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Neighborhood Socioeconomic Status and Premenstrual Symptoms: A Cross-sectional Study of Young Japanese Women

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Abstract: Recent evidence suggests reduced levels of serotonin, which may be associated with premenstrual symptoms, among populations in socioeconomically disadvantaged areas. In this cross-sectional study, we examined the association between neighborhood socioeconomic status (SES) and premenstrual symptoms. Participants were 640 female Japanese dietetic students aged 18–22 years, residing in 210 municipalities in Japan. Neighborhood SES index was defined by seven municipal-level variables (unemployment, household overcrowding, poverty, education, income, home ownership, and vulnerable groups), with an increasing index signifying increasing neighborhood socioeconomic disadvantage. Menstrual cycle symptoms were assessed using the Moos Menstrual Distress Questionnaire, from which subscale (pain, concentration, behavioral change, autonomic reactions, water retention, and negative affect) and total scores in the premenstrual phase were calculated and expressed as percentages relative to those in the intermenstrual phase. Neighborhood SES index was positively associated with pain score in the premenstrual phase ($P = 0.02$). This association remained after adjustment for potential confounding factors ($P = 0.008$). Neighborhood SES index also showed a positive relation with water retention score in the premenstrual phase ($P = 0.03$), although not independently of potential confounding factors ($P = 0.14$). However, no association was seen between neighborhood SES index and other subscale scores or total score in the premenstrual phase ($P > 0.05$). In conclusion, neighborhood socioeconomic disadvantage was independently associated with higher pain in the premenstrual phase, although a clear relationship with premenstrual symptoms was not found. Considering the plausibility of the proposed mechanism, however, further investigation using more relevant neighborhood SES indicators is warranted.

Keywords: neighborhood socioeconomic status, premenstrual symptoms, epidemiology

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Introduction

Premenstrual symptoms are characterized by a set of behavioral, somatic, and affective symptoms of varying severity which occur during the 7–10 days prior to the onset of menstruation and subside after the beginning of the menstrual flow. Although the etiology of premenstrual symptoms is largely unknown, it is suggested that serotonin may be important in the pathogenesis of premenstrual symptoms, although it may be associated with more severe spectrum of the disorders; reduction in brain serotonin neurotransmission is thought to lead to mood and behavioral symptoms associated with premenstrual symptoms, such as poor impulse control, depressed mood, and irritability.[1–3] A wide range of physiological and behavioral factors associated with premenstrual symptoms has been reported.[4–7] However, current evidence suggests that neighborhood socioeconomic status (SES) is associated with brain serotonin; Manuck and colleagues found that neighborhood socioeconomic advantage was independently associated with brain serotonergic responsivity.[8] On this basis, neighborhood socioeconomic advantage might reduce some (unknown) factors that may act to lower brain serotonin, which in turn acts to alleviate premenstrual symptoms, although it is unknown whether all premenstrual symptoms are similarly affected or some symptoms are specifically affected by neighborhood SES. To our knowledge, however, the relation between neighborhood SES and premenstrual symptoms has not been investigated. In this cross-sectional study of young Japanese women, we examined the association between a neighborhood SES index, recently formulated for Japanese conditions,[9] and premenstrual symptoms, assessed with a widely used questionnaire, the Moos Menstrual Distress Questionnaire (MDQ).[10] Although there are no direct measures of serotogergic activity in the present study and lower levels of serotonin are only inferred to occur in women endorsing premenstrual symptoms, this preliminary study would make a considerable contribution to a poorly understood research area.

Methods

Study sample

The present study was based on a cross-sectional multicenter survey conducted from January to March 2007 among female dietetic students from 11 institutions in Japan. This limited population (a homogeneous population in terms of individual-level SES and age, and thus possibly lifestyle factors) was selected to minimize possible effects of confounding factors, particularly individual-level SES, and to maximize the quality of data obtained from questionnaires. All measurements at each institution were conducted according to the survey protocol. Staff at each institution explained an outline of the survey to potential subjects (volunteers). Those who agreed to participate were then provided detailed written and oral explanations of the survey's general purpose and procedure. The protocol of the study was approved by the Ethics Committee of the National Institute of Health and Nutrition, and written informed consent was obtained from each subject, and also from a parent for subjects aged < 20 years.

