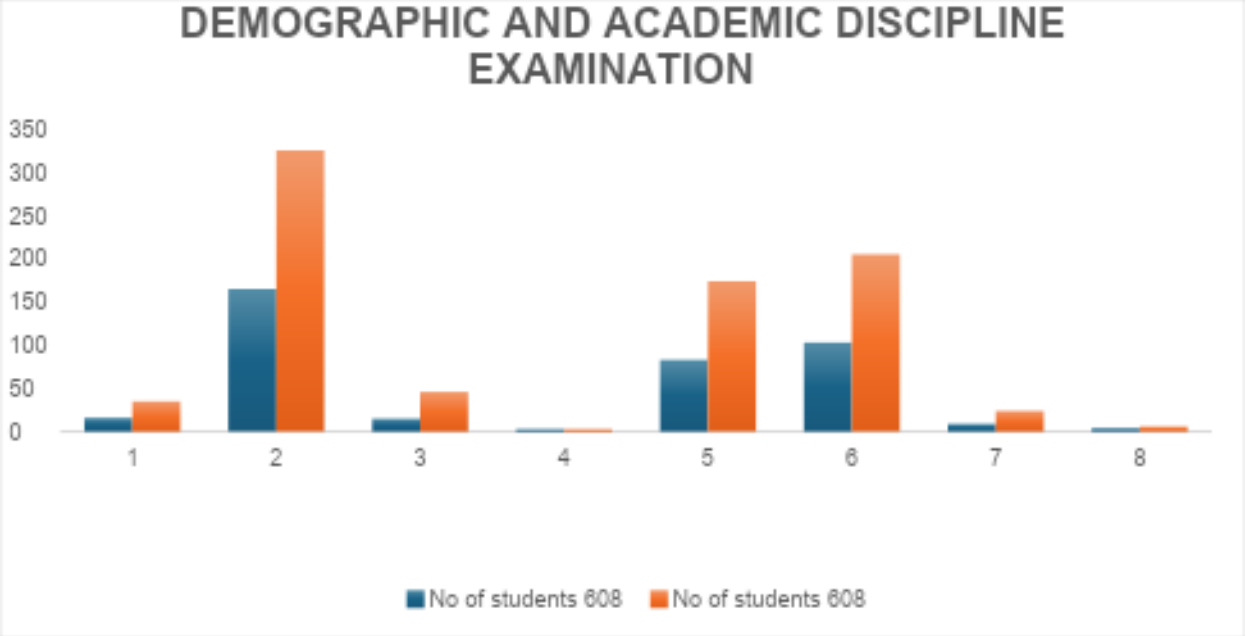

Figure 1: Baseline characters associated with dysmenorrhea

In our study, a significant proportion of the 608 students belonged to the 18-22 years age group (53.45%), with 27.13% reporting pain relief and 7.56% experiencing reduced severity in the 22-25 age group. This implies that changes in lifestyle and hormonal balance may help reduce dysmenorrhea as people age. Age showed no significant association with pain severity (p = 0.409). Academic discipline also did not significantly influence dysmenorrhea severity (p = 0.8544), with 28.61% of medical students, 33.71% from arts and science, and 3.94% from engineering disciplines reporting aggravated symptoms. This suggests that lifestyle factors such as stress, diet, and physical activity play a more influential role in dysmenorrhea severity than academic discipline. These findings are summarized in Table 1, and the distribution of age and academic discipline is illustrated in (Figure 1).

TABLE 2: EXAMINATION OF PHYSICAL ACTIVITY TYPES AND DURATION OF EXERCISE

PHYSICAL ACTIVITY EXAMINATION	CRITERIA	NO OF STUDENTS N= 608		STATS
		MITIGATING PAIN (REDUCE PAIN) (%)	EXACERBATING PAIN (INCREASING PAIN) (%)	P VALUE
Exercise type	Cardio training	130 (21.38)	70 (11.51)	0.039
	Strength training	90 (14.80)	50 (8.22)	
	Flexibility training	110 (18.09)	40 (6.58)	
	other	85 (13.98)	33 (5.53)	
Duration of exercise type	Less than 15 minutes	280 (46.05)	124 (20.39)	0.035
	15-30 minutes	70 (11.51)	25 (4.11)	
	30-60 minutes	42 (6.91)	17 (2.80)	
	More than 60 minutes	35 (5.76)	15 (2.47)	

