ESTIMATION OF FACTORS RELATED TO PREMENSTRUAL SYNDROME IN FEMALE STUDENTS BY USING ARTIFICIAL NEURAL NETWORK MODEL

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***Abstract*— Objective:** Premenstrual syndrome is a disorder with psychological and physical symptoms in almost every cycle, and it concerns almost 90% of women of reproductive age. In recent years, studies investigating the relationship between premenstrual syndrome and vitamin D, trace elements, and lymphocyte/platelet ratios have been conducted. In this study, the factors associated with PMS in female students were tried to be determined by using an artificial neural network (ANN) model. **Materials and Methods:** This study was conducted on female students at Inonu University Faculty of Medicine and Health Sciences, between 01 May and 30 June 2019. Demographic characteristics and menstruation histories of 860 female students were collected and recorded for the study. A multi-layer perceptron artificial neural network model was used to determine the factors associated with premenstrual syndrome. The performance of the model is determined by the accuracy rate and the area under the process characteristic curve. **Results:** Correct classification rates of the created multi-layer perceptual neural network model for premenstrual syndrome were calculated to be 63.2% in the training data set and 63.0% in the test data set. Considering the importance values of the variables; it was found that the duration of active internet use (phone, tablet, computer) was the most influential factor on premenstrual syndrome and the economic status of a student was the least ,influential factor. **Conclusion:** According to the findings of the designed artificial neural network model, the three most important factors related to premenstrual syndrome were determined to be the duration of active Internet use, present age and age of menarche. Given the high prevalence of PMS, the uncertainty of etiology, and its potential to affect a woman's lifestyle; the use of artificial intelligence models with larger sample size and including different factors is recommended.

***Keywords*—** *Artificial neural network model, Associated factors, Female student, Premenstrual syndrome.*

1. INTRODUCTION

PREMENSTRUAL syndrome (PMS) is a condition characterized by physical, cognitive, emotional and behavioural symptoms, which develop in the luteal phase of the menstrual cycle, decrease or end with the onset of menstruation [1,2]. Premenstrual syndrome is a common condition that concerns women's health and is seen in four out of ten women [3]. It has been reported that the prevalence of PMS is 47.8% worldwide and can vary between countries [4].

Although many studies have been conducted in the literature to determine the factors that play a role in the development of PMS, its etiology is still uncertain. The most accepted hypothesis is that PMS develops due to the effects of estrogens, and progesterone is related to neurotransmitters such as serotonin, opioids, GABA, and catecholamines [5,6]. In addition, the risk factors for PMS include genetic factors [7]. The uncertainty of the etiology of PMS indicates the need for studies evaluating PMS from different angles. Artificial Intelligence Technologies can also be used for such evaluations. Artificial Neural Network prediction technique simply imitates the human brain and has been used widely in many areas [8]. Artificial Neural Networks methodology has many essential features such as working with an unlimited number of variables, learning from data, and making generalizations. Thanks to these features, it provides very important benefits. ANN has been effectively used in many applications such as detecting previously unnoticed patterns in medical research data, classifying, determining the characteristics of medical images, and controlling medical devices [8]. It can be suggested that the ANN technique can potentially reduce the costs and the need for unnecessary researches [9]. Considering the achievements and potentiality of ANN research, there is no doubt that it will facilitate many innovations in medical science and will be a guide for more advanced diagnosis and treatment methods [10]. Th is study aimed to determine the factors associated with PMS in female students by using (ANN) model.

2. MATERIAL-METHOD

This study was designed as a cross-sectional study and conducted on female students studying in the Faculty of Medicine and Health Sciences of a public university, in the east of Turkey, between 01 May and 30 June 2019. The universe of the study consisted of all the students studying at the Faculty of Medicine and Health Sciences of the university (N = 1837). In this context, 860 students who accepted to participate in the study constituted the sample of the study. Students who accepted to participate in the study were selected from the relevant population by simple random sampling method. A personal information form and Premenstrual Syndrome Scale (PMSS) created by the researchers in line with the literature review were applied to the participants.

2.1. Data Collection Tools

2.1.1. Personal Introduction Form

The Personal Information Form includes 17 questions regarding the sociodemographic information (age, department, class, family structure, etc.) and menstruation characteristics (age of

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menarche, frequency of menstruation (days), menstruation pattern) of the participants.

