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Mental Depression Deduction Using Modified Regression Model to Prevent Suicidal Attempt

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Abstract—This study explores a novel approach for predicting depression using association-based multilevel linear regression. The suggested approach, known as association-based multilevel linear regression, uses data on mental depression to predict the prevalence of depression. Several statistical techniques can be used to forecast depression. Several statistical methods, including Linear Regression (LR), Multilevel Linear Regression (MLR), Naïve Bayes algorithm and Decision Tree (DT) were used in this investigation. Because these algorithms are able to predict mental depression based on certain characteristics such as precision and efficiency, their performance reduces. The results of these algorithms' predictions vary significantly, especially in terms of accuracy. The mental health data is fed into a developed model that has been trained to make predictions in order to address the aforementioned problem. Depression is the subject of conversation. A great degree of accuracy is shown by the association-based multilevel linear regression technique and the evaluation of prediction of accuracy in relation to other statistical methods. This study used association-based multilevel linear regression technique. When compared to traditional methods, the method exhibits a substantially greater level of accuracy, almost 99%.

Keywords- Depression data, Multiple Linear Regression (MLR), Association Based Multiple Linear Regression

I. INTRODUCTION

Mental disorders are common disorder in the world that affects the human feelings, thinking and actions. It may be chronic in our life. It affects or reduces human function and ability to communicate to others every day. Mental disorders are caused by genes, stress, feeling lonely or isolated, traumatic brain injury, alcohol or recreational drugs, having serious medical conditions and chemical imbalance in the brain.

Anxiety disorders, depression, bipolar disorders, eating disorders, personality disorders, post-traumatic stress disorders, and psychotic disorders are only a few of the different types of mental illnesses that exist. A thorough evaluation that involves a physical examination, lab testing, a psychological evaluation, and a detailed review of medical history is used to identify mental problems. Examining cognitive processes, emotional experiences, and behavioural patterns are all part of the psychological evaluation. Through a variety of therapy techniques and medical procedures, these mental diseases can be effectively addressed. The severity and precise classification of the illnesses determine the therapy option. Some people need both medication and counselling to treat their mental illnesses. In some cases, people may need severe therapy for their mental illness, which would call for their admittance to a psychiatric institution. The available treatments in this situation include

counselling, group talks, and mental exercises. People with severe mental illnesses may engage in self-harming practises. The Geriatric Depression Scale and the Zung Self-Rating depressive Scale are two depression screening measures that can be used to detect depressive disorders. A tool used to identify people who may be at risk for suicide by offering warning signals is the Columbia Suicide Severity Rating Scale.

A sizable fraction of the world's population suffers from common mental illnesses like anxiety and depression. There are an estimated 45–46 million people in India who suffer from mental illnesses like anxiety and depression. These two illnesses are becoming more common in India, especially among females and in the southern provinces. Suicide risk may rise as a result of severe depression. Therefore, it is crucial to accurately predict mental diseases in order to stop suicide attempts around the world. The prediction of mental depression uses a variety of approaches such as Fuzzy logic, Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Neural Networks, K-Nearest Neighbour (KNN) etc.. The accuracy and time requirements of the approaches shown stated above show minor variations.

II. Problem Statement

The advance predicting methods are developed still the mental depression detection from depression data. Linear Regression (LR), Multilevel Linear Regression (MLR), Decision tree (DT) and naïve bayes classifier performs less during prediction. These methods give low accuracy, time complexity and low speed. Linear regression has limited variables such as input data and output data. The association-based multilevel linear regression method is used to resolve the aforementioned issues.

III. Contributions

Predictive techniques are crucial for forecasting mental depression. A multilevel linear regression method based on associations is suggested as a solution to the aforementioned issue.

(i) To determine the depression through proposed method association based multilevel linear regression method from mental depression and suicide dataset

(ii) To use the suggested association-based multilevel linear regression method to identify depression datasets with high accuracy.

(iii) To prove the accuracy level of depression and avoid suicide attempt through statistical methods after prediction of depression data.