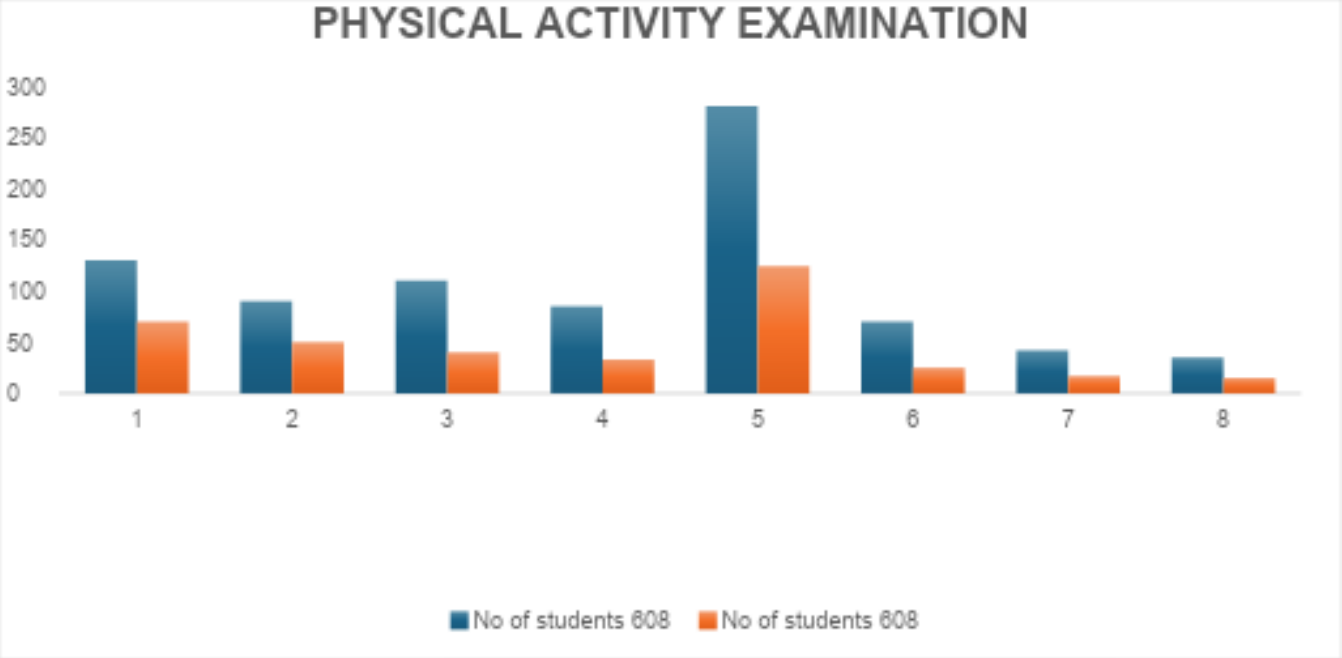

Figure 2: Assessment of Physical activity and duration of exercise

Our analysis of physical activity and dysmenorrhea severity revealed a statistically significant relationship (p = 0.039). Among different exercise types, cardio training (21.38%) and flexibility exercises (18.09%) were the most effective in alleviating menstrual pain, followed by strength training (14.80%). Exercise duration also influenced pain relief, with shorter exercise sessions (<15 minutes: 46.05% relief) being the most effective, while longer sessions (>60 minutes: 5.76% relief) provided limited benefits (p = 0.035). These findings suggest that moderate-intensity, short-duration exercises, particularly yoga and stretching, may be effective in managing dysmenorrhea without medication. The relationship between exercise type, duration, and pain relief is detailed in Table 2, and corresponding graphical representations are shown in [Figure 2].

TABLE 3: EXAMINATION OF STRESS LEVEL

STRESS	CRITERIA	NO OF STUDENTS N=608		STATS PVALUE
		MITIGATING PAIN (REDUCE PAIN) (%)	EXACERBATING PAIN (INCREASE PAIN) (%)	
Stress (impact on menstrual pain)		210 (34.54)	398 (65.46)	0.041
Due to stress factors increased	exams	100 (16.45)	110 (18.09)	0.037
	deadlines	45 (7.40)	45 (7.40)	
	Personal issues	125 (20.56)	183 (30.10)	
Stress reducing activities	Effective (reduced pain)	180 (29.60)	60 (9.87)	0.037
	Not effective (worsened pain)	160 (26.32)	208 (34.21)	

