Indian Journal of
Nutrition

Open Science Publications

Volume 8, Issue 3 - 2021

www.opensciencepublications.com

Dietary Patterns and its Association with Premenstrual Tension Syndrome in Adult Women in Mumbai City: An Exploratory Study

Research Article

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Article Information: **Submission:** 01/10/2021; **Accepted:** 03/11/2021; **Published:** 06/11/2021

Abstract

Background: Premenstrual syndrome often disturbs daily activities and reduces productivity in women of reproductive age. The exact etiological cause of PMS is unknown and theories associating nutrition with PMS exist. Studies focusing on dietary patterns and PMS are few. There is meagre evidence on this topic in the Indian scenario, therefore, the present study was undertaken to explore the association of PMS with dietary patterns.

Aim: To assess the presence of PMS in young women, 19-40 years of age, in Mumbai city; and its association with dietary patterns, BMI, and sleep.

Methods: One hundred women with regular menses were recruited, but only 54 women completed the study. PSST-A was used to confirm PMS, the dietary pattern was determined with a semi- quantitative FFQ and sleeping patterns were assessed using a 14-day sleep diary. Out of 54 women, 31 completed the sleep component of the study.

Results: Thirty-seven women had no/mild PMS (Group 1), and 17 women had moderate-severe PMS (Group 2). No participant had PMDD. The mean total PMS score of Group 2 women was significantly higher than that of Group 1 women. More number of Group 2 women tended to be overweight/obese. Group 1 reported fewer symptoms and less severe experiences than Group 2. No significant difference was found between dietary and sleep patterns of women with and without PMS.

Conclusion: The results of this study suggest that PMS may be associated with weight status. The role of obesity, diet and sleep patterns in PMS needs to be further evaluated.

Keywords: Premenstrual syndrome; PMDD; Diet; Sleep; BMI

Abbreviations

PMS: Premenstrual Syndrome; PMDD: Premenstrual Dysphoric Disorder; DRSP: Daily Record of Severity of Problems; BMI: Body Mass Index; WHO: World Health Organization; PSST-A: Premenstrual Symptoms Screening Tool for adolescents; FFQ: Food Frequency Questionnaire; SD: Standard Deviation; SOL: Sleep Onset Latency; TNFα: Tumor Necrosis Factor-α; GMSCF: Granulocyte Macrophage Colony Stimulating Factor; IFN-γ: Interferon-γ; hs-CRP: High-Sensitivity C-Reactive Protein; GI: Glycemic Index; PUFA: Polyunsaturated Fatty Acids; SFA: Saturated Fatty Acids; TFA: Trans Fatty Acids

Introduction

Since it was first identified in the 1930s, premenstrual syndrome (PMS) has presented clinicians and researchers with challenges in

ISSN: 2395-2326

terms of its aetiology as well as its treatment. PMS is a cyclic repetition of more than 100 psychological and physical symptoms observed in women in the late luteal phase of the menstrual cycle caused by a complex interplay between hormones, nutrients, neurotransmitters, and psychosocial factors [1]. Common complaints include anger, irritability, increased emotional sensitivity, bloating, insomnia, aches and pains [2]. Approximately 75% of women of reproductive age are said to suffer from at least one of these symptoms. A more severe form of the disorder, known as Premenstrual Dysphoric Disorder (PMDD) has also been described [3]. The International Classification of Diseases-11 (2018) [4] has recognised PMDD as a largely gynaecological problem 'severe enough to cause significant distress or impairment personal, family, social, educational, occupational or other important areas of functioning and do not represent the exacerbation of a mental disorder.'

The aetiological factors of PMS are not understood completely and continue to remain under investigation. Various pathways have been proposed to explain the aetiology of PMS and various nutrients have been implicated in the same. Some isolated studies have been conducted to examine the effect of carbohydrates, fatty acids and proteins on PMS symptoms [5-7]. This is because of their complex involvement in neuronal pathways, neurotransmitter function and the maintenance of the hormone milieu. Supplementation studies have been conducted with minerals such as calcium, magnesium, and some vitamins like pyridoxine, thiamine [8-11]. The results of these studies highlight the potentially important role of nutrition in PMS.

