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ORIGINAL RESEARCH

Dietary, Psychological and Lifestyle Factors Associated with Premenstrual Symptoms

AlJohara AlQuaiz[1,2], Muneerah Albugami[3], Ambreen Kazi[1,2], Fahdah Alshobaili[2], Fawzia Habib[1,4], Ellen B Gold[5]

[1]Princess Nora Bent Abdullah Chair for Women's Health Research, King Saud University Medical City, Riyadh, Saudi Arabia; [2]Department of Family & Community Medicine, King Saud University Medical city, Riyadh, Saudi Arabia; [3]Department of Medicine, King Faisal Specialist Hospital and Research Center, Riyadh, Saudi Arabia; [4]Department of Gynecology & Obstetrics, Taibah University, Madinah al Munawara, Saudi Arabia; [5]Department of Public Health Sciences, University of California Davis, Davis, CA, USA

Correspondence: Ambreen Kazi, Princess Nora Bent Abdullah Research chair for Women's Health Research, King Saud University Medical city, PO Box 231831, Riyadh, 11321, Saudi Arabia, Tel +966 1 4692714, Fax +966 1 4691127, Email akamran@ksu.edu.sa

Purpose: To measure the associations of diet, psycological distress, and lifestyle factors with premenstrual symptoms (PMSx) in women in Riyadh, Saudi Arabia.

Patients and Methods: An interview-based, cross-sectional study was conducted on 1831 women aged 18–50 years seen in primary healthcare centers and teaching institutes in Riyadh from December 2015 to June 2016. Question topics included sociodemographics, physical activity, smoking, and dietary habits information. PMSx were assessed using a symptom checklist with 6 domains: anxiety/mood changes; abdominal/back/joint pain; increased appetite/weight gain, breast pain/tenderness, severe headache, and ≥3 PMS symptoms (any). Multivariable logistic regression analyses were conducted to provide adjusted odds ratios (aORs) and 95% confidence intervals (CIs) for factors associated with each PMSx domain.

Results: Except for breast pain, drinking >5 cups of Arabic coffee was associated with increased odds of anxiety/mood [aOR 2.44 (95% CI 1.44, 4.12)], pain [1.83 (1.13, 2.98)], appetite/weight gain [1.66 (1.10, 2.50)], headache [1.57 (1.00, 2.56)] and ≥3 symptoms [1.50 (1.07, 2.11)]. A significant association was noted between sugar intake and anxiety/mood symptoms [1.53 (1.07, 2.19)] and abdominal/back pain symptoms [1.84 (1.17, 2.88)]. Increased severity of psychological distress was associated with all symptom domains: anxiety/mood [2.75 (1.92, 3.94)]; pain [1.45 (0.92, 2.28)]; appetite/weight gain [2.01 (1.53, 2.65)]; breast pain [2.19 (1.68, 2.88)]; headache [1.86 (1.37, 2.54)] and ≥3 symptoms [3.52 (2.49, 4.95)]. Low physical activity was significantly associated with odds of breast pain symptoms [1.29 (1.04, 1.59)]. Smokers were 3.41 (1.19, 9.77) times as likely to report any ≥3 symptoms compared to nonsmokers.

Conclusion: Several potentially modifiable factors, such as diet and stress, were positively associated with PMSx. Thus, we suggest that increasing women's awareness of healthy lifestyles, particularly diet and stress reduction, may help to reduce the occurrence of premenstrual symptoms.

Keywords: mental distress, coffee, diet, women, premenstrual symptoms

Introduction

Premenstrual symptoms (PMSx) were described by Dr. Robert Frank in the 1930s, calling it "premenstrual tension".[1] Although the description of PMSx was observed by Hippocrates well before the 1800s, it was not put into context until 1931.[2] The American College of Obstetricians and Gynecologists (ACOG) has defined premenstrual symptoms (PMSx) as an array of affective and somatic symptoms that usually precede the menses by 5 days and remit about 4 days after onset of menses, sometimes causing functional impairment.[3]

Epidemiological studies have shown that nearly 48% of women of childbearing age worldwide have experienced PMSx, and 90% have manifested at least one of the PMSx signs, with higher proportions, indeed the majority, of women reporting being affected occuring in low income countries.[4,5] According to a study using the ACOG diagnostic guidelines for PMS, 19–30% of American women meet the criteria for PMSx.[6] A French population-based survey revealed that 12.2% of women aged 18–44

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years reported having PMSx.[7] Data from Ukraine and other European countries indicated that 29% of menstruating women reported having moderate-to-severe PMSx.[8] However, in the Middle-East, prevalence ranged from 80% in Jordan to 35.3% among university students in Sharjah, UAE.[9,10] In a local university-based study in Riyadh, about 47% of women, aged 18–57 years, reported PMSx, with 10% of them reporting severe symptoms.[11]