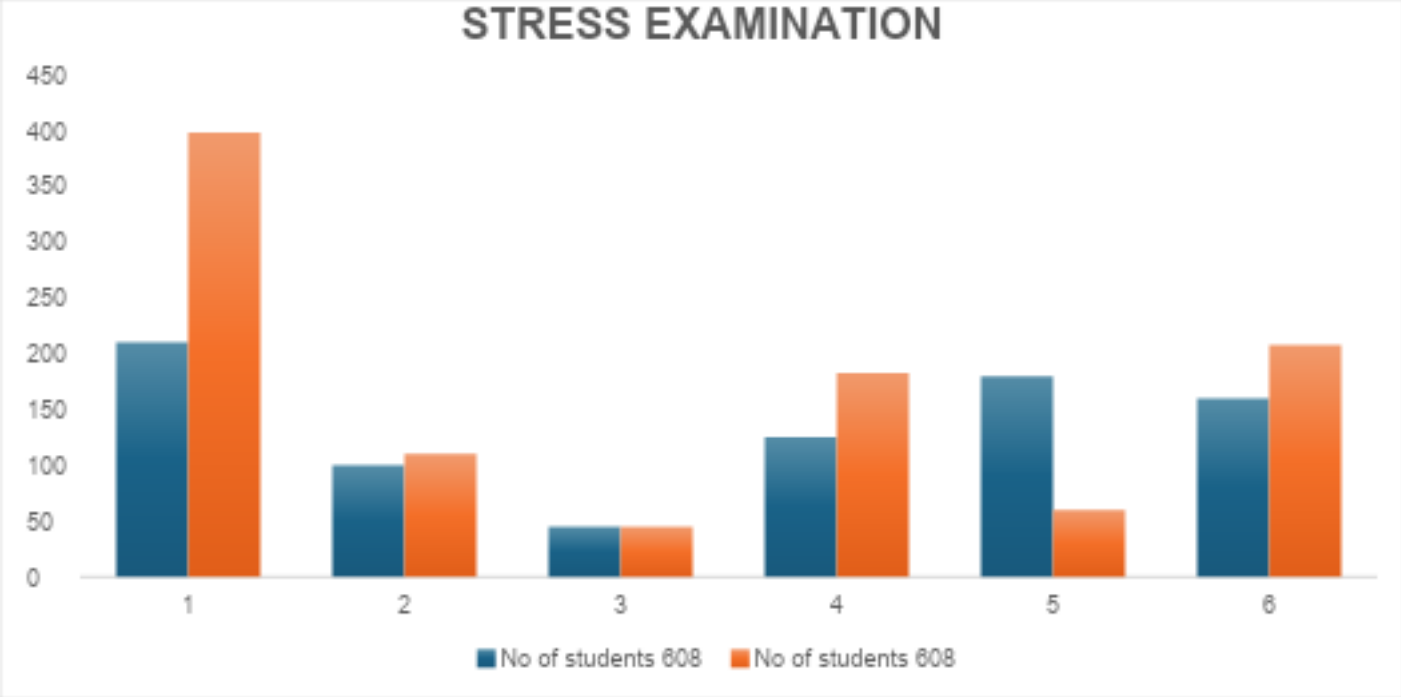

Figure 3: Assessment of stress level examination

The study found a statistically significant association between stress and dysmenorrhea severity ($p = 0.041$). A substantial 65.46% of students reported increased menstrual pain due to stress, whereas 34.54% experienced relief. Exam stress (18.09%) and personal issues (30.10%) were the most aggravating stressors. While 29.60% of students found stress-reducing activities beneficial, 34.21% still reported worsened pain despite attempting stress management techniques ($p = 0.037$). This suggests that evidence-based methods like mindfulness, relaxation techniques, and counselling may help further reduce the symptoms of dysmenorrhea, even though stress-relief techniques may be beneficial for some people. The impact of stress factors and coping strategies is summarized in Table 3, with a corresponding visual representation in [Figure 3].