However, there is meagre evidence on the role of diet and dietary patterns in PMS, particularly in the Indian scenario. Therefore, the present study was undertaken with the aim of assessing dietary patterns to determine whether there is any association with premenstrual tension syndrome in adult women aged 19 – 40 years in Mumbai city.

Materials and Methods

Ethics Approval

The study was approved by the Intersystem Biomedical Ethics Committee (ISBEC) (Approval No. ISBEC/ NR-20/ KM-VM/ 2018) (October 18, 2018).

Sample Selection

For this exploratory study, subjects were recruited by snowball sampling after obtaining written informed consent using the following inclusion and exclusion criteria.

Inclusion criteria: Women between 19-40 years of age, from upper and middle-upper socio-economic status, in seemingly good health and having a regular menstrual cycle.

Exclusion criteria: Pregnant and/or lactating women, women with chronic health problems such as diabetes, hypertension, acute respiratory distress syndrome, chronic obstructive pulmonary disorder, cancer and asthma, women from the lower socio-economic group, women having irregular menstrual cycle and women who had been on hormone therapy of any kind for two-three months preceding the study.

The study was conducted between October 2018 and February 2019. One hundred young women were recruited. Of these, 20 participants returned incomplete forms, 20 did not respond and 6 participants lost the recording formats provided to them. Therefore, data for the 54 participants who completed the study were analysed.

Data Collection

Information was collected regarding (a) General health, menstrual history and anthropometric measurements i.e., weight and height, (b) Symptoms related to PMS experienced by the participants, (c)Daily Record of Severity of Problems (DRSP), (d) Food Frequency Questionnaire and (e) Sleep Diary [12].

a. General information about family, marital status, sexual activity and menstrual history was obtained from the participants. Self-reported heights and weights were used to calculate body mass index (BMI). The subjects were classified into BMI categories as per WHO criteria for Asians [13].

b. The Premenstrual Symptoms Screening Tool for adolescents (PSST-A), developed by Steiner et al., (2011) [14], was used for the diagnosis of PMS. This consists of a 4-point scale to evaluate the presence/severity of 14 symptoms commonly observed in PMS, where 0 represents the absence of symptoms and 3 represents the presence of debilitating symptoms. As part of the tool, the disturbance caused by the symptoms on daily activities was also recorded. The participants were then categorized as no/mild PMS - designated as group 1 (n = 37), moderate- severe PMS - designated as group 2 (n = 17). No participant in this study qualified the criteria for PMDD.

c. A prospective two-month diary, the Daily Record of Severity of Problems (DRSP) was given to the participants as a diagnostic tool. The participants were explained that they were required to record their daily symptoms as well as the severity of symptoms experienced by them from the list of symptoms commonly associated with PMS and was provided to them in the recording format. They were requested to do so for duration of 2 months (starting from the 1st day of menstruation of the 1st menstrual cycle to the start of the 3rd menstrual cycle) along with measuring and noting down body temperature every day. The women were asked to separately mark the days on which they menstruated to determine the pre-menstrual phase. Only 18 participants satisfactorily provided data for daily symptoms and daily temperatures were provided by only 6 participants. Hence, due to an insufficient number of responses, this data was not analysed.

d. Dietary pattern was assessed using a Food Frequency Questionnaire (FFQ) consisting of 223 foods that are commonly available and consumed in Mumbai city. The food items were grouped ingredient-wise: cereals and cereal products; pulses and pulse products; milk and dairy products (i.e. milk, curd, cheese, paneer, khoa and cream); milk-based beverages; other beverages; sweets and bakery products; snacks /namkeens that are shelf-stable, generally energy-dense/ high fat and often contain high amounts of sodium, both Indian and other snack products like chips or wafers; freshly prepared snacks such as kachori, samosa, and vadas which are also high fat/ high sodium and energy-dense; nuts and oilseeds; food adjuncts like ketchup, pickles and papads; chicken/ meat and their