IV. Literautre survey

The literature survey reveals a comprehensive analysis of various methods employed to address the challenges associated with predicting and understanding depression and mental health disorders. Reference [1] in 2020 utilized Artificial Intelligence, specifically context-aware Deep Neural Networks (DNN), and multiple regression techniques to predict situations and environments influencing depression, showcasing best performance in regression analysis. Despite the advantages of more powerful and useful computers, the approach incurred high costs. Similarly, [2] in 2020 employed Long Short-Term Memory (LSTM) networks and deep learning techniques to estimate depression intensity, achieving superior accuracy by analyzing patients' negative words. However, the method was limited by hardware dependence, despite its fault tolerance and gradual corruption features. In [3] from 2017, Artificial Intelligence and deep learning techniques were employed to recognize mental states through gestures and facial expressions, outperforming existing methods but facing challenges due to high costs. Reference [4] in 2017 focused on automatic diagnosis of depression using deep Convolutional Neural Networks, enhancing prediction performance with fault tolerance and gradual corruption capabilities, yet being constrained by hardware dependence. In [5] from 2019, Random Forest (RF), Support Vector Machine (SVM), and Naïve Bayes (NB) were employed for identifying patients with mental illness diseases, showcasing high accuracy but suffering from slow speed and prolonged processing times. Early detection of depression to prevent suicides was addressed by [6] in 2018 through Neural Networks and supervised learning, demonstrating feasibility and practicability, though hampered by hardware dependence. Reference [7] in 2020 analyzed depressed individuals using Machine Learning, achieving the best accuracy with the advantages of easy identification and wide application, albeit challenged by data acquisition issues. In [8] from 2021, LSTM and CNN were utilized to detect anomalies in human interactions indicative of suicidal intentions, showcasing good accuracy but facing hardware dependence drawbacks. Reference [9] in 2021 used Machine Learning and SMOTE for predicting depression efficiently, offering easy identification and wide application benefits, while encountering data acquisition challenges. Additionally, [10] in 2017 utilized Support Vector Machine (SVM) and Naïve Bayes to determine mental health levels and depression, demonstrating good performance despite slow speed and extended processing times. [11] in 2018 identified independent predictors of mental health disorders risk through stepwise and multiple logistic regression, achieving high prediction accuracy but facing overfitting challenges. [12] in 2019 utilized work-focused cognitive behavioral therapy (W-CBT) to find common mental disorders, providing fast responses but requiring a commitment from individuals. [13] in 2020 employed linear regression models to analyze depression characteristics, offering better self-rating experiences but with lower efficiency. [14] in 2020 predicted mental depression using supervised learning, semi-supervised learning, and machine learning, showcasing promising performance and high accuracy, although hampered by slow processing speeds. Finally, [15] in 2018 focused on predicting suicidal thoughts and behaviors using CNN, achieving accurate predictions and better performance but facing challenges related to implementation and overfitting. These studies collectively demonstrate the progress made in leveraging various methodologies, each with its advantages and disadvantages, in

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the pursuit of understanding and addressing mental health issues.

A. Inference Acquired From Literature Survey

Different techniques, including Linear Regression (LR), Multiple Linear Regression (MLR), decision tree (DT), and Naive Bayes can be used to predict mental depression. Decision Trees are unstable and inaccurate at predicting the severity of depression. Only independent variables can be predicted using Naive Bayes, which has limited use to mental health. Two factors are used using Linear Regression to forecast the depressive episode. Although it works with numerous variables, Multilevel Linear Regression is less accurate. An Association-based Multilevel Linear Regression approach is suggested to address the aforementioned issues and it provides high performance, high speed and minimal time in prediction.

