IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 11, Issue 4, April 2024

DOI: 10.17148/IARJSET.2024.11464

PREDICTION OF MALNUTRITION IN CHILDREN USING MACHINE LEARNING

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Abstract: Malnutrition is an imbalance between the nutrients the human body wants and the nutrients it receives. Infant malnutrition is a grave health issue for every country. Children are the fateful framework of a country and as a result this issue affects monetary boom and rural development without delay. Anthropometric measurements such as WAZ, HAZ, WHZ, BMI, MUAC are used to assess an individual's dietary reputation. In this paper, we have designed an automation machine for predicting malnutrition in under five children and recommending a dietary regimen for predicted malnutrition. The layout of this venture is primarily based on a theoretical framework that has been developed utilizing the accumulated literature. In conclusion, by determining the malnutrition status and administering the diet regimen policymakers can reduce malnutrition condition. The "Prediction of Malnutrition in Children" project is dedicated to creating a reliable model for early detection and forecasting of malnutrition among children. Through meticulous data analysis and the application of advanced machine learning techniques, the project aims to accurately predict malnutrition risk by integrating diverse datasets covering nutritional, demographic, medical, and socio-economic factors. By doing so, it seeks to revolutionize intervention strategies, enabling timely and targeted interventions to mitigate the impact of malnutrition on children's health. Ethical considerations, data privacy, and stakeholder engagement are central to its approach, ensuring transparency, accountability, and respect for privacy rights. Through interdisciplinary collaboration and community involvement, the project aims to drive innovation and contribute to the global effort to combat malnutrition, ultimately promoting a healthier future for children worldwide.

I. INTRODUCTION

Child malnutrition is a significant concern for a nation, as children are the future manpower, directly influencing the economic development of the country. The main target of this research is under five children and mostly for developing countries. In this system, a data science machine learning approach is proposed to predict the malnutrition status depending on the training data-sets. Training data-sets downloaded from www.kaagle.com.

Classification techniques used for malnutrition status prediction. We have used "*bayesian classifier*" algorithm for prediction as it gives the most efficient result. To build real time application we use technologies such as "*Visual Studio*" as front end technologyand "*SQL server*" as back end technology. Both the tools are powerful tools to work with real time application. Generally, our method will obtain the most robust results to predict the malnutrition status based on clinical data-sets. Malnutrition can be categorized broadly into undernutrition and obesity. Undernutrition manifests in four broad forms: wasting, stunting, underweight, and micronutrient deficiencies. Wasting is defined as low weight for height. It often indicates recent and severe weight loss, which is unnatural. It usually occurs when inadequate quality and quantity of food and/or has frequent or long- term illnesses. Stunting is defined as low height for age. It's far the end result of chronic or recurrent undernutrition, usually related to poverty, bad maternal health and nutrients, frequent infection, and/or beside the point feeding and care in adolescence. Stunting prevents youngsters from achieving their physical and cognitive potential. An underweight child may be stunted, flabby, or both. A deficiency in micronutrients refers to the inadequate presence of vital vitamins and minerals necessary for bodily functions. Obesity is a condition characterized by an excessive accumulation of body fat, which heightens the risk of various health complications. It frequently arises from consuming more calories than the body expends through physical activity and regular daily routines. It happens to a person whose body mass index (BMI) is 25 or higher. Changes in a person's lifestyle regarding diet and exercise needs to be made as treatment for obesity. Malnutrition detection is important in today's world. Current system is guide method of toddler evaluation and leads to much less correct outcomes and not the suitable approach for malnutrition prediction. Current system involves tedious tasks and involves more time and more expensive. We implement data science algorithms to process medical data and predict malnutrition status in children. Our intention is to develop this tool for doctors. System category is browser based application where different users from different locations can access it.

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II. PROBLEM STATEMENT

In today's society, ensuring proper nutrition for children is paramount as it directly impacts their growth, development, and overall survival. However, the existing method for analyzing child nutrition status is largely manual, resulting in less accurate results and an inadequate approach for predicting malnutrition. This current system is characterized by labor-intensive tasks, consuming significant time and resources, thus making it costly and inefficient.