In Japan, the total of 2372 municipalities consisted of the 164 wards, 736 cities, 1178 towns, and 294 villages (as of October 1, 2005).[11] We used municipalities as proxies for neighborhoods,[12,13] although municipality in Japan may be a somewhat large unit of neighborhoods (given that the median population of municipalities appearing in the present study was 113268 (interquartile range = 95662, 274481)). Nevertheless, this procedure is in accordance with previous Western studies where some administrative divisions are used as proxies for neighborhoods.[8,14] Study participants were linked to their municipalities using their home address.

A total of 702 Japanese women took part. For analysis, we selected women aged 18–22 years (n = 687). We then excluded women not completing the survey questionnaires (n = 1), those not completing anthropometric measurements (n = 2), those who had been pregnant at any time in the preceding year (n = 3), those with diagnosed endometabolic diseases such as diabetes and thyroid diseases (n = 4), those currently taking oral contraceptives (n = 7) or steroid hormones (n = 16), those who had few or no menstruations during the preceding year (n = 9), those currently receiving dietary counseling from a doctor or dietitian (n = 7), and those not providing sufficient information on residential address (n = 11). As some participants were in more than one exclusion category, the final analysis sample comprised 630 women, who resided in 210 municipalities in Japan.

Neighborhood SES

We constructed a neighborhood SES index at the municipality level[12,13] using seven variables determined by

a factor analysis.[9] These variables were unemployment (percentage of unemployed persons aged ≥ 15 years); household overcrowding (average floor space per residential dwelling); poverty (number of households receiving public assistance per 1000 households); education (percentage of persons aged 20–64 years who had completed college or university); income (total taxable income divided by total population); home ownership (percentage of owned houses to total residential households); and vulnerable groups (percentage of households of single persons aged ≥ 65 years to total households).[9] Data were derived from the 2005 Census[11] and other governmental surveys.[11,15,16] These seven variables were combined into a neighborhood summary score (i.e. neighborhood SES index) constructed by summing Z scores for each of the seven variables (for unemployment, poverty, income, and vulnerable groups, data were log transformed before calculating Z scores; Z scores for household overcrowding, education, income, and home ownership were multiplied by −1 before summing), with a higher neighborhood SES index signifying increasing neighborhood socioeconomic disadvantage.[9,12,13]

Premenstrual symptoms

Menstrual cycle symptoms during the preceding year were assessed using the Japanese version[6] of Magos and colleagues' modification[17] of the retrospective version of the Moos Menstrual Distress Questionnaire (MDQ).[10] The MDQ, incorporated into the lifestyle questionnaire, consists of a total of 45 symptom items,[17] which are grouped into eight subscales:[10] pain, concentration, behavioral change, autonomic reactions, water retention, negative affect, arousal, and non-specific adverse symptoms designed to detect those experiencing symptoms (control). Each symptom item was rated by each subject on a 5-point scale from 1 (no experience of the symptom) to 5 (disabling or incapacitating experience of the symptom),[6] separately for the three menstrual cycle phases [menstrual (during menstrual flow), premenstrual (the week before the beginning of menstrual flow), and intermenstrual (remainder of cycle) phases].[10] The MDQ scores were calculated for each subscale and the total score (excluding arousal and control) for each cycle phase.[6,18] The total and subscale MDQ scores in the premenstrual phase expressed as percentages relative to those in the intermenstrual phase were used in the present study.[7]

Statistical analysis

All statistical analyses were performed using SAS statistical software version 9.1 (SAS Institute Inc., Cary, NC, USA). Using the PROC GLM procedure, linear regression models were constructed to examine the association of neighborhood SES index with subscale and total MDQ scores in the premenstrual phase. For analyses, participants were categorized into quartiles according to neighborhood SES index. Both crude and multivariate-adjusted mean values (with 95% confidence intervals) of MDQ scores in the premenstrual phase were calculated by quartile of neighborhood SES index. Potential confounding or mediating factors included in the multivariate models were physiological factors, i.e. age, age at menarche, body mass index, usual length of the menstrual cycle, usual number of days of bleeding, and menstrual cycle phase at the time of the study,[7] geographical factors, i.e., region and municipality level,[12,13] household SES factors, i.e. institution type[12,13,19] and living status,[12,13,20] and lifestyle factors, i.e. current smoking, current alcohol drinking, physical activity, and dietary glycemic index.[7] These variables were selected based on previous research on the association between lifestyle factors and premenstrual symptoms.[4–7] We tested for linear trends with increasing levels of neighborhood SES index by assigning each participant the median value for the category and modeling this value as a continuous variable. All reported p values are two-tailed, and a p value of <0.05 was considered statistically significant. As the great majority of municipalities had only a few study participants (median = 1; interquartile range = 1, 2), no special methods were needed to account for within-neighborhood correlations in outcomes.[12,13,21,22]