V. METHODOLOGY

The block diagram for the Association-Based Multiple Linear Regressions proposed approach for predicting the severity of mental depression is shown in Figure 1. There are three variables in the depression dataset, including depression, fatalism, and simplicity. These data are pre-processed before being compared using several techniques, including Decision Trees, Multiple Linear Regression and Linear Regression. The accuracy and speed of these algorithms are drawbacks when predicting the dataset. As a result, a method for Multiple Linear Regression based on associations was proposed. The suggested approach uses association-based Multiple Linear Regression to quickly and accurately predict the severity of mental depression. This precise foresight was used to stop a suicide attempt.

a) Linear Regression

Finding the linear relationship between one or more predictor variables and one output variable is done using linear regression. Predictive analysis and modelling typically use linear regression. Regression, multivariate regression, multiple regression, and ordinary least square (OLS) are other names for linear regression. There are two categories of linear regression: basic Linear Regression and Multiple Linear Regression. To determine the link between predictor and response, simple linear regression is performed. Response is a dependent variable, while predictor is an independent variable. These variables are related statistically rather than deterministically. Deterministic means that one variable can be used to express another one very effectively. The link between two variables is not accurately captured by statistics. Finding the best-fit line for the provided data is the primary goal of basic linear regression. The best-fit line's predictor error is minimal, and this error illustrates how far the points are from the regression line.

b) Multiple Linear Regression

Multiple linear regression is also called as multiple regression. Multiple linear regression is used to find the relationship between more predictor variables and outcome of response variable. Predictor is independent variable and response is dependent variable. Multiple regression is a statistical technique to find the output. Ordinary least square (OLS) is extending to multiple linear regression because it has more than one predictor variables. Multiple regression models are complex when there are more variables. Multiple linear regression calculates the line of best fit and minimizes the variance of the variables.

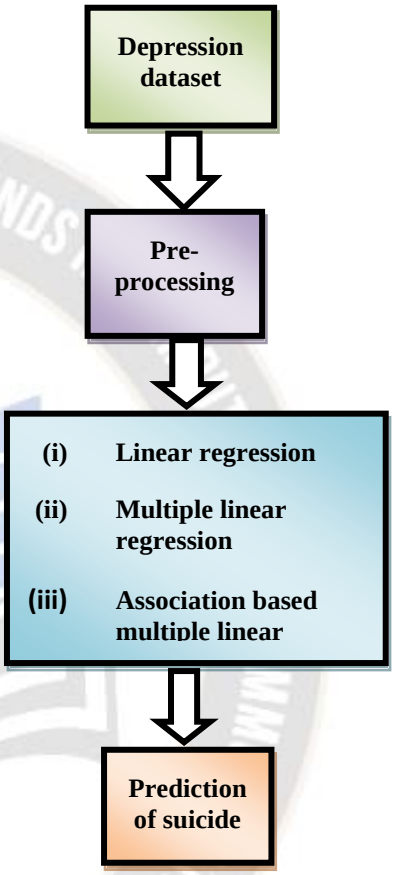

Figure 1: Association based Multiple Linear Regressions

c) Assoication Based Mulitple Linear Regression

Association based methods are data mining approach methods. There are different types of association-based classifier such as classification-based association (CBA), multi-class classification using association rule (MCAR) and classification based on predicted association rule (CPAR). Association based multiple linear regression method, compare the values to select which one is gives the best performance. Association based multiple linear regression method applicable for very large data and applied directly for classification. Association based multiple linear regression method can provide quality measures for the output of prediction. This method gives output that is more accurate and improves itself. .

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VI. RESULT AND DISCUSSION

Different types of qualities, including despair, fatalism, and simplicity, are included in the depression data. Simplicity is also referred to as thinking in black and white. The tendency to think in absolutes, such as "I am a brilliant success or a complete failure," is known as "black and white thinking." Black-and-white thinking can harm your relationships, your profession, your physical health, and your emotional well-being.. It refers dichotomous thinking. Simplicity makes extreme feeling like always, never, impossible, disaster, furious, ruined and perfect. White represents purity, peaceful, righteous and good. Black represents evil behaviour. Hence, it named as black and white thinking (simplicity). Fatalism is correlated with depression symptoms. Fatalism means the belief that regardless to actions is pre destinated to occur. Active fatalism is negatively correlated with depression. Fatalism has depression and anxiety symptoms. Fatalistic people thinking are what going to happen that cannot change and they have feelings of powerlessness or hopelessness about life. They intensively believe the fate and it cannot change by anything or anyone. This kind of thinking leads to deep depression because of over thinking and their belief.