III. PROPOSED SYSTEM

Proper nutrition stands as a crucial factor for the survival, growth, and development of children worldwide. However, malnutrition persists as a significant global challenge in contemporary times. The primary aim of the proposed system is to accurately predict the malnutrition status of under five children. The system categorizes children into various malnutrition statuses including stunted, underweight, wasted, and nutritional edema based on parameters such as age, gender, height, weight, as well as other metrics. To achieve this prediction, Bayesian classifier is employed because it is an efficient classifier. Database are taken from reputable online platforms like "Kaggle.com" and "Dataworld.com". The envisioned application aims to be a useful tool for doctors, facilitating timely intervention and treatment. Development of the application utilizes efficient technologies such as "Visual Studio" for software development and "SQL Server" for database management.

IV. LITERATURE SURVEY

Under five children are more prone to diseases caused due to lack of proper nutrients. Malnutrition if left undetected can cause non-communicable diseases(NCDs) which affects the long term health of the individual. Many research has taken place to predict malnutrition at an early age to prevent such health hazards. Around 149 million children are estimated to be suffering from malnutrition condition across the globe.

A research was conducted by authors Eliana Marina Alvarez Di Fino, Maria Daniela Defago, Carlos Marcelo Scavuzzo on 2019 at IEEE titled "Spatial Analysis Applied to Nutritional Epidemiology"[1] . The methodology used was the 2-Varogram algorithm programmed using the IDL language. The main limitation was that the system was only able to tell about the special analysis of the nutrition epidemiology and it gave only the distribution of variety of data.

Another research was conducted by authors Kaylen J Pfisterer, Robert Amelard, Braeden Syrnyk, Alexander Wong on 2019 at IEEE titled "Towards Computer Vision Powered Color-nutrient Assessment of Pureed Food"[2] .The methodology used was deep autoencoder network with 80% accuracy. The main limitation was that an autoencoder network used images as input because it is a deep learning algorithm and takes lot of time.

Another research was conducted by authors Mohammed Sami Mohammed, Arshed A. Ahmad, Murat Sari on 2020 at IEEE titled "Analyzing anemia using data mining techniques with specification of risk factors"[3] . The following techniques are used such as Naïve Bayes, Bayesian Network, Logistic Regression and Multi Layer Perceptron. The prediction is made on the basis of previously available data, which is 539 samples with 10 different parameters. The limitations were found that only two types of anemia are considered here, namely iron deficiency anemia and vitamin deficiency anemia. The data set considered here is relatively small. The results are therefore not reliable. The MLP technique may result in redundancy and inefficiency.

Another research was conducted by authors Ziaullah Momand, Pornchai Mongkolnam, Pichai Kositpantavong, Jonathan H. Chan on 2020 at IEEE titled "Data Mining-Based Prediction of Malnutrition in Afghan Children"[4] . Using various classification techniques such as RF, PART rule induction, Naïve Bayes and logistic regression to predict malnutrition status. As seen in the previous article, the RF algorithm has its own limitations in real-time execution. The method only predicts the state of malnutrition of the child, but the question remains how to overcome the problem. Another research was conducted by authors Sujit Bebortta, Manoranjan Panda, Shradhanjali Panda on 2020 at IEEE titled "Classification of Pathological Disorders in Children using Random Forest Algorithm"[5]. Many algorithms like RBF-SVM, decision tree, K-nearest neighbor, Random forest, K-star. It has limitations such as the Random Forest (RF) algorithm is efficient, but its execution is slow. Not suitable for real-time prediction.

V. SYSTEM REQUIREMENTS

HARDWARE REQUIREMENTS

Processor: Pentium IV onwards Processor Speed: 2.4GHz RAM: 2GB +
Hard disk space:40GB +
Standard PC configuration to carryout challenging computing

SOFTWARE REQUIREMENT

Operating System: Windows 8 onwards Design Tool: Visual Studio

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Front End: ASP.NET Language: C#
SQL Sever: SQL Sever
Data Access Technology: ADO.NET