Results

Mean subscale MDQ scores in the premenstrual phase (expressed as percentages relative to that in the intermenstrual phase) ranged from 107.0% (autonomic reactions) to 143.8% (water retention). Mean total MDQ score in the premenstrual phase was 125.8%.

Neighborhood SES characteristics according to quartile of neighborhood SES index are also shown in Table 1. Neighborhood SES index was associated

Table 1. Neighborhood socioeconomic status characteristics according to quartile category of neighborhood socioeconomic status index (n = 630).[a]

Variable	All (n = 630)	Quartile 1 (least disadvantaged) (n = 156)	Quartile 2 (n = 167)	Quartile 3 (n = 139)	Quartile 4 (most disadvantaged) (n = 168)	P[b]
Neighborhood socioeconomic status index (median)	–0.12	–3.15	–0.83	0.15	3.31	–
Neighborhood socioeconomic status index (range)	–12.21, 26.98	–12.21, –2.16	–2.15, –0.12	–0.11, 1.15	1.16, 26.98	–
Percentage of unemployed persons aged 15 years and over[c]	6.0 (5.9, 6.1)	5.2 (5.1, 5.3)	6.7 (6.6, 6.7)	7.3 (7.2, 7.5)	7.8 (7.6, 8.1)	<0.0001
Average floor space per residential dwelling (m^2)	90.8 (89.3, 92.3)	97.9 (94.5, 101.2)	88.3 (85.8, 90.7)	90 (87.2, 92.9)	87.3 (84.2, 90.3)	<0.0001
Number of households receiving public assistance (1000 households)[c]	14.3 (13.7, 14.9)	8.9 (8.4, 9.4)	16.5 (15.8, 17.2)	13 (12.1, 13.8)	24.6 (22.9, 26.5)	<0.0001
Percentage of persons completing college or university aged 20 to 64 years	33.1 (32.5, 33.7)	35.7 (34.2, 37.1)	35.9 (34.6, 37.1)	31.2 (30.2, 32.2)	29.6 (28.6, 30.5)	<0.0001
Total taxable income divided by total population (thousand yen)[c]	1440 (1418, 1463)	1554 (1500, 1611)	1552 (1515, 1589)	1406 (1368, 1445)	1275 (1244, 1307)	<0.0001
Percentage of owned houses to total residential households	62.9 (62.0, 63.7)	68.2 (66.4, 70.1)	62.8 (61.5, 64.1)	63.1 (61.7, 64.5)	57.6 (55.8, 59.5)	<0.0001
Percentage of households of single persons aged 65 years and over to total households[c]	6.6 (6.5, 6.8)	5.3 (5.1, 5.5)	7.3 (7.1, 7.5)	7.5 (7.3, 7.7)	9.5 (9.3, 9.8)	<0.0001

[a]Values are mean (95% confidence interval) unless otherwise indicated.
[b]A linear trend test was used with the median value in each quintile category as a continuous variable in linear regression.
[c]Calculated using back transformation of natural-log transformed values.

with each of the seven neighborhood SES variables in the expected direction.

Physiological, geographical, household SES, and lifestyle characteristics according to quartile of neighborhood SES index are shown in Table 2. Neighborhood SES index was also associated with age, region, municipality level, and institution type. The higher quartiles of neighborhood SES index (increasing neighborhood socioeconomic disadvantage) had higher mean age and included more participants living in Hokkaido and Tohoku, Chugoku and Shikoku, and Kyushu, and fewer participants living in Kanto; more participants living in wards and fewer living in cities, and towns and villages; and more participants attending 4-year and 2-year private institutions.