The mental depression data predicted with different types of algorithms such as linear regression, multilevel linear regression, decision tree, naïve bayes and associative based multilevel linear regression. Linear regression has some disadvantages such as sensitive to outliers, looks at the relationship between dependent and independent variables. Multiple regression overcomes the linear regression disadvantages such analyse with multiple variables and ability to identify outliers. But multiple regression has disadvantage is comes down to the data being used. Decision tree algorithm has some disadvantages such as unstable, inaccurate and over fitting the data. Naïve bayes has few disadvantages such as zero frequency problem, limit usability and independent predictors. To overcome these problems, association based multilevel linear regression method is proposed. The proposed method association based multilevel linear regression gives high accuracy prediction, speed and good performance. This high accuracy prediction helps to avoid suicide attempting.

Table 1 shows the depression range and Table 2 shows the statistical values of proposed method. 0.1 to 0.3 represents normal depression and this is a starting stage of depression.0.3 to 0.7 shows low level depression. 0.7 to 0.9 shows medium level depression. 0.9 to 1.5 shows high level depression and 1.5 above shows suicide attack.

TABLE I. DEPRESSION RANGE

Depression	Depression Range
NORMAL DEPRESSION	0.1 - 0.3
LOW DEPRESSION	0.3 – 0.7
MEDIUM DEPRESSION	0.7 – 0.9
HIGH DEPRESSION	0.9 – 1.5
SUICIDE ATTACK	1.5 & ABOVE

The depression range predicted through proposed method association based multilevel linear regression from depression dataset. People who have the depression range 1.5 and above, they intensively depressed and they have full of suicide thought. The proposed method association based multilevel linear regression is used to avoid suicide attempting through early prediction of mental health.

TABLE II. STATISTICS OF PROPOSED METHOD

Parameters	Linear regression	Multiple linear regression	Association based linear regression
R	0.4554	0.6277	0.47
r^2	0.2074	0.3941	0.2209
Adjusted r^2	-	0.221	-0.0017
Residual standard error	-	0.0699	0.0792
F-statistic value	-	2.277	0.9926
p-statistic value	-	0.1731	0.4174

Table 3 and Table 4 shows output parameters of multiple linear regression and association based multiple linear regression. Table 5 and Table 6 shows the analyse variance of multiple linear regression and association based multiple linear regression.

TABLE III. MULTIPLE LINEAR REGRESSION FOR DEPRESSION DATA

Predictor	Estimate	Standard error	t-statistic	p-value
Constant	0.3314	0.1118	2.9649	0.021
Simplicity	0.2264	0.1425	1.5887	0.0561
Fatalism	0.0788	0.0536	1.4688	0.1853

In Table 3, depression predicted through multiple linear regression by using simplicity variable and fatalism variable from depression data. Simplicity and fatalism variables have some parameters such as estimation, standard error, t-statistic and p-value for depression data. Standard error represents the average distance from the regression line of depression dataset. This standard error of depression data gives precious prediction through multiple linear regression. Fatalism has less standard error (0.0536) through multiple linear regression. Error of depression data calculate through multiple linear regression equation,

Depression =0.3314+0.2264.simplicity+0.0788.fatalism

Multiple Linear Regression yields 97.4% accuracy and 2.6% error values. The t-statistic shows the depression data's coefficient split by standard error. Simplicity has better t-statistic results 1.5887 for Multiple Linear Regression. The slope of the regression line is shown by the depression data's

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Ppvalue. The importance of the linear relationship between the dependent and independent variables is shown by the p-value. Simplicity has a favourable p-value for multiple linear regression (0.0561).