VI. SYSTEM ARCHITECTURE

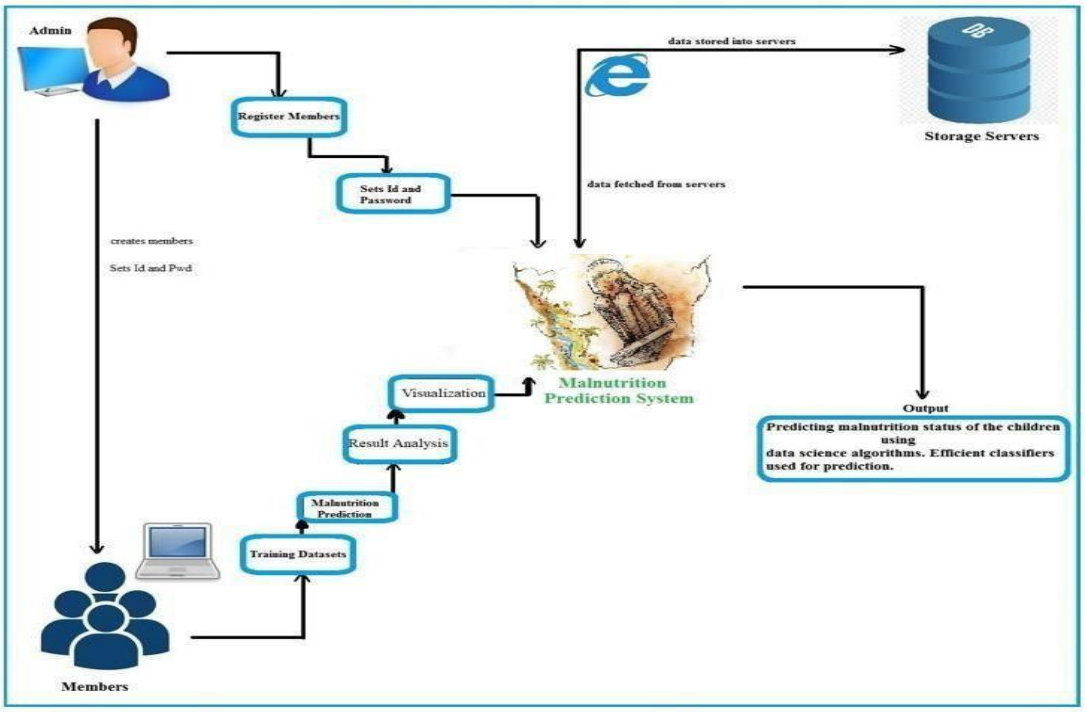

Figure 6.1: System architecture of Malnutrition Prediction System

As shown in the above figure admin Server manages user authentication, system configuration, and overall system administration tasks. It handles user requests for accessing the system and coordinates communication between different components. Admin adds members or doctors using ID and password. Only the Admin can add or delete new members. Member server hosts the machine learning model, specifically the naive bayes algorithm for child malnutrition prediction. It processes incoming data, trains the model, and performs predictions based on the trained model. It also provides diet recommendation for the malnutrition status predicted. It provides approach to the data for the member server to train the model and make predictions. Output component receive prediction results from the member server and presents them to the user. When a user wants to login be it admin or member they must enter the correct credentials. When the user presses enters the information then it is checked with the database. This user authentication ensures the safety of the system. This login check allows only registered users to access. The admin or member server send the request message for login check to the database server. It processes this request and sends a response message back to the admin or member server. This web application is implemented using OOPS approach. Using this approach, we can modularize a program by creating an area of memory divided into both data and functions. This can be used as template for making more copies on demand of these modules.

VII. METHODOLOGY

Machine learning (ML) is a subset of artificial intelligence that deals with the development and study of statistical algorithms that can effectively generalize and thus perform tasks without explicit instructions. ML supports many techniques. In the project, we use "supervised learning techniques" for data processing and prediction. Classification is basically used to classify each and every item in a data set into one of a predefined set of classes or groups. In this project, we use either "naive bayes" and a "KNN" or "decision tree" classifiers for processing previous data and for prediction. These specified algorithms are the most efficient and take less time to process the data.