Contradictory evidence is available regarding the relations of different lifestyle factors to PMSx. Tobacco consumption has been associated with a higher risk of PMSx, with a tendency of a dose–response relationship.[12,13] Coffee and tea, on the other hand, like most caffeinated beverages, have not been associated with more severe PMSx.[14] A sub-study of a large prospective cohort of 116,429 US female nurses observed no significant association between fat intake and higher PMSx risk.[15] However, in another study, maltose was associated with PMSx, while other carbohydrates and fibers were not.[16] Consuming foods rich in salt and sugar might be associated with PMSx.[10] Conversely, consumption of fish, fruits, as well as calcium, and vitamins D, E, and B6 have been observed to be protective against PMSx.[17,18]

In a Polish study conducted of 476 women, twice as many women with body mass index (BMI) <25 kg/m^2 had PMSx than those with a BMI ≥25 (kg/m^2).[19] These findings differ from those of a study by Bertone-Johnson et al, which revealed that women with BMI ≥27.5 kg/m^2 had a higher risk of PMSx.[20] A large number of studies have identified stress as a risk factor for the exacerbation of PMSx.[21] Hence, exploring the association between various lifestyle factors and PMSx in a local context is essential for identifying the key factors, which might suggest potential preventive measures. However, very few studies have examined PMSx in Saudi Arabian women, particularly examining PMSx risk factors such as, psychological distress, in this population. Thus, this study's objectives were to determine the associations of dietary habits, mental distress and lifestyle factors with PMSx and its prevalence among women, aged 18 to 50 years, in Riyadh, Saudi Arabia.

Materials and Methods

Study Design, Setting, and Participants

This was a cross-sectional survey conducted from December 2015 to June 2016. A list of 100 primary health care centers (PHCCs) was obtained from the Health Ministry. The online random number selection program (https://www.random.org/) was used to select 20 PHCCs from various administrative regions of Riyadh city (north, east, west, south, and center).

The inclusion criteria were mentioned on posters, pamphlets, and letters, stating that any Saudi women aged 18–50 years, who were not pregnant and were permanent residents of Riyadh city could participate. Exclusion criteria were women who were pregnant, previously had a hysterectomy, or were diagnosed with hormonal problems, such as polycystic ovarian syndrome or endometriosis, or those taking any form of contraception (hormonal or barrier method). Invitation flyers were written in the local language, stating the study's main objective and the method to contact the study staff.

Neither compensation nor any type of payment was offered to participants. Multiple strategies were adopted to invite the participants. These included placing advertisements and informational materials at the selected PHCCs and institutions (at least one week before the start of the study) and nearest largest shopping malls and handing invitations to other family members through patients/attendants visiting the PHCCs. About 2100 women were approached, and 2029 (96.6%) agreed to participate; 1896 (93.4%) women fulfilled the eligibility criteria. We excluded a further 65 women due to incomplete information; hence, complete interviews from 1831 women were included in the final analyses.

Data Collection Procedure

A team of five female data collectors were rigorously trained by the researchers to conduct the interviews. The data collectors were trained on developing rapport with the participants, explaining to them the reason for and importance of the study, answering their questions, trying to reduce any apprehensions related to confidentiality, and making participants comfortable in answering all types of questions. Training sessions were followed by a pilot study that was conducted on a separate sample of 50 participants to pretest the questionnaire and identify and overcome any logistic or technical issues. A separate room with closed doors was arranged for the interviews. Each participant was assigned a unique identity number, and participants' identification details were kept confidential during data entry, analysis, and

write-up of the manuscript. The study protocol was reviewed and approved by the King Saud Institutional Review Board, and all women provided written and signed informed consent.

Data Collection Tools

A detailed questionnaire in Arabic was used to collect information on sociodemographic factors, mental health, social support, smoking, physical activity and lifestyle. Menstrual history included age at menarche and pattern and duration of menstrual cycles. Detailed dietary history was taken regarding frequency of consumption of common food items, including meat, chicken, fish, rice, flour, bread, sweets, drinks, fast foods, snacks, etc. Frequency was noted as how many times a specific dietary item was consumed in a day, week, month or year. In addition, information was collected on consumption of specific vitamin supplements, with information on the quantity and frequency of intake. Physical activity was measured using the International Physical Activity Questionnaire (IPAQ-short) validated by World Health Organization.[22] Social support was measured using the brief four-itemed, multi-dimensional scale that was developed for patients in the Medical Outcomes Study.[23] The Cronbach's alpha value for the social support items was 0.83.

Premenstrual Symptoms

A symptom checklist was used to assess PMSx. The original checklist was translated and pretested after obtaining permission from the authors.[24] It comprised 12 symptoms: abdominal pain, breast pain, swelling of extremities, weight gain, increased appetite/weight gain, abdominal/back/joint pain, headaches, fatigue, changes in mood, anger, tension, and anxiety. For each symptom, a question inquired if, during the last year, the symptom had occurred during at least half of the menstrual periods and in the week before menses. If a participant answered yes to any one of the symptoms, she was further asked: Did this sign/symptom usually (more than half of the time) disappear within 1–3 days after the onset of periods? Based on the previous literature, the symptoms were further grouped under six symptom domains: anxiety/mood changes, abdominal/back/joint pain, increased appetite/weight gain, breast pain/tenderness, severe headache and ≥3 symptoms (any 3 or more symptoms) domain.[24] Additionally, two questions on increased and decreased sexual interest were asked only of married women. The Cronbach's alpha value for the translated PMSx scale was 0.87.

