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Mathematical modeling of intelligent system for predicting effectiveness of premenstrual syndrome

Ruchi Joshi [§]
Department of Psychology
Manipal University Jaipur
Jaipur
Rajasthan
India

Priya Mathur [†]
Department of Mathematics
Poornima Institute of Engineering & Technology
Jaipur
Rajasthan
India

Amit Kumar Gupta*
Department of Computer Science & Engineering
Manipal University Jaipur
Jaipur
Rajasthan
India

Suyesha Singh [‡]
Department of Psychology
Manipal University Jaipur
Jaipur
Rajasthan
India

[§] *E-mail:* jruchijoshi43@gmail.com
[†] *E-mail:* drpriyamathur21@gmail.com
* *E-mail:* dramitkumargupta1983@gmail.com (Corresponding Author)
[‡] *E-mail:* suyeshasingh@gmail.com

Vismita Paliwal [@]
Amity Institute of Behavioral & Allied Sciences
Amity University Rajasthan
Jaipur
Rajasthan
India

Sejal Nayar [#]
M.A. Clinical Psychology
Amity Institute of Behavioral & Allied Sciences
Amity University Rajasthan
Jaipur
Rajasthan
India

Abstract

Majority of reproductive-aged women experience some form of physical discomfort or emotional unease in the weeks leading up to the onset of menstruation. The symptoms are often not severe, but they can cause significant discomfort and disrupt day to day activities of the person experiencing them. It is estimated that between 5 and 8 percent of women experience severe premenstrual syndrome (PMS); the majority of these women may also fall under the category of premenstrual dysphoric disorder (PMDD). The most bothersome symptoms are those associated with the mood and behaviour, such as impatience, tension, sad mood, tearfulness, and mood swings. However, physical problems, such as breast soreness, indigestion and bloating, can also be problematic. Using the Gradian Boost regressor (GBR) method of machine learning, the researchers in this study made a prediction regarding the effects of premenstrual syndrome (PMS). Kelly Wallance classifies premenstrual syndrome as PMS-A, PMS-C, PMS-D, and PMS-H, in addition to other symptoms. Researchers circulated the Kelly Wallance questionnaire on Google Form, which was then used to collect the data for the dataset. The accuracy of the model was measured at 99.99% for PMS-A, 99.93% for PMS-C, 99.87% for PMS-D, 99.92% for PMS-H, and 99.97% for other symptoms.

Subject Classification: *62P15.*

Keywords: *Mathematical modeling, Premenstrual syndrome, Premenstrual dysphoric disorder, Gradian boost regressor, Machine learning, Computational intelligence.*

1. Introduction

Pre Menstrual Syndrome are a group of Physiological, Psychological, cognitive and emotional symptoms that starts almost seven to ten days prior to luteal phase and comes to end after menstrual cycle is over [1-2]. On the

[@] *E-mail:* **vismitapaliwal@gmail.com**
[#] *E-mail:* **nayar.sejal@gmail.com**

extreme Psychological end of PMS spectrum is Premenstrual dysphoric disorder (PMDD). According to Diagnostic and Statistical Manual (V) , the characteristics of PMDD are marked affective lability, marked irritability or anger, markedly depressed mood, feelings of hopelessness and anxiety, tension and feelings of being keyed up or on the edge [3].Genetic dispositions and hormonal disorders, thyroid dysfunction, fluid retention and stress factors may be attributed to Pre Menstrual Syndrome [4]. One fifth of the female population in the world constitute of adolescents and this age group is generally considered healthy, therefore the required medical attention to this age group is not provided on health programmes [5]. In countries like India Menstrual practices and conversation are stigmatic and tabooed. Due to lack of awareness and knowledge related to menstrual practices PMS symptoms tend to get worsened. Knowledge related to physical symptoms and hygiene is still being provided, it is the mental health and hygiene during menses that are being overlooked and neglected.

PMS symptoms are associated with self-reported anxiety, stress, depression, substance abuse, self-harming and in extreme cases suicidal ideation and behaviours [6-8]. A growing body of research provides evidence that PMS symptoms adversely affects quality of life ,academic performance and may lead to anger and aggression[9-12].

Menstruating females in their reproductive years' experience different symptoms whether physical, psychological or behavioural. Based on experience of symptoms by females, PMS can be divided into following categories; PMS A or Anxiety (marked by feelings of anxiety, overwhelming, sensitivity), PMS C or Craving(desire for carbohydrates, increased appetite, fatigue, headaches etc.), PMS D or Depression(low mood, lethargy, crying bouts) and PMS H or Hydration or Water retention (bloating, breast tenderness, swelling weight gain) [13].