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products; seafood i.e. shellfish, fish, crabs and prawns; fruits; dark green leafy vegetables; yellow, red and orange coloured vegetables; other vegetables; and roots and tubers. In addition, the foods were classified as high fat, high salt, low fat, whole grain products i.e., whole cereals and millets foods/ products, milled and polished rice foods/ products, and refined flour products. Information about the consumption of the foods in terms of frequency i.e., number of days per week and number of portions consumed per time were recorded. From this, the weekly frequency of consumption and the number of portions consumed per week were calculated.

e. Participants were asked to maintain a sleep diary from the American Academy of Sleep Medicine for a fortnight (any 2 weeks during the two months) [12]. The information recorded included self-reported hours of sleep, time taken to fall asleep, hours spent exercising and the consumption of tea, coffee or cola to estimate caffeine consumption. Thirty-one out of the 54 participants completed the sleep diary and the data for these participants were analyzed.

Data Analysis

Data was coded in MS Excel and SPSS version 25 was used for statistical analysis. Independent t-test, paired t-test, and chi-square test were applied.

Results

Profile of participants

The demographic profiles of participants from both groups were similar. Participants from both groups were similar in age, age at menarche, duration of last period and the interval between two periods (days) (Table 1). Among the 54 women, only two were sexually active and both of them belonged to group 2.

Symptoms of Pre-Menstrual Syndrome

The mean total PMS score for severity of 14 symptoms was significantly higher in group 2 compared to group 1 (p = 0.000). A significantly higher percentage of women in group 2 experienced tension/anxiety, tearfulness, decreased interest in home and social activities, fatigue, difficulty in concentrating, insomnia and feeling overwhelmed compared to group 1 (Table 2) PMS is characterized by the presence of physical and/or psychological symptoms in the week preceding menstruation that causes some disturbance in the day-to-day activities of women. In the present study, all participants from group 2 complained of moderate disturbance in daily activities due to the presence of symptoms, in contrast to group 1, where only 70.3% of participants reported being disturbed by the symptoms (p = 0.000). A significantly higher percentage of group 2 women reported a disturbance in relationship with co-workers, family and social life activities due to the symptoms experienced (Table 3).

Anthropometry

Mean body weight for group 2 women (59.31 ± 13.18 kg) tended to be higher than group 1 women (57.35 ± 9.48 kg) although there was no statistically significant difference between the two groups (t= -0.622, p = 0.537). Although mean BMI was higher for group 2, there was no statistically significant difference between the groups (Group 1 – 22.58 ± 3.07 kg/m^2, Group 2 – 22.72 ± 4.34 kg/m^2) (t =-0.144, p = 0.886). In group 2, 11.8% women were underweight compared to only 2.7% women from group 1, 41.2% in group 2 had normal BMI, which was much lower than the 62.2% of group 1 women who had normal BMI. In group 2, 23.5% women were overweight compared to 18.9% from group 1, 17.6% of group 2 were in the obese I category and 5.9% women were in the obese II category. In contrast, among the group 1 women 13.5% were categorized as obese I and 2.7% were in the obese II category (WHO, 2004). However, the results of the chi-square analysis indicated that the differences between the two groups were not significant ($\chi 2 = 3.219$, p = 0.522). Self-reported pre-menstrual weight gain appeared to be significantly higher in group 2 women (0.52 ± 0.79 kg) compared to group 1 (0.08 ± 0.40 kg) (t = 2.702, p = 0.016).