TABLE 4: EXAMINATION OF DIETARY INTAKE AND HYDRATION LEVEL:

DIETARY INTAKE	CRITERIA	NO OF STUDENTS N=608		STATS P VALUE
		MITIGATING PAIN (REDUCE PAIN) (%)	EXACERBATING PAIN (INCREASE PAIN) (%)	
Whole grain consumption	never	70 (11.51)	110 (18.09)	0.043
	Sometimes (1-2 times/week)	115 (18.91)	95 (15.63)	
	Often (3-5 times/week)	85 (13.98)	35 (5.76)	
	Always	75 (12.34)	23 (3.78)	

Dairy product consumption	never	65 (10.69)	95 (15.63)	0.041
	sometimes(1-2 times/week)	100 (16.45)	80 (13.16)	
	Often (3-5 times/week)	90 (14.80)	50 (8.22)	
	always	95 (15.63)	33 (5.43)	
High sugar consumption		189	419	<0.001
Hydration level	Rarely (less than 1 litter/day	60 (9.87)	100 (16.45)	0.038
	Sometimes (1-2 liters/day)	170 (27.96)	80 (13.16)	
	Often (more than 2 liters/day	140 (23.03)	58 (9.54)	

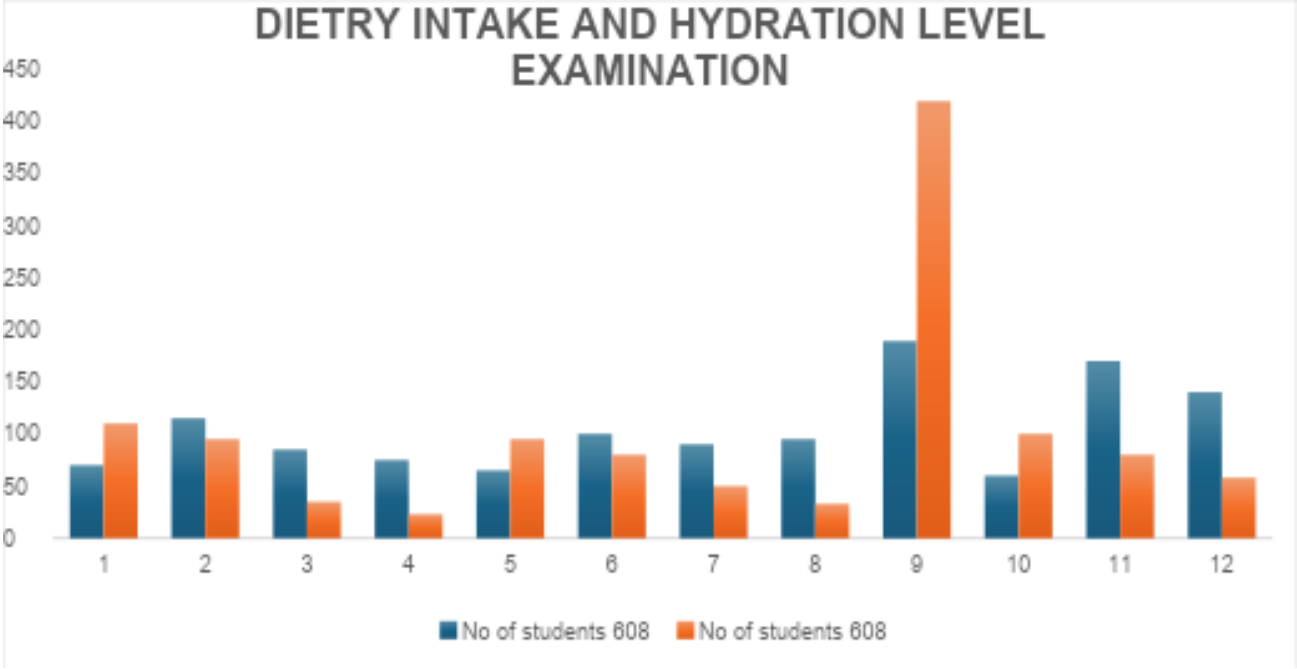

Figure 4: Assessment of dietary intake and hydration level

Our examination of dietary intake and hydration levels demonstrated a significant role in dysmenorrhea severity ($p < 0.05$). Whole grain consumption provided pain relief to 46.76% of students, whereas avoiding whole grains aggravated pain ($p = 0.043$). Dairy product consumption was also beneficial, with 56.87% of participants reporting pain relief ($p = 0.041$). On the other hand, high sugar intake significantly worsened pain ($p < 0.001$), supporting the role of inflammation and hormonal imbalances in dysmenorrhea. Another important factor was hydration, as 23.03% of participants reported that drinking more than 2L per day reduced their pain, whereas 16.45% reported that drinking less than 1L per day made their pain worse ($p = 0.038$). These findings underscore the importance of a balanced diet, reduced sugar intake, and proper hydration in dysmenorrhea management. The dietary intake and hydration effects on dysmenorrhea are detailed in Table 4, and corresponding graphical representations are shown in [Figure 4].