Kessler Psychological Distress Scale (K-10)

This is a ten-item questionnaire intended to yield a global measure of distress based on questions about anxiety and depressive symptoms that a person has experienced in the most recent 4-week period.[25] A Likert scale of the frequency (none of the time, little of the time, some of the time, most of the time, and all the time; scores range from 10 to 50) of experiencing each of five items was used. Scores under 20 indicate that the person is likely to be well; a score of 20–24 indicates that the person is likely to have a mild mental disorder, while a score of 25–29 indicates that the person is likely to have a moderate mental disorder. Scores of 30 and above indicates that the person is likely to have a severe mental disorder. The Cronbach's alpha value for the translated K-10 distress scale was 0.88. Participants having K-10 scores ≥25 were asked to have a follow-up with their family physician in the PHCC.

Anthropometric Measurements

Anthropometric indices included weight, which was measured with an electronic scale (Seca 220—Hamburg, Germany, 2009), and height, which was measured following the standard protocol for a stadiometer. Weight and height were used to calculate the body mass index (BMI) as weight (kg)/height in m)^2. BMI was divided into three categories by using the internationally recommended cut-offs:[26] normal BMI was 18.5–24.;, overweight was BMI of 25.0–29.9, and obese was BMI ≥30. Waist circumference (WC) was measured at the midpoint between the lowest rib and top of the hip bone (iliac crest). WC was divided into three categories for females according to the WHO criteria: no central obesity ≤80 cm; moderate central obesity = >80 to <88 cm; and high central obesity = ≥88 cm.

Statistical Analysis

The data were analyzed using the Statistical Package for the Social Sciences (IBM SPSS statistics version 21.0). Percentages/proportions and mean values with standard deviations were calculated for categorical and continuous

variables, respectively. Each of the symptom domains was converted to binary variable by labeling 1 as having symptoms and 0 as having no symptoms. Univariate analysis and multivariable logistic regression analyses, were conducted to calculate the unadjusted and adjusted, respectively, odds ratios (aOR) and 95% confidence intervals (CI). Frequency of consuming dietary items was converted to binary variable, with "frequent" defined as consuming an item on daily or weekly basis and "infrequent" meant monthly or yearly or never. Independent associations were observed for each of the six symptom domains with sociodemographic variables, K-10 score, diet, and lifestyle factors (independent variables). The independent variables and covariates that were significantly associated with any symptoms in univariate analyses caused a >10% change in the estimates, or were biologically plausible were entered into the multivariate analyses for each symptom domain. All plausible interactions were checked before the final model. The threshold for statistical significance was $p < 0.05$. The Hosmer–Lemeshow test was used to assess model fit.

Results

The mean age of participants women was 35.30 ± 8.90 years, with 66% (n = 1208) and 24% (n = 439) being aged ≥30 and <30 years, respectively (Table 1). Most were married (72%), university educated (61%), and working outside the home (45%). Approximately 60% had more than three children. The mean BMI and WC were 29.42 ± 6.89 cm and

Table 1 Sociodemographic Characteristics and Anthropometric Measurements of Women Aged 18–50 Years in Riyadh, Saudi Arabia (n = 1831)

Sociodemographic Characteristics	N (%)
Age in years (Mean (±SD)	35.30 (±8.90)
Marital Status	
Single	512 (28.0)
Married	1319 (72.0)
Educational level of participant	
Primary and below	211 (11.5)
Intermediate/Secondary	504 (27.5)
University and above	1116 (61.0)
Participant's Occupation	
Student	347 (19.0)
Housewife	660 (36.0)
Working women	824 (45.0)
Household Monthly Income (in SAR)*	
≥10,000	751 (41.0)
< 10,000	848 (46.0)
Do not know or do not want to tell	232 (13.0)
Smoking	
No	1779 (97.0)
Yes	52 (3.0)
Duration smoking among smokers (n=47)	
1–2 years	19 (40.4)
3–5 years	9 (19.1)
>5 −10 years	12 (25.5)
>10 years	7 (15.0)

(*Continued*)

Table 1 (Continued).

Sociodemographic Characteristics	N (%)
Anthropometric measurements	
Body Mass Index (kg/m^2) Mean (±SD)	29.42 (±6.89)
Normal (<25.0)	500 (27.0)
Overweight (≥25.0–29.9)	542 (30.0)
Obese (≥30.0)	789 (43.0)
Waist circumference (cms)	
Normal <80)	554 (30.0)
Moderate central obesity (80–88)	462 (25.0)
Severe central obesity (>88)	815 (45.0)
Physical activity	
High/moderate	782 (43.0)
Low	1049 (57.0)

Note: *10,000 SAR = 2666 USD.