Table 1: Profile of women with and without PMS

	Group 1 (n = 37) Mean ± SD	Group 2 (n = 17) Mean ± SD	t	*p*
Age (years)	22.16 ± 1.44	23.47 ± 4.86	-1.513	0.136
Age at Menarche (years)	13.00 ± 1.53	12.97 ± 1.28	0.069	0.945
Interval between two cycles (days)	28.10 ± 3.29	28.59 ± 2.77	-0.522	0.604
Duration of last period (days)	4.73 ± 0.81	5.12 ± 1.15	-1.422	0.161

Table 2: Severity of Premenstrual Symptoms between two groups

Symptoms of PMS	Group 1 (n = 37) % (n)	Group 2 (n = 17) % (n)	χ^2	*p*
Irritability/ anger	81.1 (30)	100 (17)	6.939	0.074
Tension/ anxiety	37.8 (14)	82.4 (14)	**20.982**	**0.000**
Tearful/ increased sensitivity to rejection	48.7 (18)	82.4 (14)	**13.103**	**0.004**
Depressed mood/ hopelessness	62.2 (23)	88.2 (15)	6.018	0.111
Decreased interest in work activities	64.9 (24)	88.2 (15)	3.171	0.205
Decreased interest in home activities	51.4 (19)	94.1 (16)	**21.145**	**0.000**
Decreased interest in social activities	48.7 (18)	100 (17)	**23.322**	**0.000**
Difficulty concentrating	40.5 (15)	88.2 (15)	**15.733**	**0.001**
Fatigue/ lack of energy	78.4 (29)	100 (17)	**18.551**	**0.000**
Overeating/ food cravings	62.2 (23)	88.2 (15)	5.709	0.127
Insomnia	18.9 (7)	52.9 (9)	**8.986**	**0.029**
Hypersomnia	29.7 (11)	41.2 (7)	1.975	0.373
Feeling overwhelmed	40.5 (15)	70.6 (12)	**11.090**	**0.004**
Physical symptoms	70.3 (26)	94.1 (16)	6.040	0.110
Disturbance by symptoms	70.3 (26)	100 (17)	**42.178**	**0.000**

Table 3: Frequency of disturbance in daily activities between two groups.

	Group 1 (n = 37) % (n)	Group 2 (n = 17) % (n)	χ^2	*p*
Work Efficiency	43.2 (16)	64.7 (11)	2.146	0.143
Relationship with Co-workers	10.8 (4)	35.3 (6)	**4.627**	**0.031**
Relationship with Family	29.7 (11)	70.6 (12)	**7.953**	**0.005**
Home Responsibilities	24.3 (9)	47.1 (8)	2.791	0.095
Social Life Activities	29.7 (11)	88.2 (15)	**15.970**	**0.000**

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Dietary Patterns

More women from group 2 skipped breakfast thrice a week (17.6%) and daily (11.8%) compared to group 1 (8.1%, respectively). A higher percentage of group 2 women (11.8%) consumed breakfast items purchased from outside every day in contrast to group 1 (5.4%). Significantly more women from group 2 were vegan (5.9%), lacto-ovo-vegetarian (23.5%) and ovo-vegetarian (11.8%) compared to group 1 (5.4%, 2.7% and 0% respectively) ($\chi 2 = 11.465$, $p = 0.022$)

The frequency of consumption per week for the 16 food groups was compared between the two groups. The frequency of consumption in group 2 tended to be more than group 1 for cereal products, dairy products, beverages, namkeens, adjuncts, snacks, fruits, and root and tubers (Table 4). Similarly, women in group 2 consumed a higher number of portions of cereal products, dairy products, beverages, namkeens, adjuncts, fruits, vegetables, and roots and tubers than women in group 1 per week (Table 5).

However, the frequency of consumption of whole wheat and millet products, refined flour products, high fat and high sodium-containing foods appeared to be higher in group 2 than in group 1. In contrast, group 1 consumed low-fat foods more frequently than group 2 participants. Group 2 also consumed a greater number of portions of rice and rice products, whole wheat and millet products, refined flour products and high sodium foods than group 1 per week (Table 6).