Discussion

This study examined how dietary practices, physical activity, and psychophysiological stress interact to influence dysmenorrhea in female college students. According to the findings, lifestyle factors significantly affect the frequency and intensity of dysmenorrhea (21). This is in line with earlier studies that demonstrated the detrimental effects of chronic stress and poor nutrition on menstrual health. Previous studies have shown that stress elevates cortisol levels, which can lead to hormonal imbalances and menstrual irregularities (22). Additionally, stress-related disruptions in the hypothalamic-pituitary-ovarian axis may exacerbate menstrual pain and metabolic dysfunction. In our study, 69.9% of participants reported worsened pain due to stress, with personal issues (41.1%) and academic stressors (19.6%) being the most aggravating factors. While 35.9% benefited from stress-reducing activities, nearly half still experienced persistent pain. These findings highlight the need for effective stress management interventions, such as counselling, mindfulness, and relaxation techniques, to mitigate menstrual discomfort. The relationship between physical activity and dysmenorrhea severity was statistically significant ($p = 0.039$). Cardio exercises (21.38%) and flexibility workouts (18.09%) were the most effective in alleviating menstrual pain. The duration of exercise also influenced pain relief, with shorter sessions (<15 minutes: 46.05% relief) being the most beneficial, while longer sessions (>60 minutes: 5.76% relief) showed minimal improvement ($p = 0.035$). These findings support the integration of moderate-intensity, short-duration exercises, particularly yoga and stretching, as non-pharmacological interventions for dysmenorrhea management. Our study further confirmed that dietary habits play a crucial role in menstrual health ($p < 0.05$). Whole grain consumption provided pain relief for 46.76% ($p = 0.043$), while dairy intake benefited 56.87% ($p = 0.041$). Conversely, high sugar intake worsened dysmenorrhea symptoms in 39.47% of participants ($p = 0.037$), reinforcing its association with inflammation and hormonal imbalances. Hydration was also a key factor, with drinking more than 2 L/day reducing pain by 23.03%, whereas consuming less than 1 L/day aggravated symptoms in 16.45% ($p = 0.038$). These findings highlight the importance of balanced nutrition, limited sugar intake, and proper hydration in managing dysmenorrhea severity. Age was a determining factor in dysmenorrhea severity ($p = 0.409$). Among participants aged 18-22 years, 53.45% experienced worsened pain, while 27.13% reported relief; however, students in the 22-25 age group experienced significantly lower pain levels (7.56%), suggesting that hormonal balance and lifestyle modifications contribute to reduce dysmenorrhea severity. Academic discipline had no significant effect ($p = 0.8544$), emphasizing that lifestyle factors like stress and diet play a more substantial role in menstrual pain regulation. This study underscores the significant role of lifestyle modifications in dysmenorrhea management, including stress management, balanced nutrition, regular exercise, and proper hydration. Findings suggest that limiting sugar, engaging in physical activity, staying hydrated, and managing stress effectively can serve as non-pharmacological strategies for menstrual pain relief. Given the high prevalence of dysmenorrhea among students, educational institutions should integrate menstrual health awareness programs to promote proactive lifestyle interventions. Further research is warranted to assess the long-term effectiveness of these strategies in reducing menstrual pain and improving overall well-being.

Conclusion

This study examined the effects of stress, diet, physical activity, and hydration on dysmenorrhea severity among 608 female college students. The findings show that lifestyle modifications play an important role in managing menstrual pain. Regular exercise, stress management, a balanced diet, and proper hydration were identified as key factors in reducing discomfort.

Managing stress and sugar intake was strongly linked to lower pain levels, emphasizing the need for healthy lifestyle habits. Engaging in physical activity, maintaining a nutritious diet with whole grains and dairy, and staying hydrated can help reduce both the occurrence and severity of dysmenorrhea.

Future research should explore the long-term benefits of these interventions and assess their effectiveness across diverse populations. Promoting healthy lifestyle habits among young women may serve as a preventive strategy for managing dysmenorrhea and enhancing overall menstrual health.

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