The present study was conducted to examine the prevalence and characteristics of different types of PMS symptoms among adolescents. Among gynaecological problems faced by females, PMS symptoms are considered as one of the major ones. [14], but as mentioned above usually the physiological aspects of PMS symptoms are taken into consideration ,the present research studies not just physiological but psychological, cognitive, affective and behavioural aspects of PMS into consideration of adolescent females from age group of 10-19 years of age. It aims to establish Machine learning model that is based on different factors contributing characteristics of anxiety, depression, cravings, water retention as well as other aspects of PMS symptoms.

The study is divided into different sections as follows; the work related to prevalence, characteristics and consequences related to PMS

was introduced, planned model for analysing4 types of PMS symptoms was defined, methodology employed for the study, results, discussion and conclusion followed by references.

Review of literature

This section elucidate on research undertaken by other authors on same lines. A leading body of research provides evidence for presence of PMS symptoms among adolescents across the world as well about cultural, societal and racial aspects that affects PMS symptoms . The studies also explicate the various symptoms and experiences related to different types of PMS with regard to anxiety, depression, cravings , water retention and other symptoms.

Etiological studies across world divulges that about 80% to 90% of females demonstrate at least one of the PMS signs; but among 2.5% to 3% of women, the experience of symptoms is so severe that the personal, social, professional lives are affected so adversely that is results into PMDD or what is known as Pre Menstrual Dysphoric Disorder.[15].Females falling between age group from 10 to 19 years of age who are usually students of Schools, colleges and universities students are more likely to experience negative effects of PMS thereby resulting in adverse effect on their performance in academics as well as overall well-being. The incidence of PMS among the female students of universities across various nations as follows: India- 43% ,China-33.82 %, Ethiopia- 37%, Taiwan-39.9%, Egypt-65% Japan.-79 [16-21].Mandal, Sarkar and Ghorai (2017) conducted a study on adolescents in Kolkata found that 54% girls experienced PMS syndrome[22]. However there is lack of awareness of symptoms related to PMS. Katjiukua, Simon ,Chatterjee & Akinola (2020) in their meta-analysis done on prevalence and knowledge of PMS symptoms in India found around 50% of girls had a lack of or little knowledge of PMS symptoms [23].Apart from the above mentioned researchers, a leading body of research also supports that factors related to geography, genes and diet among young females along with community-adopted practices before and during menstruation also impact the knowledge and experience of PMS symptoms [24-25].

One of the studies from Egypt (2019) uncovered a positive corelation between PMS and extra consumption of food that tastes sweet along with junk food as well as caffeine. The findings clearly shows that life styles have an considerable role in experience of symptoms of PMS and PMDD. Another study conducted by Cheng et al (2019) supported the above

mentioned study and established that more than required intake of fast food, sugary drinks, fried eatables as well as flawed sleep habits, lesser exercise also play a considerable role in increased experience of PMS and PMDD [26].

PMS symptoms co-occur with fluctuations of hormones in menstrual cycle that usually results in imbalance of hormones such as estragon and progesterone either being produced in surplus or in deficiency. Bu, Li et al, (2019) in their research found low levels of estragon release norepinephrine through hypothalamus resulting in decline of dopamine, serotonin, which in turn results in conditions like insomnia, fatigue and depression, which are usually frequently experienced symptoms of PMS [27].

2. Methodology

The researcher has described the approach for predicting the effectiveness of Premenstrual Syndrome (PMS) in this section of the report. The Kelly Wallance has categorized the PMS in PMS-A, PMS-C, PMS-D, and PMS-H, in addition to other symptoms categories. The questionaries defined by the Kelly Wallance as follows:

(a) PMS-A have the sections (Anxiety, Irritability, Mood Swings and Nervous Tension)

(b) PMS – C have the Section (Appetite Increase, Headache, Fatigue, Dizziness or Fainting and Palpitations)

(c) PMS – D have the section (Depression, Crying, Forgetfulness, Confusion, and Insomnia)

(d) PMS – H have the section (Fluid Retention, Weight Gain, Swollen Extremities, Breast Tenderness and Abdominal Bloating)

(e) OTHER SYMPTOMS have the section (Oily Skin, Acne, Constipation, Diarrhea, Backache, Hives, Weakness & radiation, and Down thighs).

These all categories are defined in terms of score as 1 = Mild, 2 = Moderate and 3 = Severe.

Based on all from (a-e), the researchers have prepared a google form and circulated over the social media. The google form is filled by the 317 females age between 13–19-year-old. Based on data collected from google form the dataset is prepared for the generation of GBR Model.