2.1.2. Premenstrual Syndrome Scale (PMSS)

The Premenstrual Syndrome Scale is a 44-item, five-point Likert-type scale developed by Gençdoğan in 2006 to measure premenstrual symptoms and determine the severity of these symptoms. The scale questions the symptoms in the last three months. The scale consists of 9 sub-dimensions, including depressive affection, anxiety, fatigue, irritability, depressive thoughts, pain, appetite changes, sleep changes, and distension. The sum of the scores obtained from 9 sub-dimensions constitutes the total score of PMSS. The lowest total score is 44, and the highest score is 220. The presence of PMS was defined as a score exceeding 50% of the highest score that can be obtained from the total scale and sub-dimensions. Cronbach alpha reliability of the scale was found to be 0.75 [11]. In this study, the Cronbach alpha reliability of the scale was found to be 0.96.

2.2. Data analysis

The data were analyzed by using SPSS 25.0 statistical package program. In the evaluation of the data percentage distribution and arithmetic mean were used. A value of $p<0.05$ was accepted as statistically significant. The factors associated with PMS were determined by using the multi-layer perceptron (MLP) ANN model. A single layer perceptron can only predict linear functions. The feed-forward multi-layer perceptrons with hidden layers between the input and output layers have no limitations in comparison to the single-layer perceptrons. In this study, 70% of the data was used to train the MLP ANN model, and the remaining 30% was used to test the model [12]. The performance of the model is determined by the accuracy rate and the area under the curve.

2.3. Ethical Approval

Ethical approval for the study was obtained from the Health Sciences Scientific Research and Publication Ethics Committee of Inonu University (No. 2020/1182). Before starting the research, the students were informed about the study, and it was warranted that their personal information would be protected and the volunteers were included in the study.

3. RESULTS

The distribution of the students participating in the study according to their socio-demographic characteristics is given in Table 1. It was found that the average age of the participants was 21.11 ± 1.97, the average height was 163.52 cm, and the average weight was 57.03 kg. It was determined that 75.6% of the students studied in health sciences, 24.4% were in the medical school, and 31.4% were 2nd graders. It was determined that 82.6% of the students had a nuclear family structure, 50.9% had a medium economic status, 53.7% resided in a dormitory, and 45.8% were born and raised in the Eastern Anatolia region (Table 1).

The distribution of the students, according to their menstrual characteristics, is given in Table 2. The average age of menarche was found to be 13.39 ± 1.23.

TABLE I.
DİSTRİBUTİON OF SOCİO-DEMOGRAPHİC CHARACTERİSTİCS OF PARTİCİPANTS (n=860)

Descriptive Characteristics	$\bar{X}$ ± SS	
Age (years)	21.11± 1.97 (min:17, max:35)	
Height (cm)	163.52± 5.65 (min:140, max:178)	
Weight (kg)	57.03± 9.05 (min:28, max:100)	
	n	**%**
Faculty		
Faculty of Health Sciences	650	75.6
Faculty of Medicine	210	24.4
Department		
Child Development	148	17.2
Midwifery	200	23.3
Physical therapy and rehabilitation	150	17.4
Audiology	152	17.7
Medicine	210	24.4
Class		
1st Class	202	23.5
2nd Class	270	31.4
3rd grade	177	20.6
4th Grade	177	20.6
5th grade	25	2.9
6th grade	9	1.0
Economic Status		
Low (0-500 TL)	234	27.2
Medium (501-1000 tl)	438	50.9
High (1001 TL and above)	188	21.9
Family structure		
Nuclear family	710	82.6
Extended family	127	14.8
Broken Family	23	2.7
Place of Residence		
Family	339	39.4
Student house	59	6.9
Dormitory	462	53.7
Geographical Region where she was born and raised		
Eastern Anatolia	394	45.8
Southeastern Anatolia	216	25.1
Aegean	25	2.9
Mediterranean	125	14.5
Central Anatolia	65	7.6
Black Sea	19	2.2
Marmara	16	1.9
Total	**860**	**100.0**

It was determined that the menstruation period was between 6-8 days in 59.4% of the students, the menstruation frequency of was between 21-34 days 82.4%, and menstruation was regular in 71.5%. It was found that 84.2% of the students did not have intermittent bleeding other than menstruation, 59.0% experienced pain from time to time during menstruation, and 84.4% did not have polycystic ovary syndrome (Table 2).