TABLE IV. ASSOCIATION BASED MULTILEVEL LINEAR REGRESSION FOR DEPRESSION DATA

Predictor	Estimate	Standard error	t-statistic	p-value
Constant	0.3723	0.1243	2.9962	0.02
Simplicity	0.2161	0.162	1.3337	0.2241
Adjfatal	0.0214	0.0613	2.001	0.02

In Table 4, depression predicted through association based multilevel linear regression by using simplicity variable and adjfatal variable from depression data. Simplicity and adjfatal variables have some parameters such as estimation, standard error, t-statistic and p-value for depression data. Fatalism has less standard error (0.0613) through association based multiple linear regression. Error of depression data calculated through association based multiple linear regression equation,

Depression=0.3723+0.2161.simplicity+0.0214.adjfatal

Association based multiple linear regression gives 2% error values and it gives 98% accuracy. The t-statistic represents the coefficient divided by its standard error of depression data. The adjfat has better t-statistic value (2.001) for association based multiple linear regression. The adjfat has good p-value (0.02) for association based multiple linear regression. Compared to other methods association based multiple linear regression gives the best standard error, t-value, p-value and high accuracy.

TABLE V. ANALYSE OF VARIANCE OF MULTIPLE LINEAR REGRESSION

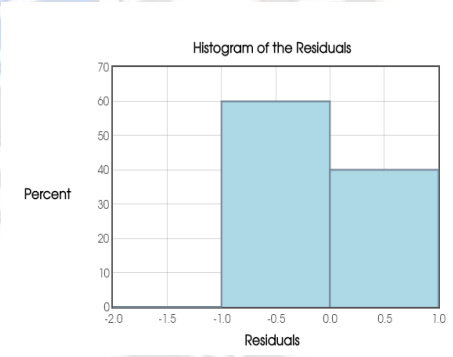
Source	Df	SS	MS	F-statistic	p-value
Regression	2	0.0222	0.0111	2.277	0.1731
Residual error	7	0.0342	0.0049	-	-
Total	9	0.0564	0.0063	-	-

In Table 5, Df stands for degrees of freedom and is defined as the sum of the degrees of freedom associated with regression and residuals. SS value is calculated using degrees of freedom. There are nine total degrees of freedom (Df) for the depression data. The sum of squares (SS) statistic was used to analyse depression data to determine the association between dependent and independent variables. The depression data's overall sum of squares (SS) score is 0.0564. The MS abbreviates the depression data's mean squared error value. This mean squared value was discovered using the mean of the squared values. Data on depression obtained by multiple linear regression have a total mean square error (MS) value of 0.0063. F-statistic is used to examine the slope hypothesis. The depression data's F-statistic score is 2.277. The multiple linear regression's p-value is 0.1731. Multiple linear regression is used to calculate the values of Df, SS, MS, F-statistic, and p-values from the depression dataset.

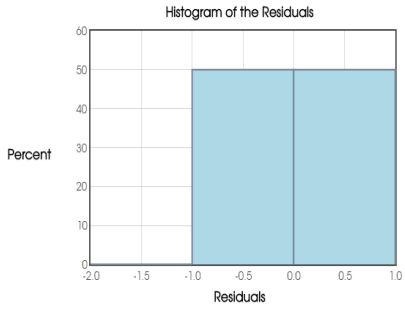
Total degrees of freedom (Df) for the data on depression are nine in Table 6. The depression data's overall sum of squares (SS) score is 0.0564. Data on depression obtained by multiple linear regression have a total mean square error (MS) value of 0.0063. The depression data's F-statistic score is 0.9926. Multiple linear regression has a p-value of 0.02. A depression dataset is used to calculate the values of Df, SS, MS, F-statistic, and p-values using association-based multiple linear regression. Association-based multiple linear regression provides the best df, SS, MS, F-statistic, and p-value for depression data when compared to other statistical methods. The results of association-based multiple linear regression on depression data are displayed in Figure 2.