Table 4: Frequency of Consumption of Foods (Per Week).

Food Groups	Group 1 Mean ± SD	Group 2 Mean ± SD	t	P
Cereal products	28.27 ± 9.21	33.10 ± 10.34	-1.724	0.091
Pulse products	6.34 ± 4.86	5.15 ± 4.19	0.871	0.388
Dairy products	10.52 ± 7.61	12.06 ± 7.21	-0.701	0.486
Other Beverages	2.78 ± 2.44	3.38 ± 3.00	-0.778	0.440
Sweets and Bakery Products	9.25 ± 8.23	9.21 ± 6.75	0.019	0.985
Namkeens (high salt, ready-to-eat snacks)	5.26 ± 5.78	6.03 ± 7.77	-0.409	0.685
Snacks (freshly prepared)	12.49 ± 6.22	13.32 ± 9.48	-0.387	0.700
Nuts and oilseeds	12.40 ± 11.98	11.71 ± 8.65	0.214	0.832
Adjuncts	2.43 ± 2.64	3.56 ± 7.03	-0.864	0.391
Meat and meat products	1.65 ± 3.10	1.85 ± 2.69	-0.234	0.816
Seafood	0.47 ± 1.09	0.29 ± 0.61	0.629	0.532
Fruits	18.64 ± 19.05	22.00 ± 15.69	-0.634	0.529
Vegetables (Dark Green Leafy Vegetables, red, yellow and orange)	26.82 ± 17.37	25.29 ± 16.17	0.306	0.761
Other Vegetables	2.70 ± 3.61	2.06 ± 2.52	0.664	0.510
Roots and Tubers	9.27 ± 8.78	11.44 ± 8.16	-0.862	0.393

Table 5: Total consumption of foods (Portions Per Week).

Food Groups	Group 1 Mean ± SD	Group 2 Mean ± SD	t	P
Cereal products	48.00 ± 13.97	54.68 ± 20.22	-1.413	0.164
Pulse products	6.34 ± 4.86	5.15 ± 4.19	0.871	0.388
Dairy products	11.67 ± 11.19	13.56 ± 11.13	-0.578	0.566
Other Beverages	2.82 ± 2.59	3.35 ± 3.01	-0.662	0.511
Sweets and Bakery Products	16.50 ± 15.07	15.28 ± 13.13	0.286	0.776
Namkeens (high salt ready-to-eat snacks)	5.89 ± 7.34	6.63 ± 9.27	-0.316	0.753
Snacks (freshly prepared)	26.36 ± 15.53	26.04 ± 20.51	0.065	0.948
Nuts and oilseeds	34.72 ± 33.68	35.15 ± 25.36	-0.046	0.963
Adjuncts	2.55 ± 2.64	4.47 ± 10.23	-1.075	0.287
Meat and meat products	3.09 ± 6.65	2.57 ± 3.60	0.302	0.764
Seafood	1.50 ± 3.21	1.22 ± 2.89	0.306	0.761
Fruits	34.16 ± 36.87	36.47 ± 31.89	-0.223	0.825
Vegetables (Dark Green Leafy Vegetables, red, yellow and orange)	28.67 ± 18.94	31.40 ± 22.62	-0.462	0.646
Other Vegetables	2.69 ± 3.61	2.26 ± 3.07	0.419	0.677
Roots and Tubers	8.84 ± 9.08	12.68 ± 9.79	-1.408	0.165