TABLE II.
DİSTRİBUTİON OF THE STUDENTS PARTİCİPATİNG İN THE STUDY ACCORDİNG TO THEİR MENSTRUAL CHARACTERİSTİCS (n= 860)

	$\bar{x} \pm SS$	
Menarş Age (years)	13.39± 1.23 (min:9, max:18)	
	n	**%**
Menstruation time (days)		
3-5 days	322	37.4
6-8 days	511	59.4
9 ≥ days	27	3.2
Menstruation frequency (days)		
Less than 21 days	44	5.2
21-34 days	709	82.4
35 days and more	107	12.4
Menstruation Order		
Yes	615	71.5
No	245	28.5
Presence of Intermediate Bleeding Other Than Menstruation		
No way	724	84.2
It happens from time to time	83	9.7
Happens occasionally	53	6.1
Presence of Pain During Menstruation		
No way	81	9.4
It happens from time to time	507	59.0
Happens occasionally	272	31.6
Presence of Polycystic Ovary Syndrome		
Yes	134	15.6
No	726	84.4
Total	**860**	**100.0**

The distribution of the participants, according to their PMS experience, is shown in Table 3. It was found that 68.1% of the students experienced PMS, and 31.9% did not experience PMS (Table 3).

The distribution of the mean lowest and highest total scores of PMSS and subscales is given in Table 4. We found that the mean score of depressive affection was 19.02 ± 6.12, irritability 14.87 ± 5.27, depressive thoughts 18.26 ± 7.17, pain 8.93 ± 3.24, appetite changes 9.34 ± 3.54, sleep changes 8.43 ± 3.45, and distension was 9.30 ± 3.67. The mean total PMSS score was found to be 126.69 ± 35.8 (Table 4).

TABLE III.
DİSTRİBUTİON OF PARTİCİPANTS BY PMS LİVİNG STATUS (n=860)

PMSS	n	%
Yes	586	68.1
No	274	31.9
Total	860	100.0

TABLE IV.
DİSTRİBUTİON OF THE LOWEST-HİGHEST SCORES THAT CAN BE OBTAİNED FROM PMSS TOTAL AND SUB-DİMENSİONS, AND THE LOWEST-HİGHEST SCORES AND AVERAGE SCORES OF THE PARTİCİPANTS (n=860)

		Obtainable		Received	
PMSS	X ± SS	Min-Max		Min- Max	
Depressed affect	21.46±6.93	7	35	7	35
Anxiety	17.04 ±6.65	7	35	7	35
Tiredness	19.02±6.12	6	30	6	30
Irritability	14.87±5.27	5	25	5	25
Depressive thoughts	18.26±7.17	7	35	7	35
pain	8.93±3.24	3	15	3	15
Change in appetite	9.34±3.54	3	15	3	15
Sleep change	8.43±3.45	3	15	3	15
Swelling	9.30±3.67	3	15	3	15
PMSS Total	**126.69±35.8**	**44**	**220**	**44**	**220**

The significance values of the factors affecting PMS are given in Table 5. Correct classification rates of the created MCA ANN model for PMS were 63.2% in the training data set and 63.0% in the test data set. When the significance values of the variables are examined; it was found that the duration of active Internet use (phone, tablet, computer, etc.) was the most influential factor on PMS and the economic status of the student was the least influential factor (Table 5).

4. DISCUSSION

Premenstrual syndrome is a common and essential condition affecting most women of the reproductive age, and the number of women suffering from PMS is increasing [13,14]. It has been reported that PMS negatively affects women's self-confidence and social relations, causes workforce loss and decrease in work productivity, increases the tendency to crime and domestic fights, causes mothers to behave negatively towards their children and negatively affects the girls especially in terms of attendance to the classes. The etiology of PMS is not fully understood yet; however, it has been associated with diet, lifestyle, and hormonal and neuronal imbalance [15]. In this study, which was conducted to predict the factors associated with premenstrual syndrome, by using the ANN model, it was found that the duration (years) of active use of the Internet (phone, tablet, computer, etc.) was the most influential factor.

Similarly, Ko et al., found that the probability of having Internet use disorder was approximately five times higher in women with the premenstrual dysphoric disorder compared to those without [16].

TABLE V.

SİGNİFİCANCE VALUES OF FACTORS AFFECTİNG PMS

Factors affecting PMS	**Significance Value**
The duration of active use of the internet (phone, tablet, computer, etc.) (years)	0.112
Age (years)	0.108
Age of menarche (years)	0.107
Height (cm)	0.100
Weight (kg)	0.100
The number of pads he changed on the busiest day of menstruation (pieces)	0.077
How much of his day he spends on the internet (phone, tablet, computer) (hours)	0.050
Frequency of menstruation	0.046
Menstruation time	0.045
Polycystic ovary diagnosis	0.044
The geographical region where he was born and raised	0.044
Menstruation scheme	0.033
Family type	0.032
Place of residence	0.028
Pain during menstruation	0.025
Breakthrough bleeding other than menstruation	0.025
Economical situation	0.023

In this study, we found that age was the second factor affecting PMS (Table 5). In the literature, studies are reporting that the age affected PMS symptoms, similar to our study [17,18]. In some studies, it has been found that the prevalence of PMS increased as the age increased [19,20]. In a study, conducted by Chayachinda et al., in Thailand, it was found that the prevalence of PMS differs according to age, and it was seen in 70.8% of the women aged 30 and younger [21]. Similarly, in a study conducted in Manisa, it was found that PMS symptoms are more common in young people [22]. In the study by Tschudin et al., the prevalence of PMS was found to be higher in women aged 35-44 [23]. On the other hand, in the study conducted in Virginia, it was found that women between the ages of 35-44 had PMS less frequently compared to younger women, and the highest prevalence was between the ages of 25 and 34 [24]. In addition, in the literature, there are studies suggesting that there is no significant relationship between PMS and age [14, 25-30].