Figure 1

Methodology for predicting the effectiveness of Premenstrual Syndrome (PMS)

Carrying out of Survey

While carrying out this study, researchers reviewed the literature and related studies conducted previously on prevalence and characteristics on types of PMS among adolescents. The questionnaire consists of items that cover different aspects of PMS. Most importantly the study was carried out to understand how frequently and to what extent did adolescents experience symptoms of PMS related to anxiety, depression, cravings, water retention and other symptoms?

The implementation of the GBR-GSO (Gradian Boost Regression with Grid Search Optimization) Machine Learning Model is shown in Figure 1. In this model, the input features have been obtained from PMS-A/C/D/E/O, which are defined in the section above, starting at point (a-e). The target data or output has been given an average score in the range where 1 represents a mild problem, 2 represents a moderate problem, and 3 represents a severe problem. The data set has been divided into training data (which accounts for 80%) and tested data (which accounts for 20%).

Following that, the trained data set was used to the process of training the GBR Model. The grid search optimization method, commonly known as GSO, is employed in the process of identifying the optimal hyperparameter. The model is then trained utilizing the optimum hyperparameters with the use of GSO. After the training is complete, the accuracy of the model is evaluated using a score known as the r2 score, which is based on the coefficient of determination.

3. Results and Discussion

In this section the researcher has defined the results in terms of accuracy of GBR-GSO model for PMS-A, PMS-C, PMS-D, and PMS-H, and PMS-O.

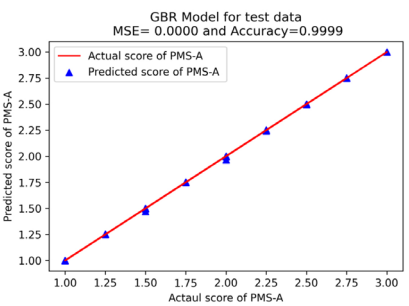

Figure 2

Graph between Actual Score and Predicted Score for PMS-A on Testing Data using GBR-GSO

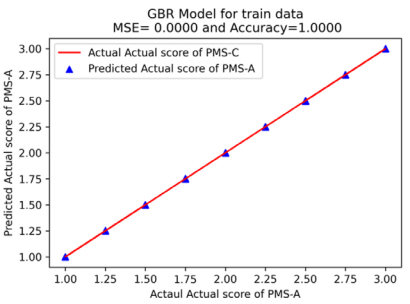

Figure 3

Graph between Actual Score and Predicted Score for PMS-A on Training Data using GBR-GSO

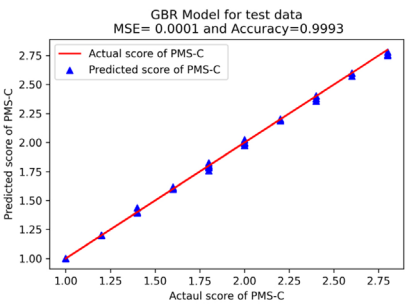

Figure 4

Graph between Actual Score and Predicted Score for PMS-C on Testing Data using GBR-GSO

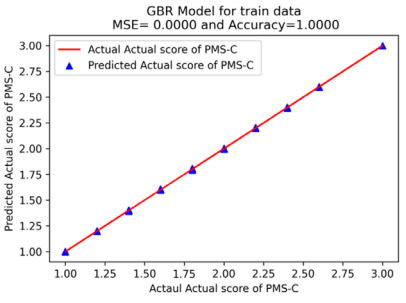

Figure 5

Graph between Actual Score and Predicted Score for PMS-C on Training Data using GBR-GSO

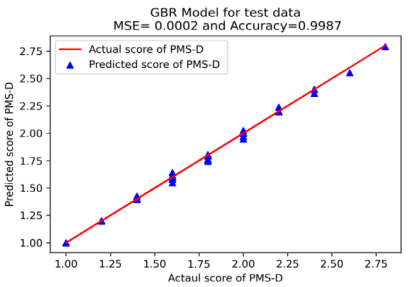

Figure 6

Graph between Actual Score and Predicted Score for PMS-D on Testing Data using GBR-GSO

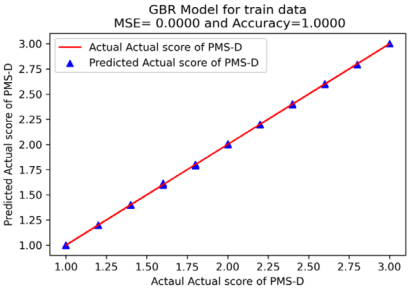

Figure 7

Graph between Actual Score and Predicted Score for PMS-D on Training Data using GBR-GSO