Table 6: Dietary patterns of group 1 and group 2

	Frequency of consumption per week (Mean ± SD)		Number of Portions consumed per week (Mean ± SD)	
	Group 1	Group 2	Group 1	Group 2
Rice Products	1.40 ± 2.00	1.40 ± 2.01	1.23 ± 2.00	1.44 ± 2.08
Wheat & Millet Products	1.24 ± 1.08	1.36 ± 0.51	2.59 ± 2.90	2.74 ± 2.90
Refined Flour Products	0.35 ± 0.18	0.46 ± 0.42	0.48 ± 0.46	0.64 ± 0.80
High Fat Foods	0.21 ± 0.13	0.22 ± 0.34	0.41 ± 0.52	0.35 ± 0.46
High Sodium Foods	0.32 ± 0.22	0.37 ± 0.36	0.61 ± 0.54	0.67 ± 0.91
Low Fat Foods	0.45 ± 0.62	0.40 ± 0.34	0.95 ± 1.33	0.86 ± 1.29
t, *p*	0.127, 0.901		-0.147, 0.886	

Sleep Patterns

Sleep patterns of the 31 participants who completed the sleep diary (Group 1 = 23, Group 2 = 8), indicated that 87% (n = 20) of the participants in group 1 generally slept after midnight compared to a lower percentage of women in group 2 (50%, n = 4). Only 13% (n = 3) of the women from group 1 slept between 11pm and midnight compared to 50% (n = 4) of the women from Group 2 ($\chi 2 = 4.637$, $p = 0.031$).

Sleep onset latency (SOL) was seen in a slightly but not significantly higher percentage of women in group 2 (87.5%, n = 7) as compared to group 1 (69.6%, n = 16). Group 1 had a mean SOL of 47.4 ± 38.4 minutes that was lower as compared to the SOL of 61.2 ± 31.8 minutes for group 2. Women from group 2 reported SOL for 12

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out of 14 days when they maintained the sleep diary whereas in group 1 SOL was reported for only 9 out 14 days.

Further, as part of the sleep diary, the participants were asked about their consumption of caffeine beverages (cola, coffee, tea). The average frequency of caffeine consumption (number of times per day) during the two weeks when they maintained records for Group 1 women (n = 23) was 1.00 ± 0.54 and that of Group 2 women (n = 8) was slightly higher (1.19 ± 0.69). The two groups did not differ significantly in their frequency of caffeine consumption (t = -0.794, p = 0.434).

Discussion

"Premenstrual Syndrome is the occurrence of cyclical somatic, psychological and emotional symptoms that occur in the luteal (premenstrual) phase of the menstrual cycle and resolve by the time menstruation ceases." [15]. Out of the 54 participants in the age group of 20-36 years who participated in our study, 47 women (87%) had premenstrual syndrome with a majority of them reporting experiencing at least one symptom associated with PMS. A meta-analysis of 17 prevalence studies conducted in different countries [16] found the overall prevalence of PMS to be 47.8% in the years 1996-2011. The highest prevalence was seen in Iran (98.2%), followed by Nigeria (85%). India ranked fifth highest in prevalence with 67% while the lowest prevalence was found in France (10%). Nationwide/ State wise/ regional data for the prevalence of PMS in India is not available, although some investigators have reported their observations from different parts of the country [17], found a total prevalence of 53% in their study conducted at Peshawar, Pakistan among college girls and Rezaeian (2015) [18] found 63% prevalence of PMS in a group of 18-26 years old women at Tehran, Iran. There are few reports in the literature from India, but an observational study from Andhra Pradesh found 55% of their participants to be suffering from PMS [19]. In the present study, women who experienced PMS symptoms appeared to gain more weight. This is in line with reports in the literature that weight gain/bloating is a common symptom of PMS [20]. The relationship between obesity and PMS could be attributed to the fluctuation of female hormones (low oestrogen) seen in women with a high BMI. Reduced oestrogen levels may be in turn be associated with decreased serotonin function which is one of the established etiological pathways for PMS [21].