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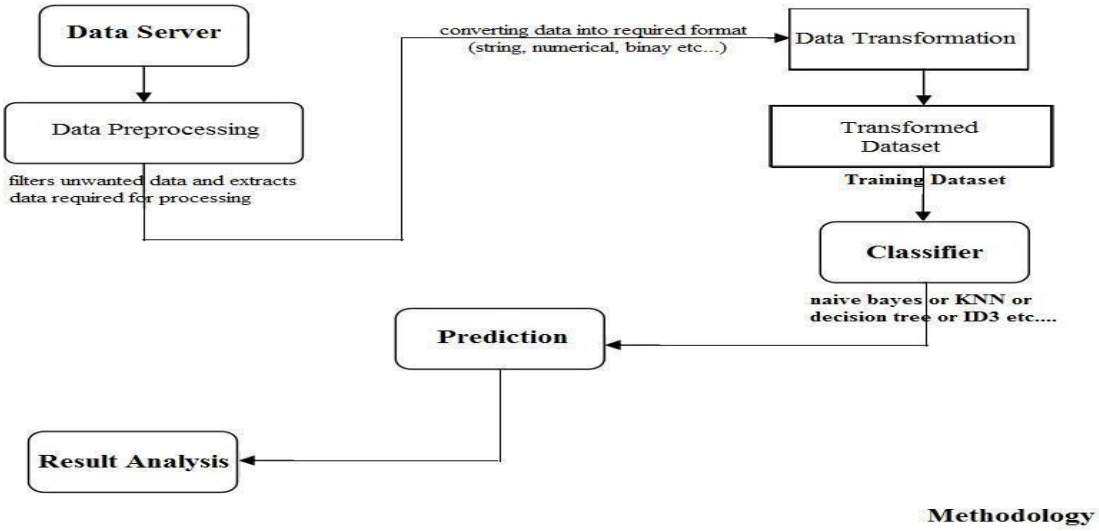