87.44 ± 14.27 cm, respectively, with 73% of participants being overweight/obese (based on BMI) and around 70% having central obesity (WC >80 cms).

Smoking was rare, with only 3.0% of the women being current smokers, and over one-third of these having only started smoking during the last two years. The most frequently reported form of smoking was shisha (water-pipe), followed by cigarettes. More than 70% of the participants reported that they smoked shisha for 2 to 3 hours/day, and 20% were passively exposed to tobacco smoke. Approximately 57% (n = 1049) of the women reported low physical activity, while the rest were performing moderate-to-high activity.

Most women reported menarche between the ages of 12 and 14 years (74%), with regular current cycles (66%) (Table 2). A lack of emotional support was more frequently reported than lack of tangible support (43% vs 37.0%).

Table 2 Characteristics of Menstrual Cycles, Mental Distress and Social Support Reported by Women Aged 18–50 Years in Riyadh, Saudi Arabia (n = 1831)

Menstrual Cycle Characteristics	N (%)
Age at menarche	
≤ 11 years	228 (13.0)
12–14 years	1362 (74.0)
≥14 years	241 (13.0)
Pattern of menstrual cycles	
Becoming further apart	127 (7.0)
Becoming closer together	178 (9.5)
Varied pattern	320 (17.5)
Regular	1206 (66.0)
Length of menstrual cycles	
< 24 days	446 (24.0)
24–35 days	1021 (56.0)
>35 days	71 (4.0)
Irregular	293 (16.0)

(*Continued*)

Table 2 (Continued).

Menstrual Cycle Characteristics	N (%)
K-10 scores for mental distress	
Well (no distress) (<20)	703 (38.0)
Mild (20–24)	453 (25.0)
Moderate (25–29)	286 (16.0)
Severe (≥30)	389 (21.0)
Social support	
Someone to listen to you when you want to talk	
Mostly/Always	1050 (57.0)
Rarely/ not at all	781 (43.0)
Someone in whom to confide or discuss your problem	
Mostly/Always	1048 (57.0)
Rarely/ not at all	783 (43.0)
Someone to take you to the Doctor when needed	
Mostly/Always	1248 (68.0)
Rarely/ not at all	583 (32.0)
Someone to help with daily chores when sick	
Mostly/Always	1154 (63.0)
Rarely/ not at all	677 (37.0)

About one-third of the participants mentioned that they mostly discussed their problems with their siblings, whereas only 10% of them discussed their problems with their parents. The mean (±SD) scores for the K-10 were 23.03 ± 8.13. Approximately 21% of the women reported severe distress, with another 15.6% reporting moderate distress. The mean age of those with severe distress was 33.16 ± 8.5 years, which was significantly lower than that of women with normal scores (35.68 years, $p < 0.001$).

The majority (87%) of participants reported drinking Arabic coffee frequently, and most of them drank three to five cups per sitting (Table 3). Frequent consumption (daily or weekly) of a healthy diet, comprising vegetables and fruits, was reported by 85% and 57.5% women, respectively. However, most of them mentioned eating only one fruit per sitting. Cheese intake was frequent (86%), with 22% on an average consuming ≥4 slices per serving on daily/weekly basis. The most frequently reported supplements taken were vitamin D (18%) and calcium (9%).

Table 3 Frequency of Consumption of Dietary Items and Supplements Reported by Women Aged 18–50 Years in Riyadh, Saudi Arabia (n = 1831)

Dietary Items*	N (%)
Milk Intake	
Infrequent	664 (36.0)
Frequent	1167 (64.0)
Cheese	
Infrequent	257 (14.0)
Frequent	1574 (86.0)
Arabic coffee	
Infrequent	237 (13.0)
Frequent	1594 (87.0)

(*Continued*)

Table 3 (Continued).

Dietary Items*	N (%)
Nescafe	
Infrequent	1072 (58.5)
Frequent	759 (41.5)
Green Tea	
Infrequent	1451 (79.0)
Frequent	380 (21.0)
Red Tea	
Infrequent	391 (21.4)
Frequent	1440 (78.6)
Fruits	
Infrequent	779 (42.5)
Frequent	1052 (57.5)
Vegetables	
Infrequent	278 (15.0)
Frequent	1553 (85.0)
Dates	
Infrequent	543 (30.0)
Frequent	1288 (70.0)
Nuts	
Infrequent	1049 (57.0)
Frequent	782 (43.0)
Sugary items	
Infrequent	412 (22.5)
Frequent	1419 (77.5)
Fast Food	
Infrequent	903 (49.0)
Frequent	928 (51.0)
Processed food (sausages/smoked turkey/etc.)	
Infrequent	1591 (87.0)
Frequent	240 (13.0)
Carbonated drinks	
Infrequent	1040 (57.0)
Frequent	791 (43.0)
Multivitamin (any type)	
Yes	422 (23.0)
No	1409 (77.0)
Vitamin A	
Yes	25 (1.4)
No	1806 (98.6)
Vitamin B12	
Yes	40 (2.0)
No	1793 (98.0)

(*Continued*)

Table 3 (Continued).