MDQ scores in the premenstrual phase according to quartile of neighborhood SES index are shown in Table 3. Higher neighborhood SES index (increasing neighborhood socioeconomic disadvantage) was significantly associated with higher pain score in the premenstrual phase. This significant association remained after adjustment for not only possible confounding factors (physiological, geographical, and household SES variables) but also potential mediating factors (lifestyle factors). Higher neighborhood SES index was also associated with higher water retention score in the premenstrual phase, although this was not independent of potential confounding or mediating factors. However, no association was seen between neighborhood SES index and other subscale scores including concentration, behavioral change, autonomic reactions, and negative affect, as well as total MDQ scores in the premenstrual phase.

Discussion

In this preliminary cross-sectional study of young Japanese women, no evident association was observed between neighborhood SES and premenstrual symptoms, although increasing neighborhood socioeconomic disadvantage was independently associated with higher pain in the premenstrual phase. To our knowledge, this is the first study to examine the relationship between neighborhood SES and premenstrual symptoms.

Although the etiology of premenstrual symptoms is largely unknown, current evidence suggests that they may arise from a decrease in brain serotonin neurotransmission.[1–3] Another line of evidence suggests lower levels of serotonin among populations in socioeconomically disadvantaged areas than in socioeconomically advantaged areas.[8] On this basis, neighborhood socioeconomic advantage might reduce some (unknown) factors that may act to lower brain serotonin, which in turn acts to alleviate premenstrual symptoms. However, owing to the lack of both a clear association between neighborhood SES and premenstrual symptoms and measurement of brain serotonergic responsivity, we can only speculate on this mechanism. Nevertheless, we observed an association of neighborhood SES with at least some aspects of premenstrual symptoms (such as pain and water retention) in the expected direction. We are unable to explain why we found the association only for some aspects of premenstrual symptoms (particularly pain). This may be due to potential measurement error in neighborhood SES and premenstrual symptoms, as described below. Statistical chance is also possible. Alternatively, neighborhood SES might not necessarily be associated with premenstrual symptoms, at least among Japanese women, given that although serotonergic function is the presumed mediator of premenstrual symptoms, it may not be the only reason for the occurrence of symptoms. This might be supported by several findings from Asian populations that depression, a disorder possibly caused by decreasing brain serotonin, is not related to SES, as assessed at the individual level at least.[23,24]

Several limitations of the present study warrant mention. First, the cross-sectional nature of the study did not permit the assessment of causality owing to the uncertain temporality of the association although, as mentioned above, a biologically plausible mechanism for the relationship between neighborhood SES and premenstrual symptoms has been identified.

Second, the participants were selected female dietetic students, not a random sample of Japanese people. Further, owing to the recruitment procedure used the response rate could not be precisely determined, although the approximate rate was 63%. These elements of the design may have produced recruitment bias. Thus, our results might not apply to the general Japanese population.

Third, we relied on census-based measures at the municipality level as proxies for neighborhoods, but these might not correspond to socially defined neighborhoods. Our study is also limited by the use of the

Table 2. Physiological, geographical, household socioeconomic status, and lifestyle characteristics according to quartile category of neighborhood socioeconomic status index (n = 630).[a]