In our study, the age of menarche was found to be the third factor affecting PMS (Table 5). In the literature, it has been reported that there was a relationship between PMS and the age of menarche and the possibility of PMS increases as the age of menarche decreases [24,25, 31-36]. In the study of Selçuk et al., the average PMS score was found to be higher in those with menarche age 14 and above, although it was not statistically significant [37]. On the other hand, studies are reporting that there was no relationship between the age of menarche and experiencing PMS [28,30,38-42].

Obesity, which is an important problem today, is also an essential major risk factor for PMS. Masho et al., reported that obese women (BMI≥30) had approximately three times the risk of PMS compared to non-obese women [43]. Similarly, in the study of Özmermer, it was observed that the prevalence of PMS increases as the weight increases [19]. On the other hand, in Şahin's study, the frequency of PMS was found to be lower in overweight / obese students [44]. The risk of having PMS is lower for women with a BMI in the normal range. The increase in BMI causes an increase of PMS symptoms, and this situation continues to increase as a vicious circle [29]. In another study, it was found that there is a strong relationship between BMI and risk of PMS, and 1 kg / m increase in BMI is associated with a significant increase of 3% in PMS risk [45]. When relevant studies are evaluated, as BMI values increase, the frequency of PMS symptoms also increases [14,29,46]. On the other hand, studies are suggesting that BMI does not affect PMS [41,47-49]. In our study, by using the ANN model, we found that weight and height were associated factors in BMS (Table 5).

We found that the time spent on the internet during the day (hours) is another factor influencing PMS (Table 5). Similar to our results, Yoshimi et al., in their study, reported that women with PMS spent a significantly longer time on the internet compared to women without PMS [36].

In our study, features such as the number of pads changed on the heaviest day of menstruation, frequency, duration, the pattern of menstruation, presence of polycystic ovary, and non-menstrual intermittent bleeding were found to be other factors affecting PMS. In the study of Aşçı et al., No significant difference was found between the students with and without PMS in terms of menstruation frequency and duration [41]. In the study of Çitil and Kaya, it was reported that there was no statistically significant relationship between menstruation period and PMS [14]. In this study, the pain was one of the most common symptoms experienced during the menstruation. In our study, we also found that pain during menstruation is one of the factors affecting PMS (Table 5). In the literature, it was reported that PMS was significantly higher in those who had pain during menstruation [21,39,41,47,50,51].

The geographical region where the students were born and raised, family type and place of residence are other factors that have smaller effects on PMS (Table 5). In the study of Aşçı et al., no significant difference was found in terms of the place where the student resided during university education. In the study of Kırcan et al., it was found that 62.9% of the students living in the city center and 76.2% of the students living in the rural regions had PMS symptoms, but the difference was not statistically significant. In the study of Selçuk et al., it was found that students living in dormitories are at 4.19 times higher risk of PMS compared to students living at home [37].

In our study, it was determined that the economic status of the student was the least effective factor in PMS. This finding suggests that in training aimed at preventing PMS, all women should be addressed regardless of their income level differences. In the literature, some studies did not find a

statistically significant relationship between economic status and PMS, similar to our study [7,30,41,49]. On the other hand, there are studies that found that women experienced PMS symptoms more intensely as their income decreased [14,21].

5. CONCLUSIONS

In this study, we determined the factors associated with PMS in female students and the level of significance of these factors by using the proposed ANN model. Thus, due to the limited number of studies using ANN models in PMS, it is anticipated that the results of this study will create an infrastructure for other similar studies. In the literature, it has been reported that factors such as staying in a dormitory, gynecological diseases, fast-food consumption, age, weight, income level, smoking, and history of PMS in the mother and sister are associated with PMS [19,37,52]. According to the findings of the ANN model designed in this study, the three most important factors associated with PMS were found to be the duration of active internet use, present age and age of menarche were. Considering the high prevalence of PMS, the uncertain etiology, and its effects on the lifestyle of the woman, we recommend using artificial intelligence models that can include further factors, in larger samples.

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