Obesity has repeatedly been shown as a risk factor for PMS. A cross-sectional study of 847 women (18-44 years) found PMS to be higher in women who were overweight i.e., high BMI than in underweight women i.e., low BMI [22]. The same study found obese women thrice as likely to have PMS compared to underweight women. A similar observation relating adiposity to PMS was seen in a nested study of the Nurses' Health Study II, where women free from PMS at baseline were observed over 10 years. The risk of PMS was significantly higher in women with BMI ≥ 27.5 kg/m^2 with each 1 kg/m^2 increase in BMI being associated with a 3% increase in PMS risk [21]. In India, Akbari et al., (2017) [23], studied 270 girls in the Chitradurga district of Karnataka. Among the girls with PMS (n = 84), 67.8% had normal BMI, 18% were pre-obese and 10.8% were underweight. Ashfaq and Jabeen (2017) [24] found that of the 118 girls with PMS, 92.9% were overweight, 89.3% were obese and 82.8% were underweight suggesting that both extremes of weight status seem to affect the severity and existence of PMS symptoms. Similar trends were observed in the present study, where more women with a high BMI tended to suffer from moderate-severe PMS compared to women with normal BMI. However, the anthropometric measurements here were self-reported and a more careful examination is warranted to elucidate the extent to which overweight/obesity increases the risk of PMS in Indian women. Studies focusing on diet patterns and anthropometric measurements such as body mass, adiposity concerning PMS in the published literature are limited. Larger and well-designed studies with these factors in mind would be helpful. Larger and more detailed studies with these factors in mind are pertinent.

PMS commonly consists of several affective symptoms such as depression and anxiety for which inflammation is often implicated as one of the etiological factors. Inflammation is also implicated in several other symptoms commonly seen in PMS such as lethargy, cognitive impairment, decreased social interaction [25]. Bertone-Johnson et al., (2014) [26] compared f inflammatory biomarkers in PMS and control participants, i.e., IL-1β (interleukins), IL-2, IL-4, IL-5, IL-6, IL-7, IL-8, Il-10, IL-12, IL-13, Tumor necrosis factor-α (TNFα), granulocyte macrophage colony stimulating factor (GMSCF) and Interferon-γ (IFN-γ). Total symptom score was positively associated with IL-2, IL-4, IL-10, and IL-12 ($p < 0.05$) with the strongest relation with IL-4, IL-10, IL-12 and IFN-γ. Depression and other psychological disorders can be attributed to an increase in cytokines via cytokine effect on neurogenesis, neurotransmitter functions, and stress response pathways [26]. Gold, Wells & Rasor, (2016) [27], in their cross-sectional study, found most symptoms of PMS in obese women. hs-CRP (C-reactive protein) levels > 3mg/L were associated with abdominal cramps, cravings/weight gain/ bloating and mood symptoms.

Inflammation also has a well-documented close relationship with diet and multiple indicators of inflammation like IL-2, -6, -4, and hs-CRP have been studied. High glycemic index (GI) foods have been shown to increase hs-CRP levels. In a Dutch study, every 10-unit increase in GI leads to a 29% increase in hs-CRP [28] whereas, diets rich in dietary fibre have shown an inverse relation with hs- CRP [29]. Clarke et al., (2008) [30] have shown that high serum saturated fatty acids (SFA) are positively correlated with hs-CRP and fibrinogen and polyunsaturated fatty acids (PUFA) are inversely correlated with hs-CRP [31] found every 1% decrease in energy from SFA causes hs-CRP to decrease by 0.14 mg/L. The Nurses' Health Study found trans-fatty acids (TFA) to be associated with IL-6 and hs-CRP in women with high BMI indicating systemic inflammation [32]. These works and observations indicate the role of diet in both creating and relieving an inflammatory environment in the body. Obesity and/or obesity-induced inflammation could also be associated with the severity of PMS symptoms. Although intakes of fibre or fat and fatty acids could not be calculated in the present study, we attempted to examine the intakes of such foods using an FFQ. The present study saw Group 2 consuming a higher number of portions of high salt and processed foods such as namkeens, and adjuncts (papads, pickles) more frequently in terms of number times per week compared to group 1. This can also be a contributing factor

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to systemic inflammation. Animal studies have shown that high salt intake can lead to inflammation and exacerbated autoimmunity apart from being an independent factor for obesity. [33] found a positive association between high sodium intake, and adiposity and inflammation. Subcutaneous abdomen adipose tissue and TNF-α were significantly higher in adolescents with high dietary sodium intake. A similar association may exist in women with PMS where the severity of symptoms could be exacerbated due to high salt intake and/or inflammation.