Figure 7.1: Methodology of Malnutrition Prediction System

VIII. FLOWCHART

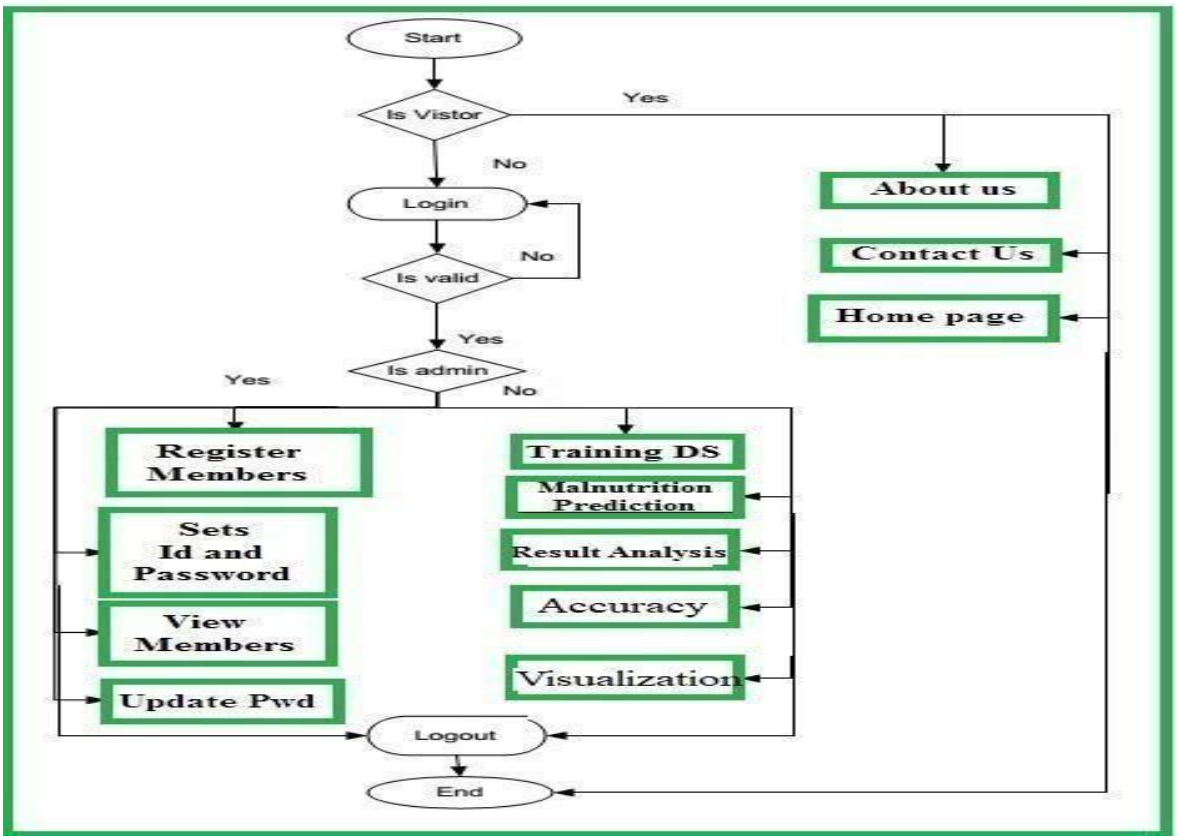

Figure 8.1: Flowchart of Malnutrition prediction

As shown in the above flowchart, it represents a user authentication system with multi-level access control, catering to different user roles: admin, members, and visitors. Upon initiating the login process, the system first verifies the entered credentials against stored data. If the credentials match, the user gains access based on their role. For admin users, successful authentication grants access to a range of administrative functions. This includes the ability to register new

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members, manage member IDs and passwords, view member details, and update passwords as necessary. Admin privileges empower efficient management of the system and ensure smooth operation. On the other hand, authenticated members are directed to a set of functionalities designed to support their specific tasks. Members can set up the necessary data structures for training, apply the Naive Bayes algorithm for malnutrition prediction in children aged upto five and conduct detailed analyses of prediction results. The system categorizes predicted outcomes into distinct categories such as normal, stunted, underweight, and obese, providing valuable insights into the nutritional status of the target population. Additionally, members can evaluate the accuracy of predictions, enabling continuous improvement and refinement of the prediction model. For visitors who do not require authentication, the system offers limited access to static pages containing general information. Visitors can explore pages like "About Us," "Contact Us," and the homepage, which informs about the system and its purpose. This restricted access ensures that visitors can still engage with the system's content without compromising sensitive functionalities or data. By structuring user access levels and functionalities in this manner, the flowchart establishes a clear and intuitive user journey tailored to the specific needs and responsibilities of each user role. This approach enhances usability, security, and efficiency within the system, facilitating seamless interaction and collaboration among users.

IX.IMPLEMENTATION

- **Presentation layer** is Asp.net (frontend) which invokes the business logic through button click or page load event or SelectedIndexChange event from the dropdown list.
- **Business Logic** comprises class attributes and methods. An instance of the business logic class is instantiated, and it calls upon the methods.

In this implementation tailored for predicting malnutrition in children aged upto five using the Naive Bayes algorithm, the system architecture is structured into distinct layers, each serving specific purposes and facilitating efficient data flow and processing. At the presentation layer, ASP.NET is employed to create a user-friendly interface, allowing users to engage with the system using different methods button clicks or dropdown list selections. Behind the scenes, the business logic layer encapsulates the core functionality of the system, housing class members and functions responsible for handling data processing tasks. When user actions trigger events, the presentation layer invokes corresponding methods within the business logic layer. An instance of the business logic class is instantiated to facilitate these interactions, ensuring seamless communication between the presentation layer and the underlying business logic. At the heart of the system lies the data layer, where interactions with the backend SQL Server 2005 database occur. Leveraging a SqlDataSource and the specified connection string stored in the web.config file, the system establishes and manages connections to the database. The table adapter serves as a bridge between the application and the database by executing data commands and facilitating data retrieval and updates. Upon retrieving data from the database, the system stores it in a Dataset, providing an in-memory cache for efficient data manipulation and processing. The Dataset, named "DataLayer.xsd" in the project, acts as a repository for the data required for malnutrition prediction. By employing this layered architecture, the implementation ensures modularity, scalability, and maintainability of the system. The clear separation of concerns between the presentation layer, business logic layer, and data layer allows for easier development, testing, and maintenance of the system. Furthermore, leveraging ASP.NET for the front end and SQLServer 2005 for data storage enhances the system's robustness and performance, enabling accurate prediction of malnutrition.