Dietary Items*	N (%)
Vitamin D	
Yes	327 (18.0)
No	1504 (82.0)
Calcium	
Yes	165 (9.0)
No	1666 (91.0)
Cod liver oil	
Yes	34 (2.0)
No	1797 (98.0)
Soy supplements	
Yes	15 (1.0)
No	1816 (99.0)
Omega-3 supplements	
Yes	81 (4.4)
No	1750 (95.6)

Note: *Frequent means consuming a dietary item on daily or weekly basis and infrequent means monthly or yearly or never.

"Abdominal/back/joint pain" was the most frequently reported premenstrual symptom domain (90%), followed by "anxiety/anger symptoms" (79%) and "weight gain symptoms" (62%) (Table 4). Breast pain and headache were next most frequently reported, by 44% and 38% of participants, respectively. More than 40% of women

Table 4 Frequency of Premenstrual Symptoms Reported by Women Aged 18–50 Years in Riyadh, Saudi Arabia (n = 1831)

Premenstrual Symptoms	Yes, and Disappears Within 1–3 Days of Menstruation n (%)	Yes, But Does Not Disappear with Menstruation n (%)	Symptom Not Reported n (%)
Abdominal pain	1293 (71.0)	149 (8.0)	389 (21.0)
Breast Pain	808 (44.0)	231 (13.0)	792 (43.0)
Swelling of extremities	273 (15.0)	373 (20.0)	1185 (65.0)
Weight Gain	913 (50.0)	245 (13.0)	673 (37.0)
Changes in mood	1195 (65.0)	202 (11.0)	434 (24.0)
Anger/ aggressiveness	1045 (57.0)	192 (10.5)	594 (32.5)
Tension/ Irritability	924 (50.5)	220 (12.0)	687 (37.5)
Increase in appetite	594 (32.5)	284 (15.5)	953 (52.0)
Anxious/Jittery	1097 (60.0)	204 (11.0)	530 (30.0)
Back or joint pain	1290 (70.5)	258 (14.0)	283 (15.5)
Headache	692 (38.0)	377 (20.0)	762 (42.0)
Fatigue/ tired easily	1118 (61.0)	268 (15.0)	445 (24.0)
Decreased sexual interest*	450 (25.0)	78 (4.0)	1303 (71.0)
Increased sexual interest*	112 (6.0)	26 (1.5)	1693 (92.5)

Note: *Only from married women.

reported ≥3 symptoms. All symptoms were more frequently reported by single women, except for the "headache", which was more frequently reported among married women. Women aged 18–30 years reported all symptoms more frequently (except for back/joint pain) than those >30 years. Premenstrual fatigue, weight gain, swelling of extremities and breast pain did not significantly differ by age. In addition, a significant proportion of married women (24.6%, n = 450) reported less sexual desire between 1 and 3 days following onset of periods, whereas only 6% reported experiencing an increase in sexual desire prior to menstruation.

Multivariate analyses of variables related to symptoms under each domain were adjusted for marital status, occupation, and social support. A dose–response association was observed between the symptoms and increasing number of cups of coffee consumed. Drinking >5 cups of Arabic coffee was associated with a 2.44 (95% CI 1.44, 4.12), 1.83 (95% CI 1.13, 2.98), 1.66 (95% CI 1.10, 2.50), 1.57 (95% CI 1.00, 2.56), and 1.50 (95% CI 1.07, 2.11) times greater likelihood of reporting abdominal/back/joint pain, severe headache, anxiety/mood changes, ≥3 symptoms, and increased appetite/weight gain, respectively (Table 5). Similar to ingestion of Arabic coffee, frequent consumption of sugary items was significantly associated with PMSx, after adjusting for potential confounders, particularly for anxiety/mood changes

Table 5 Multiple Logistic Regression Results (Adjusted Odds Ratios [OR] and 95% Confidence Intervals [CI]) for Factors Related to Premenstrual Symptom Domains in Women Aged 18–50 Years in Riyadh, Saudi Arabia