One other finding seen commonly in PMS is sleep disturbance. Sleep is an integral part of health and sleep-related disturbances can affect the functional ability and increase the risk of psychiatric disorders [34], found that people with sleep insufficiency were more likely than people with sufficient sleep to report fair/poor general health, frequent physical and mental distress, frequent activity limitations, and frequent symptoms of depression, pain and anxiety. They were also more likely to have health-risk behaviours including smoking, obesity, physical inactivity and heavy drinking (in men).

Sleep onset latency (SOL) is the duration of time between when the lights are turned off until the time person falls asleep [35]. It is the time taken to accomplish the transition from complete wakefulness to sleep. Sleep debt may be accumulated by sleep-deprived individuals, exhibited by an increased need to recover lost sleep which leads to shorter sleep latency, and greater total sleep time [36].

The present study found women with moderate-severe PMS experiencing SOL more than women with no/mild PMS. Group 2 women also showed more frequent consumption of caffeine compared to group 1. The late hours of going to sleep and caffeine consumption that are attributable to the occupational and personal life demands among millennials can be associated with disturbed sleep and the accumulation of sleep debt. Findings related to sleep disturbance in PMS have been demonstrated by [37]. They found daytime sleepiness to progressively decrease with a decrease in the severity of symptoms (PMDD> moderate-severe PMS> no/mild PMS; $p = 0.000$). Caffeine consumption may also be associated with sleep disturbances. It is an adenosine receptor antagonist and can modulate physiological and mental state via mechanisms related to sleep, arousal and cognitive performance. It has been known to increase SOL by attenuating the readiness to fall asleep (sleep propensity) [38]. However, further work is required to study the association between PMS and sleep health.

Despite the absence of significant results, the trends for an association between diet patterns, BMI and the PMS were observed in the present study. While all these factors could affect the presence and severity of PMS, one of the major limitations was the sample size. A larger and more diverse sample would be helpful to conclusively establish the trends seen here. The present study was an exploratory study and was restricted to diet patterns. The relationship between vitamin B6 and other nutrients with PMS was not explored. It may be worthwhile to also include a study of nutrient intakes and their association with PMS. The relationship between dietary factors and PMS needs to be explored to gain a better understanding of the role nutrition plays in premenstrual syndrome. We also did not include participants with other endocrine disorders in this study which could be a determinant in PMS and should be better understood. It might also be of consequence that the tedious nature of the diagnostic tool proved to be discouraging for a large number of participants in the present study and prevented the use of a more detailed diet recall. A simpler and easier-to-use tool may be helpful in future studies aimed at studying PMS. This study was also not conducted in a clinical setting which would have allowed a case-control methodology of the study.

Conclusion

In conclusion, the present study sheds some light on how diet and lifestyle may affect the severity of symptoms seen in premenstrual tension syndrome. The number of women suffering from PMS in the present study confirms that it is a common problem amongst women of reproductive age and affects their productivity, ability to participate in work and household activities and day-to-day life.

Despite its limitations, the present study was able to find trends between the two groups in terms of the relationship of PMS and weight status, dietary patterns and sleep patterns. This is a testimony to the fact that nutrition does have a role to play in the management of premenstrual syndrome. Further studies are required to confirm the findings of this study in a larger sample.

Acknowledgement

We extend our sincere gratitude to the women who spared their valuable time to participate in this study.

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Citation: Goyal A, Thorat A, Udipi SA, Vaidya RA. Dietary Patterns and its Association with Premenstrual Tension Syndrome in Adult Women in Mumbai City: An Exploratory Study. Indian J Nutri. 2021;8(3): 242.

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