X. TESTING

As shown in the below table the test cases provided offer a comprehensive validation of key functionalities within the malnutrition prediction application, with a primary focus on the login process and navigates to admin page. In TC01, the primary objective is to ensure the seamless execution of the application without any interruptions. The expected outcome is a smooth running of the application, devoid of errors or disruptions. Upon execution, the application indeed operates without any hiccups, meeting the expected result and warranting a "Pass" status.

Moving to TC02, the emphasis lies on validating the functionality of the login page. This involves inputting a username and password and subsequently verifying their authenticity against the database. As expected, the entered credentials successfully authenticate against the database, corroborating the expected outcome and leading to a "Pass" status for this test case.

TC03 delves deeper into the verification process, particularly focusing on the admin page. Here, the aim is twofold: first, to ensure that valid admin credentials seamlessly navigate to the admin homepage, and second, to appropriately handle invalid credentials by displaying an error message. As per expectations, valid admin credentials smoothly transition to the admin homepage, while invalid credentials prompt the display of an error message, aligning with the anticipated outcomes. Consequently, TC03 earns a "Pass" status, affirming the successful validation of admin page navigation functionality.

In essence, these meticulously crafted test cases provide a robust evaluation of critical functionalities within the

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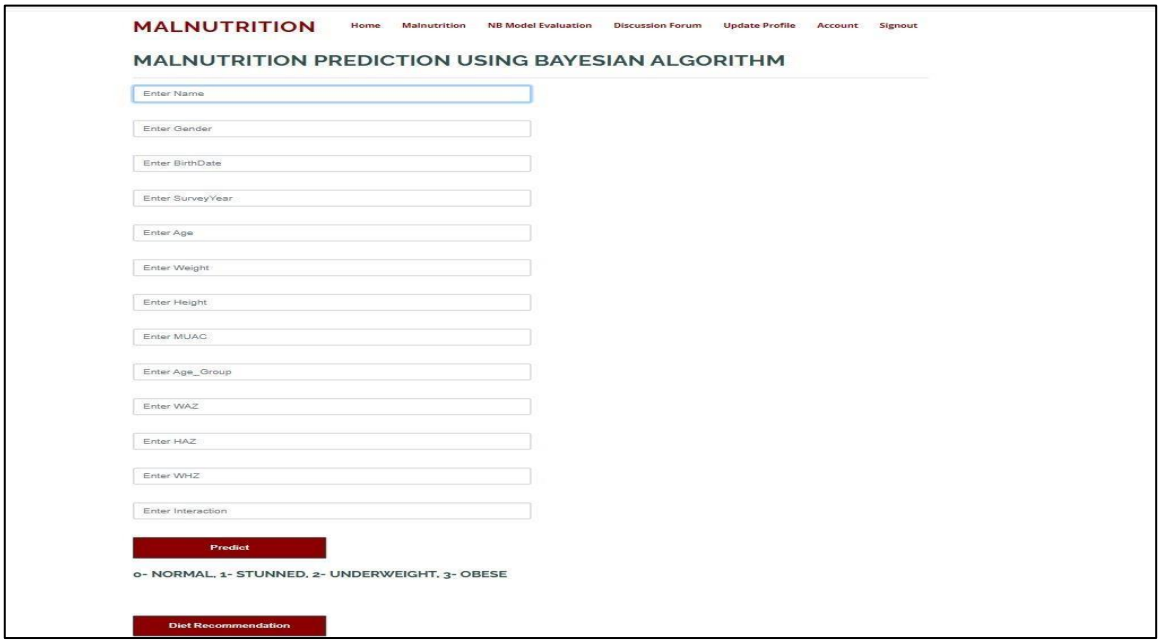
malnutrition prediction application. By meticulously validating each aspect of the application's functionality, these test cases instill confidence in the reliability and effectiveness of the application, thereby ensuring its seamless operation and user satisfaction.

Table 1: Test cases for working of the malnutrition prediction.