Variable	All (n = 630)	Quartile 1 (least disadvantaged) (n = 156)	Quartile 2 (n = 167)	Quartile 3 (n = 139)	Quartile 4 (most disadvantaged) (n = 168)	P[b]
Age (years)	19.7 (19.6, 19.8)	19.5 (19.3, 19.7)	19.6 (19.5, 19.8)	19.3 (19.1, 19.4)	20.2 (20.0, 20.4)	<0.0001
Age at menarche (years)	12.3 (12.2, 12.4)	12.3 (12.1, 12.6)	12.2 (12.0, 12.4)	12.3 (12.0, 12.6)	12.4 (12.2, 12.6)	0.47
Body mass index (kg/m^2)	21.4 (21.2, 21.6)	21.0 (20.6, 21.3)	21.2 (20.8, 21.6)	21.9 (21.5, 22.4)	21.4 (20.9, 21.8)	0.13
Usual length of menstrual cycle (day)	31.9 (31.0, 32.8)	31.9 (30.3, 33.6)	30.7 (29.5, 32.0)	32.6 (30.2, 34.9)	32.5 (30.7, 34.3)	0.46
Usual number of days of bleeding	6.1 (6.0, 6.2)	6.2 (5.9, 6.4)	6.1 (5.9, 6.3)	6.0 (5.8, 6.2)	6.3 (6.1, 6.5)	0.29
Menstrual cycle phase at the time of the study (%)						0.86
Menstrual	19.1	19.9	16.8	18.0	21.4	
Premenstrual	27.9	29.5	30.5	27.3	24.4	
Intermenstrual	53.0	50.6	52.7	54.7	54.2	
Region (%)						<0.0001
Hokkaido and Tohoku	4.3	0	1.2	0.7	14.3	
Kanto	50.2	62.2	65.9	60.4	14.9	
Hokuriku and Tokai	11.6	6.4	18.0	20.1	3.0	
Kinki	16.7	28.2	13.2	0.7	22.6	
Chugoku and Shikoku	6.0	1.3	0.6	0	20.8	
Kyushu	11.3	1.9	1.2	18.0	24.4	
Municipality level (%)						<0.0001
Ward	15.2	8.3	9.0	9.4	32.7	
City	80.6	80.1	89.8	89.2	64.9	
Town and village	4.1	11.5	1.2	1.4	2.4	
Institution type (%)						<0.0001
4-year private	65.4	59.6	53.9	73.4	75.6	
2-year private	5.9	1.9	1.2	19.4	3.0	
4-year public	11.8	23.7	1.2	3.6	17.9	
2-year public	17.0	14.7	43.7	3.6	3.6	
Living status (%)						0.77
Living with family	57.3	57.7	64.6	40.3	63.7	

Living alone	38.4	38.5	31.1	55.4	31.6	
Living with others	4.3	3.9	4.2	4.3	4.8	
Current smokers (%)	2.2	1.3	0.6	3.6	3.6	0.06
Current alcohol drinkers (%)	42.5	38.5	45.5	36.0	48.8	0.19
Physical activity (total metabolic equivalents-hours/day)	33.8 (33.6, 34.0)	33.7 (33.4, 34.1)	34.0 (33.5, 34.4)	33.7 (33.3, 34.1)	33.9 (33.4, 34.4)	0.62
Dietary glycemic index	65.4 (65.1, 65.7)	65.2 (64.6, 65.8)	65.5 (65.0, 66.0)	65.2 (64.4, 66.0)	65.7 (65.1, 66.4)	0.26

[a]Values are mean (95% confidence interval) unless otherwise indicated.
[b]For continuous variables, a linear trend test was used with the median value in each quintile category as a continuous variable in linear regression; for categorical variables, a Mantel-Haenszel chi-square test was used.

neighborhood SES score as an indirect proxy for the specific features of neighborhoods that may be more relevant.[22]

Fourth, we assessed premenstrual symptoms using a retrospective questionnaire (i.e. MDQ). Notwithstanding that this method is often the only choice in large-scale epidemiologic research, it has been criticized for providing an inflated estimation of symptom severity and its heavy reliance on subject memory of past menstrual-related symptoms. The MDQ is the most widely recognized and used questionnaire, and most of the various other measurement instruments currently available draw on aspects of it. In the present study, the MDQ scores of subscales which do not vary across the menstrual cycle (i.e. arousal and control)[10] showed very small fluctuation between the premenstrual and intermenstrual phases (<4%), in contrast to the other MDQ subscale scores (7%–44%), which may support the validity of this method.

Fifth, although we attempted to adjust for a variety of potential confounding (or mediating) variables, we cannot rule out residual confounding. In particular, while the influence of stress on premenstrual symptoms has been suggested,[4,5] we unfortunately had no information on stress in the present study. Finally, the calculation of the statistical power, which is needed for presenting null findings, was impossible because of the lack of information on the effect size.

In conclusion, in this preliminary cross-sectional study of young Japanese women, neighborhood socioeconomic disadvantage was independently associated with higher pain in the premenstrual phase, although a clear relationship with premenstrual symptoms was not found. Considering the plausibility of the proposed mechanism, however, namely that neighborhood socioeconomic advantage might reduce some (unknown) factors that may act to lower brain serotonin, which in turn acts to alleviate premenstrual symptoms, further well-designed investigation using more relevant neighborhood SES indicators is warranted.