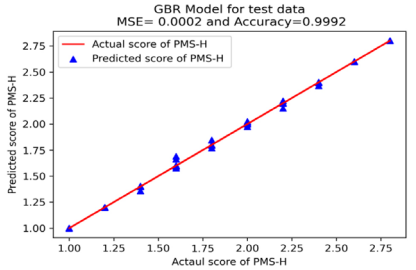

Figure 8

Graph between Actual Score and Predicted Score for PMS-H on Testing Data using GBR-GSO

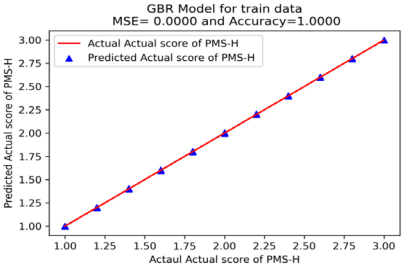

Figure 9

Graph between Actual Score and Predicted Score for PMS-H on Training Data using GBR-GSO

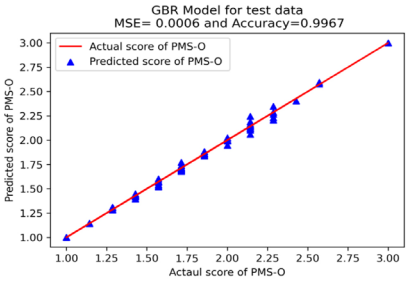

Figure 10

Graph between Actual Score and Predicted Score for PMS-O on Testing Data using GBR-GSO

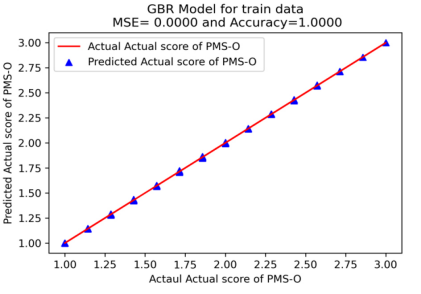

Figure 11

Graph between Actual Score and Predicted Score for PMS-O on Testing Data using GBR-GSO

Pre Menstrual Syndrome symptoms emerge at the onset of puberty, interventions for the same should be focused on adolescents at high risk. This study assess the occurrence as well prevalence of symptoms of PMS and predict the chances of experience of PMS symptoms by adolescents related to anxiety, depression, cravings, water retention and other symptoms. Research indicates that experience of PMS symptoms leads to diminished quality of life, adversely affect academic, personal and professional lives of adolescents. The current study can be used by medical and mental health practitioners, family members and policy makers for designing and implementing psychoeducation and counselling. Apart from pharmacological approach that includes using anti- depressants, mood alleviators cognitive behavioural therapy and alternate medicine approaches such as herbal and ayurvedic can also be used. The findings can also be used to promote and modify lifestyle changes in terms of healthy and balanced eating habits and increased physical activities. Practices related to mindfulness, meditation, relaxation techniques can also implemented to reduce experience of adverse effects of PMS symptoms by adolescents to enhance their quality of life. [28-31.

Pre-menstrual symptoms in their most severe form turn into Premenstrual Dysphoric Disorder (PMDD) which can result in extreme sadness, hopelessness, irritability and anger.

4. Conclusions

The Figure 2-Figure 12 represents the testing data and training data accuracy for GBR-GSO model for different categories of PMS. The Figure 2 shows that GBR-GSO model accuracy for testing data is 99.99% for PMS-A. The Figure 3 shows that GBR-GSO model accuracy for training data is 100% for PMS-A. The Figure 4 shows that GBR-GSO model accuracy for testing data is 99.93% for PMS-C. The Figure 5 shows that GBR-GSO model accuracy for training data is 100% for PMS-C. The Figure 6 shows that GBR-GSO model accuracy for testing data is 99.87% for PMS-D. The Figure 7 shows that GBR-GSO model accuracy for training data is 100% for PMS-D. The Figure 8 shows that GBR-GSO model accuracy for testing data is 99.92% for PMS-H. The Figure 9 shows that GBR-GSO model accuracy for training data is 100% for PMS-H. The Figure 10 shows that GBR-GSO model accuracy for testing data is 100% for PMS-O. The Figure 11 shows that GBR-GSO model accuracy for training data is 100% for PMS-O. The study will prove beneficial for predicting types of PMS

among adolescents and help in early detection and prevention of PMDD , providing intervention and assisting in policy making and administration.

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