TABLE VI. ANALYSE OF VARIANCE OF ASSOCIATION BASED MULTILEVEL LINEAR REGRESSION

Source	Df	SS	MS	F-statistic	p-value
Regression	2	0.0125	0.0062	0.9926	0.02
Residual error	7	0.044	0.0063	-	-
Total	9	0.0564	0.0063	-	-



(a) HISTOGRAM OF MULTIPLE LINEAR REGRESSION



(b) HISTOGRAM OF ASSOCIATION BASED MULTIPLE LINEAR REGRESSION

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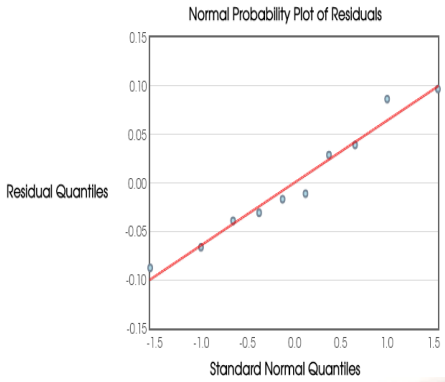
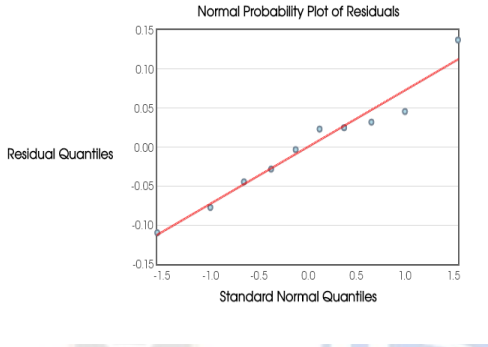


(c) REGRESSION PLOT OF MULTIPLE LINEAR REGRESSION



(d) REGRESSION PLOT OF ASSOCIATION BASED MULTIPLE LINEAR REGRESSION

Figure 2 Output of Association Based Multiple Linear Regression for depression data

The multiple linear regression histogram is shown in Figure 2 (a) and is displayed between the variables of simplicity and fatalism for depression data. Plotted between the simplicity and adjfatal variables of the depression data, Figure 2 (b) displays the histogram of association-based multiple linear regression. This histogram uses a bar graph to display the form of numerous datasets. The results of multiple linear regression are displayed in Figure 2 (c). Simpleness of depression data is on the X-axis, while fatalism of depression data is on the Y-axis. The results of multiple linear regression are displayed as a straight line, but they are less accurate at predicting depression. The results of association-based multiple linear regression are displayed in Figure 2 (d). The y-axis contains the adjfatal variable of the depression data, while the x-axis contains the simplicity variable. Multiple linear regression using associations produces a straight line as a result and has a high level of accuracy in predicting depression. This highly accurate depression forecast was used to stop a suicide attempt. Because early depression detection helps to prevent suicidal thoughts before they become serious. Table 7 and Figure 3 shows the comparison of different algorithms.

TABLE VII. COMPARISON OF DIFFERENT ALGORITHMS

Algorithm	**True negative**	**True positive**	**False negative**	**False positive**
Association based MLR	686	1315	123	234
LR	100	1000	879	987
MLR	123	1034	945	756

True Negative (TN) represents the cases where the algorithm correctly identified individuals who do not have depression. In the case of "Association based MLR," the algorithm correctly identified 686 cases as not having depression. True Positive (TP) indicates the cases where the algorithm correctly identified individuals who do have depression. For "Association based MLR," the algorithm correctly identified 1315 cases as having depression. False Negative (FN) represents the cases where the algorithm incorrectly predicted that individuals do not have depression when they actually do. In the case of "Association based MLR," there were 123 cases where the algorithm failed to identify depression when it was present. False Positive (FP) indicates the cases where the algorithm incorrectly predicted that individuals have depression when they do not. For "Association based MLR," there were 234 cases where the algorithm wrongly identified depression when it was not present.