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Table 3. MDQ scores in the premenstrual phase according to quartile category of neighborhood socioeconomic status index (n = 630).[a]

Variable	All (n = 630)	Quartile 1 (least disadvantaged) (n = 156)	Quartile 2 (n = 167)	Quartile 3 (n = 139)	Quartile 4 (most disadvantaged) (n = 168)	P[b]
Pain	132.9 (129.6, 136.1)	125.7 (119.2, 132.2)	138.3 (132.0, 144.6)	127.3 (120.4, 134.2)	138.7 (132.5, 145.0)	0.02
Adjusted model[c]	–	123.5 (116.3, 130.8)	138.3 (131.2, 145.4)	127.4 (119.3, 135.4)	140.7 (132.5, 148.8)	0.008
Concentration	114.2 (111.6, 116.9)	114.2 (108.8, 119.5)	119.3 (114.2, 124.5)	109.1 (103.5, 114.8)	113.5 (108.4, 118.6)	0.55
Adjusted model[c]	–	112.4 (106.4, 118.4)	121.4 (115.6, 127.3)	110.7 (104.0, 117.3)	111.8 (105.1, 118.4)	0.80
Behavioral change	129.6 (125.5, 133.7)	126.8 (118.6, 135.0)	133.8 (125.8, 141.7)	121.5 (112.8, 130.2)	135.0 (127.1, 142.9)	0.24
Adjusted model[c]	–	125.3 (116.0, 134.5)	137.3 (128.3, 146.4)	122.4 (112.2, 132.7)	132.1 (121.7, 142.4)	0.47
Autonomic reactions	107.0 (104.9, 109.0)	105.3 (101.2, 109.4)	107.4 (103.5, 111.4)	107.4 (103.1, 111.8)	107.7 (103.8, 111.7)	0.44
Adjusted model[c]	–	105.4 (100.8, 110.0)	107.4 (102.9, 111.9)	108.5 (103.4, 113.6)	106.8 (101.6, 112.0)	0.66
Water retention	143.7 (139.1, 148.3)	139.7 (130.5, 149.0)	140.0 (131.0, 148.9)	142.3 (132.5, 152.0)	152.7 (143.8, 161.5)	0.03
Adjusted model[c]	–	139.4 (129.1, 149.6)	140.8 (130.8, 150.7)	143.4 (132.0, 154.7)	151.3 (139.8, 162.8)	0.14
Negative affect	130.6 (126.3, 134.9)	129.1 (120.4, 137.7)	133.4 (125.0, 141.8)	127.7 (118.5, 136.8)	131.8 (123.4, 140.1)	0.77
Adjusted model[c]	–	126.6 (116.9, 136.3)	136.7 (127.2, 146.2)	130.6 (119.8, 141.4)	128.4 (117.5, 139.3)	0.82
Total	125.8 (123.1, 128.5)	123.2 (117.7, 128.6)	128.8 (123.5, 134.0)	121.7 (115.9, 127.4)	128.8 (123.6, 134.0)	0.22
Adjusted model[c]	–	121.6 (115.6, 127.6)	130.6 (124.7, 136.5)	123.0 (116.3, 129.7)	127.4 (120.7, 134.2)	0.25

[a]Values are mean (95% CI). MDQ scores in the premenstrual phase were expressed as percentages relative to those in the intermenstrual phase.
[b]A linear trend test was used with the median value in each quintile category as a continuous variable in linear regression.
[c]Adjusted for age (years, continuous), age at menarche (years, continuous), body mass index (kg/m^2, continuous), usual length of the menstrualcycle (day, continuous), usual number of days of bleeding (continuous), menstrual cycle phase at the time of the study (menstrual,premenstrual, or intermenstrual), region (Hokkaido and Tohoku; Kanto; Hokuriku and Tokai; Kinki; Chugoku and Shikoku; and Kyushu), municipality level (ward; city; and town and village), institution type (4-year private, 2-year private, 4-year public, and 2-year public), living status (living with family, living alone, and living with others), current smoking (yes or no), current alcohol drinking (yes or no), physical activity (total metabolic equivalents-hours/day, continuous), and dietary glycemic index (continuous).
Abbreviation: MDQ, Menstrual Distress Questionnaire.

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