Variables	Mood Changes	Abdominal/ Back/Joint Pain	Increased Appetite/ Weight Gain/ Bloating	Breast Tenderness	Severe Headache	PMS ≥3
Arabic coffee						
Infrequent	**1.0**	**1.0**	**1.0**	1.0	1.0	1.0
1–2	**1.54**	**1.84**	1.35	*NS*	**1.85**	1.41
	(1.00, 2.38)	**(1.07, 3.15)**	(0.94, 1.91)		**(1.10, 3.08)**	(0.84, 2.37)
3–5	**1.67**	**2.26**	1.21		**1.76**	1.34
	(1.13, 2.47)	**(1.39, 3.69)**	(0.88, 1.67)		**(1.09, 2.86)**	(0.83, 2.18)
>5	**1.66**	**2.44**	**1.50**		**1.83**	**1.57**
	(1.10, 2.50)	**(1.44, 4.12)**	**(1.07, 2.11)**		**(1.13, 2.98)**	**(1.00, 2.56)**
K-10 (scores)						
Well (<20)	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
Mild	**2.08**	1.48	**1.59**	**1.45**	1.02	**1.75**
(20–24)	**(1.51, 2.84)**	(0.96, 2.27)**	**(1.23, 2.04)**	**(1.12, 1.86)**	(0.76, 1.36)	**(1.29, 2.37)**
Moderate	**2.85**	**1.88**	**1.80**	**1.79**	**1.93**	**3.09**
(25–29)	**(1.89, 4.29)**	**(1.10, 3.23)**	**(1.33, 2.43)**	**(1.32, 2.41)**	**(1.38, 2.70)**	**(2.15, 4.42)**
Severe (≥30)	**2.75**	1.45	**2.01 (1.53, 2.65)**	**2.19**	**1.86**	**3.52**
	(1.92, 3.94)	(0.92, 2.28)		**(1.68, 2.88)**	**(1.37, 2.54)**	**(2.49, 4.95)**
Sugary foods						
Infrequent/ none	1.0	1.0				
1–2	0.91	1.36	*NS*	*NS*	*NS*	*NS*
	(0.63, 1.31)**	(0.86, 2.15)				
≥3	**1.53**	**1.84**				
	(1.07, 2.19)	**(1.17, 2.88)**				
Educational level						
Primary/Illiterate	**1.0**		**1.0**	**1.0**		1.0
Secondary /intermediate	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
University &above	**1.76**		**1.90**	**1.69**		**2.03**
	(1.21, 2.56)		**(1.37, 2.64)**	**(1.21, 2.37)**		**(1.39, 2.96)**
Age category						
>30–50	**1.0**				**1.0**	
18–30	1.35	*NS*	*NS*	*NS*	**1.57**	*NS*
	(0.93, 1.97)**				**(1.12, 2.19)**	

(*Continued*)

Table 5 (Continued).

Variables	Mood Changes	Abdominal/ Back/Joint Pain	Increased Appetite/ Weight Gain/ Bloating	Breast Tenderness	Severe Headache	PMS ≥3
Duration of smoking*						
No smoking	*NS*	*NS*	*NS*	*NS*	*NS*	1.0
1–2 years						*NS*
≥ 3 years						**3.41 (1.19, 9.77)**
BMI (kg/m^2)***						
Normal			**1.0**			
Overweight	*NS*	*NS*	1.26 (0.96, 1.66)**	*NS*	*NS*	*NS*
Obese			**1.63 (1.24, 2.14)**			
Physical activity						
High/moderate				1.0		
Low	*NS*	*NS*	*NS*	**1.29 (1.04, 1.59)**	*NS*	*NS*

Notes: All associations were adjusted for age, marital status, occupation, social support. Values in bold are significant results with p <0.05. *This was inquired from women who were current smokers. **Marginally significant with p=0.07. ***BMI (kg/m^2) cut-offs: Normal (<25.0), Overweight (≥25.0–29.9), Obese (≥30.0). In addition to above associations, following associations were also significant. Current smoking was 2.69 (1.22, 5.95) times associated with increased appetite/weight gain. Frequent fast food 2.03 (1.24, 3.32) and dates intake (0.69 (0.49, 0.98) associated with increased appetite/weight gain. Cheese slices >5 were associated with mood/anxiety domain and abdominal/back/joint pain domain. Central obesity (waist circumference >80 cms) 1.37 (1.01, 1.86) associated with severe headache. Aged 12–14 years at menarche 1.67 (1.04, 2.68) associated with abdominal/back/joint pain domain.

[aOR 1.53 (95% CI 1.07, 2.19)] and abdominal/back/joint pain [aOR 1.84 (95% CI 1.17, 2.88)]. Smoking for ≥3 years was associated with having ≥3 PMSx [aOR 3.41 (95% CI 1.19, 9.77)], whereas being a current smoker was associated with increased appetite/weight gain [aOR 2.69 (95% CI1.22, 5.95)]. Low physical activity was significantly associated only with the breast pain [aOR1.29 (1.04, 1.59)].

Significant increases in aORs were observed for the association between different levels of distress (mild, moderate, and severe) and the symptom domains (Table 5). Moderate distress was associated with a 2.85 (95% CI 1.89, 4.29), 1.88 (95% CI 1.10, 3.23), 1.80 (95% CI 1.33, 2.43), 1.79 (95% CI 1.32, 2.41), 1.93 (95% CI 1.38, 2.70), and 3.09 (95% CI 2.15, 4.42) times greater likelihood for reporting anxiety/anger, abdominal/back/joint pain, increased appetite/weight gain, breast pain, severe headache, and ≥3 premenstrual symptoms, respectively. Similarly, severe distress was associated with 1.86 (95% CI 1.37, 2.54), to 3.52 (95% CI 2.49, 4.95) times of reporting all symptom domains except for abdominal/back/joint pain.