SL.NO	Description	Expected Result	Actual Result	Status of Execution Pass/Fail
TC01	Execute/run the application	Application should run without any interrupts	Application is executing properly	Pass
TC02	Verification of Admin/Member login	Enter User Name and Password. It should verify with database.	Entered User Name and Password are successfully verifying with database.	Pass
TC03	Verification of Admin Page input User Name and password	If Admin Login Name & Password is valid then it should navigate to respective Admin home page. If invalid then show message that Input Username & Password is wrong.	Admin User Name & Password is valid then successfully navigating respective home page. If User Name & Password is not valid or wrong input then message box shown that User Name & Password wrong.	Pass

XI. RESULT

In our child malnutrition prediction project, the result of this project includes 0- NORMAL, 1- STUNNED, 2- UNDERWEIGHT, 3- OBESE using these values we will check whether the children are malnourished or not with the help of Naïve Bayes algorithm.



Snapshot 11.1: Malnutrition Prediction and Diet Recommendation

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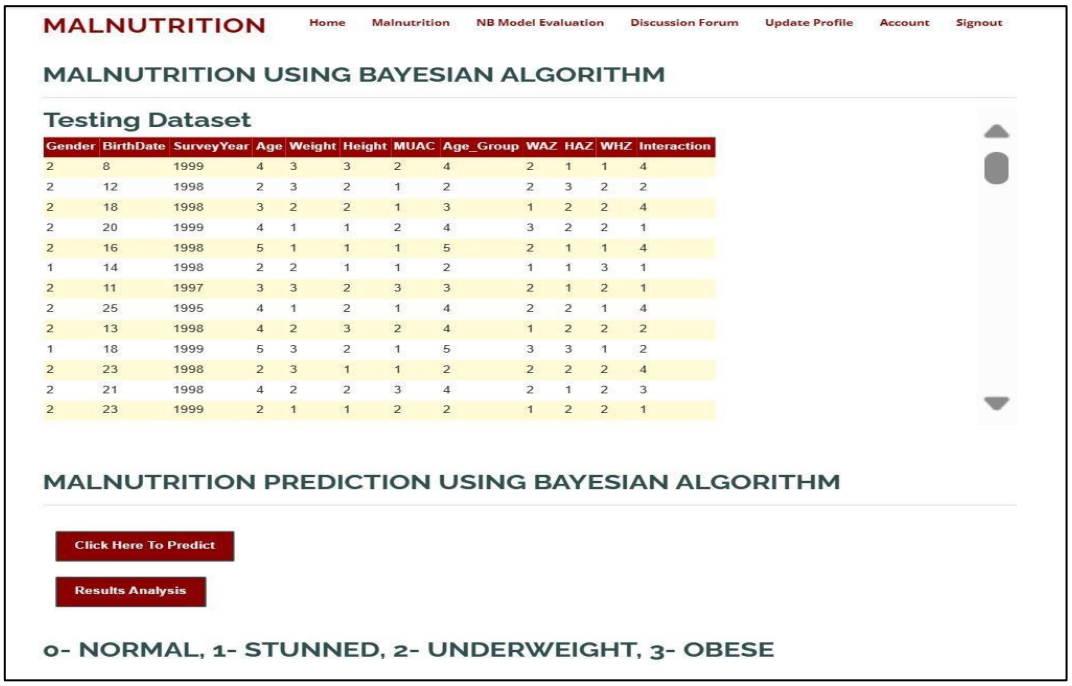

Snapshot 11.2: Result Analysis of Child Malnutrition Prediction

XII. CONCLUSION

Proper nutrition is an essential component for the growth and development of children. Malnutrition is a global problem of today's life. The main goal of the proposed system is to predict the state of malnutrition of children up to five years of age. The system classifies children into stunted, underweight, wasting, and nutritional edema states. We use parameters such as age, sex, height, weight, WAZ, HAZ, WHZ etc... Classifiers used to predict malnutrition in children. The system also predicts anemia and suggests suitable dietary recommendation for users.

XIII. FUTURE ENHANCEMENT

Additionally, multiple algorithms can be used and algorithms compared to identify an efficient algorithm. Multiple training datasets can be used for prediction.

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