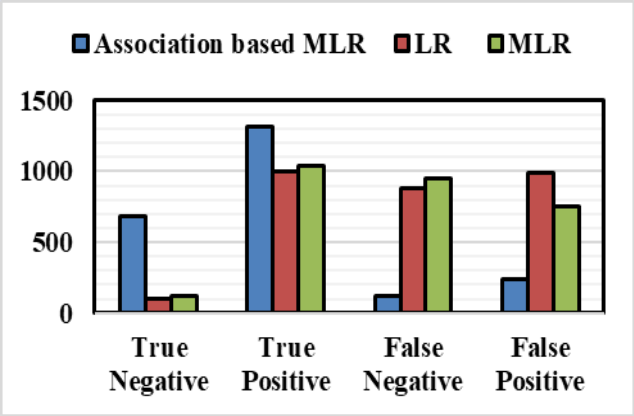


Figure 3 Comparison of different algorithms

Association based MLR demonstrated relatively balanced performance in terms of true positives and true negatives, all three algorithms have room for improvement, especially concerning false negatives and false positives, which are crucial factors in the context of depression detection. Further refinement and optimization of these algorithms might be necessary to enhance their accuracy and reliability in identifying individuals with depression. Table 8 and Figure 4 shows the comparison of the performance of different algorithms.

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TABLE VIII. COMPARISON OF THE PEFORMANCE OF DIFFERENT ALGORITHMS

Algorithm	Accuracy	Precision	Sensitivity	Specificity
Association based MLR	99	98	100	94
LR	84	85	86	85
MLR	80	78	79	76

Accuracy is the overall correctness of the algorithm. It measures the percentage of correctly classified cases out of the total cases. For "Association based MLR," it achieved an accuracy of 99%, indicating that 99% of the cases were correctly classified by the algorithm. Precision measures the accuracy of positive predictions made by the algorithm. It is the percentage of true positive predictions out of all positive predictions made by the algorithm. For "Association based MLR," it achieved a precision of 98%, suggesting that 98% of the cases predicted as positive by the algorithm were true positives. Sensitivity measures the algorithm's ability to correctly identify positive cases out of all actual positive cases. For "Association based MLR," it achieved a sensitivity of 100%, indicating that the algorithm correctly identified all actual positive cases. Specificity measures the algorithm's ability to correctly identify negative cases out of all actual negative cases. For "Association based MLR," it achieved a specificity of 94%, suggesting that 94% of the actual negative cases were correctly identified by the algorithm.

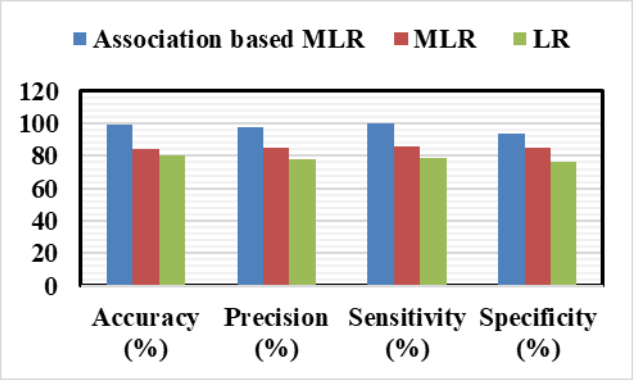

Figure 4 Comparison of the performance of different algorithms

In the case of Association based MLR the high accuracy, precision, sensitivity, and specificity values collectively indicate that this algorithm performed exceptionally well. It correctly identified almost all positive cases (sensitivity), made very few false positive predictions (precision), accurately classified both positive and negative cases (specificity), and achieved an overall high accuracy rate. Association based MLR outperformed both "LR" and "MLR" in all metrics, indicating it is the most reliable algorithm for depression detection among the three evaluated in this context.

VII CONCLUSION

The Association-based Multiple Linear Regression strategy that is suggested in this study uses depression dataset to predict mental depression. In comparison to other statistical techniques, the multiple linear regression method based on association produces improved results for the depression dataset. In comparison to other methods, the association-based multiple linear regression method provides good performance, responsiveness, regression, and clear plots of the depression dataset. For the depression dataset, the association-based multiple linear regression technique provides high accuracy (around 98%) in a short amount of time. This forecast served as a deterrent to suicide attempts.

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