After adjustment for covariates, young women aged 18–30 years reported symptoms more frequently and were 1.35 (95% CI 0.93, 1.97) times as likely to report anxiety/mood changes, compared to women aged >30–50 years, but severe headache was more frequently reported by women aged >30–50 years (aOR 1.57, 95% CI 1.12, 2.19) (Table 5). Compared to women who were illiterate or had only a primary level education, the university-educated group were almost twice as likely to report all symptom domains (except back/join pain or severe headache): anxiety/mood changes [aOR 1.76 (95% CI 1.21, 2.56)], increased appetite/weight gain [aOR 1.90 (95% CI 1.37, 2.64)], breast pain [aOR 1.69 (95% CI 1.21, 2.37)], and ≥3 symptoms [aOR 2.03 (95% CI 1.39, 2.96)]. Compared to normal-weight women, women who were obese had increased appetite/weight gain [aOR 1.63 (95% CI 1.24, 2.14)], and those with central obesity (moderate and severe combined) were more likely to report severe headache [aOR 1.37 (1.01, 1.86)] than those without central obesity.

Multivariate analyses for the sexual symptoms revealed no factor significantly associated with an increase in sexual desire, whereas a decrease in sexual desire was significantly associated with moderate distress [aOR 1.45 (95% CI 1.01, 2.08)], severe distress [aOR 1.59 (95% CI 1.13, 2.22)], and university-level education [aOR 1.66 (95% CI 1.14, 2.41)]. No significant association was observed for sexual symptoms with dietary intake, physical activity or smoking.

Discussion

In addition to the majority of women reporting having experienced PMSx, several important associations with dietary, psychological distress and lifestyle factors were identified. Significant associations were observed with varying PMSx for intake of different dietary items, psychological distress, and lifestyle factors such as physical activity and smoking. Additionally, our study demonstrated more symptom reporting among young women aged 18–30 years than among older women, which is similar to results reported in previous studies, which demonstrated that more frequent and more severe PMSx were reported in young women, especially among university students.[49,50]

Many studies have highlighted the association between PMSx and diet.[24] Arabic coffee intake has been associated with higher prevalence of PMSx.[27] Most women in the present study drank three to five cups per sitting. One ounce of Arabic coffee contains 40 milligrams of caffeine, while a 4-ounce cup of Arabica drip brewed coffee contains 100 milligrams of caffeine.[28] Arabic coffee is thus considered a mild drink due to its low dose of caffeine per cup. In the current study, a dose–response association was observed between all domains of PMSx (except breast tenderness and headache) and the number of cups of coffee consumed, with increasing number of cups associated with higher adjusted odds ratios. This finding was consistent with the results of a previous Saudi study that showed a significant, positive, and independent effect on PMSx of total intake of caffeinated coffee.[29] Caffeine could either affect or exacerbate symptoms of anxiety or depression and may exacerbate these symptoms during the premenstrual period.[29] In the literature, a large variation has been observed in the evidence of caffeine intake being related to PMSx. Several publications have confirmed that women with PMSx tended to consume more caffeine than those without such symptoms. The ACOG recommended that women who experience PMSx should avoid caffeine consumption.[30] However, women who experience fatigue may try to treat this symptom with increased caffeine consumption.[14] Women could have a slower response time in cognitive (psychomotor) tasks during their luteal phase than during their follicular phase.[30] Higher caffeine intake has been associated with lower luteal phase concentrations of estradiol and higher concentrations of progesterone.[31] Thus, some women may self-medicate themselves with caffeine during the premenstrual period.[31] The depressive action of adenosine on central neurons could be the mechanism by which caffeine might affect PMSx.[32]

Many studies, however, have failed to demonstrate a significant association between caffeine intake and PMSx.[14] When comparing women with the highest and lowest caffeine intakes in these studies, even high caffeinated coffee intake was not significantly positively associated with PMSx or any specific symptoms, such as breast tenderness.[14] One of the theories about the association between coffee and PMSx is that women who drink high amounts of caffeine are smokers, which could cause a false association between caffeine intake and PMSx.[33,34] One study found that caffeine intake was higher in heavy smokers than in nonsmokers.[12] However, our results for the association of symptoms with number of coffee cups consumed were statistically significant even after adjusting for smoking.

Previous studies have highlighted the significant association between smoking and PMSx.[12] In the current study, smoking was rare, as only 2.5% of the women were current smokers. Smoking and the duration of smoking were both associated with reporting ≥3 symptoms. Many publications have confirmed the association between smoking status and depressive symptoms/anxiety during the premenstrual period.[33,34] This could be explained by the effect of cigarette smoking on dysregulating estrogen, progesterone, androgen, and gonadotropin levels, which might be involved in the etiology of PMSx.[35] Smoking might lead to development of PMSx, or worsen the affective symptoms in women with PMSx, as nicotine's effect on neurocircuitry is an increased susceptibility to environmental stressors. Nicotine potentiates the hypothalamic–pituitary–adrenal axis, resulting in the hypersecretion of cortisol and alterations in the activity of the associated monoamine neurotransmitter system.[35]

In the current study, the consumption of sugar was significantly positively associated with the anxiety/mood and pain symptom domains. Arabic coffee is bitter, but typically, no sugar is added. Instead, most Saudis like to eat sweet-tasting food while drinking Arabic coffee.[29] A significant and independent increase in the prevalence of PMSx with intake of high-sugar foods was also observed in a previous Saudi study; however, the study was comprising of young women only (aged 17 −27 years).[29] The positive association between the consumption of high-sugar foods and PMSx havs been reported in many previous studies.[10,36] Many women change their eating habits during the premenstrual period, especially in consuming chocolates and sweets.[24] Food cravings and binge eating of specific food items like

high-sugar foods have been reported more frequently by women in the luteal phase of the menstrual cycle.[37–39] High-sugar foods may improve emotion and ameliorate the effects of stress through brain opioidergic and dopaminergic neurotransmission.[40] Repeated short-term positive experiences after the ingestion of sweet foods might create positive emotional expectations for the ingestion of sweets, thus making women temporarily happier when feeling low, anxious, or irritated. Depressed women might have more emotional eating to improve their negative emotion.[40]

Serotonin level dropping during PMSx is one of the hypotheses explaining the increased high-sugar food intake during PMSx. Sugar cravings may be a physiological response to serotonin deficiency. The increased production of serotonin relieves symptoms; so, craving for sweet foods like chocolate would be an unconscious way of improving such symptoms, since by increasing serotonin levels, a balance would be achieved as a form of relief; thus, eating sweets may reduce irritability or promote a positive mood. Temporarily, PMSx might be reduced; however, the long-term intake of sugars might worsen PMSx.[40] Estrogen and progesterone levels have been linked to disordered eating during PMSx. Day-to-day associations have been observed between ratings of emotional eating and estradiol and progesterone levels.[41] Reducing consumption of high-sugar foods might thus be associated with a decreased prevalence of PMSx.[42,43]

Consumption of dairy products, especially calcium, has been associated with a reduction in PMSx;[44] however, after adjusting for covariates, we did not find any significant association. The cyclic fluctuations in calcium levels may help to explain some features of PMSx.[44,45] Evidence suggests that estrogen has calcium antagonistic properties, inhibiting calcium flow thus decreasing calcium entry into vascular smooth muscle.[46]

Differing distress levels were associated with different symptoms. This finding is consistent with the results of previous research that confirmed the correlation between PMSx and changes in emotional processes.[47] Women with high stress reported more frequent and severe episodes of PMSx. Several publications have reported that moderate or severe PMSx were reported during the cycle that was preceded by higher stress levels,[48] hence a cumulative effect of chronic distress on the symptom severity is possible. Some literature has suggested that stress reduction programs could help in mitigating these symptoms, so that women might not need medical therapy.[36]

Our findings regarding the associations of a number of dietary items with several PMSx indicate the importance of providing menstruating women with information about dietary risk factors for PMSx so that they might change their dietary intake to help reduce their symptoms. It would also be useful to undertake a trial of dietary changes in relation to PMSx and a trial of a stress reduction program to see if it can help women to cope with stress and potentially reduce PMSx. In addition, it is important to organize health promotion programs and create awareness about PMSx and its dietary, lifestyle and mental distress correlates among menstruating women and health care professionals. The key messages can be posted using the local health apps so that women are made aware about these issues.

Strengths and Weaknesses

The present study had several strengths. First, the large sample size was a major strength, allowing sufficient statistical power to detect modest and meaningful associations as statistically significant. Second, the study sample was selected by probability sampling (the PHCCs were selected randomly, and all eligible participants were approached and invited) which made the sample representative of the varying genetic, racial and socioeconomic backgrounds of menstruating Saudi women seen in these clinics, so that the results of the study can be generalized to those from varying backgrounds. Some limitations should also be noted. First, inaccuracy in recall could have resulted in misclassification of symptoms and potential bias if recall of symptoms differed by characteristics of the participants. Second, the classification of frequent and infrequent consumption of dietary items may have resulted in misclassification, which could have in turn resulted in under- or over-estimation of effects on PMSx. Third, the multiple comparisons made may have resulted in significant findings by chance. Finally, the cross-sectional design did not permit assessment of whether the factors examined actually preceded new onset of PMSx or followed such onset.

Conclusion

This study identified the significant associations between PMSx in women and the consumption of high-sugar foods and Arabic coffee and mental distress. Further, the results of this study highlight the need to increase women's awareness about healthy lifestyles, including dietary habits and stress reduction programs, which could help reduce PMSx. Patient

education and potential involvement of women's partners in understanding the factors associated with PMSx may assist in providing supportive behaviors and thus potentially preventing or reducing such symptoms.

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Disclosure

The authors report no conflicts of interest in this work.

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