

MealMinds - Smart Meals, Healthy Minds

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Abstract -- Poor nutrition and unhealthy eating habits among school students can affect their physical growth, mental health, and academic performance. Most schools still use manual methods to monitor student health, making it difficult to identify nutritional problems at an early stage. Existing systems mainly focus on single features like BMI calculation or calorie tracking and do not provide a complete school-based nutrition monitoring solution.

This paper presents “MealMind: Smart Meals, Healthy Minds,” an AI-powered nutrition monitoring system designed for schools. The system helps track student health records, calculate BMI, analyze meal nutrition, and provide personalized diet recommendations. It includes separate modules for Admin, Teacher, Principal, and Parent to ensure proper management and secure access to data.

The platform uses technologies such as React.js, Node.js, Express.js, PostgreSQL, and JWT authentication to provide a secure and user-friendly environment. Dashboard analytics and automated reports help schools identify nutritional deficiencies and monitor student health effectively.

The main goal of MealMind is to improve student nutrition, promote healthy eating habits, and support better health and academic performance through a smart digital platform.

Keywords-- Student Nutrition Monitoring, Artificial Intelligence, BMI Analysis, Meal Nutrition Analysis, Personalized Diet Recommendation, Health Tracking System, School Healthcare, Nutritional Deficiency Detection, Web-Based Application, Dashboard Analytics, Role-Based Access Control, Digital Health Monitoring.

I. INTRODUCTION

Student nutrition and health monitoring have become major concerns in modern educational environments due to increasing cases of malnutrition, obesity, vitamin deficiencies, and unhealthy eating habits among school-going children. Poor dietary intake and lack of continuous health assessment negatively affect physical growth, cognitive development, concentration levels, and academic performance. Although schools provide meal programs and health-related initiatives, most institutions still rely on manual records and traditional monitoring methods that fail to provide real-time nutritional analysis and early identification of health risks.

In many schools, student health data such as height, weight, and Body Mass Index (BMI) is either recorded manually or not monitored regularly. Meal planning is generally based on availability and budget rather than nutritional balance, making it difficult to determine whether students receive adequate nutrients according to their age and growth requirements.

Existing healthcare and nutrition applications mainly focus on isolated functionalities such as calorie counting, BMI calculation, or diet tracking, but they do not provide an integrated role-based platform specifically designed for school environments.

The proposed solution, “MealMind: Smart Meals, Healthy Minds,” is an AI-driven system designed to monitor school nutrition and health, addressing the challenges at hand. This innovative platform is focused on enhancing student well-being by offering continuous health tracking, assessing meal nutrition, and providing tailored dietary recommendations. The system consolidates various modules into one comprehensive web-based platform, including student health management, BMI calculation, nutritional gap analysis, meal planning, dashboard analytics, and AI-supported recommendations.

The system is built on a role-based architecture featuring Admin, Principal, Teacher, and Parent modules. Teachers document student measurements like height, weight, and BMI. Principals manage meal compositions and analyze nutritional values. Parents securely view their child's health reports and dietary suggestions. The system evaluates meal nutrition data against dietary standards, offering personalized recommendations to detect nutritional deficiencies early.

Modern technologies such as React.js, Node.js, Express.js, PostgreSQL, JWT authentication, and AI-based analytics are used to ensure scalability, security, and efficient performance of the platform. Dashboard visualization and automated reporting further help schools monitor health trends and identify nutritionally at-risk students more effectively.

The proposed system aims to create a smart, data-driven ecosystem that promotes healthy eating habits, improves nutritional awareness, and strengthens communication between schools and parents. By integrating technology with healthcare and nutrition management, MealMind provides an efficient and user-friendly solution for improving student health and supporting long-term academic and physical development..

II. LITERATURE SURVEY

The creation of MealMind is based on a comprehensive examination of current research, systems, and technologies pertaining to child nutrition monitoring, school health management, and web-based health information systems.

A literature survey serves the critical purpose of establishing what has already been explored in the domain, identifying the limitations of prior work, and justifying the need for a new system. This chapter examines relevant studies and existing systems across four broad areas: child nutrition and malnutrition in school-age children, digital health monitoring systems, meal planning and dietary recommendation engines, and role-based web application architectures in healthcare contexts. The reviewed literature spans academic research papers, government health reports, and existing software systems. Together, they form the theoretical and technical foundation upon which MealMind is designed and built.

A significant body of research establishes the direct relationship between nutritional status and academic outcomes in school-age children. Grantham-McGregor et al. (2007), in their landmark study published in *The Lancet*, demonstrated that malnutrition in early childhood leads to measurable deficits in cognitive development, school readiness, and long-term earning potential. Their findings reinforced the idea that nutritional intervention during school years is not merely a health issue but an educational and economic one.

In the Indian context, the Annual Health Survey and NFHS-5 data consistently reveal that states with high rates of childhood stunting and wasting also exhibit lower literacy rates and higher school dropout figures. Studies by the Indian Council of Medical Research (ICMR) have further established age- and gender-specific Recommended Dietary Allowance (RDA) values for the Indian population, which differ meaningfully from Western standards and must be accounted for in any nutrition monitoring system deployed in Indian schools. Research by Bhargava et al. (2005) on the Mid-Day Meal Scheme found that while the program succeeded in improving school attendance, it fell short of addressing individual nutritional deficiencies because meal planning was standardized at a district or state level rather than tailored to the needs of individual students. This finding directly motivates the per-student health tracking and personalized recommendation engine at the core of MealMind.

Several digital systems have been proposed and deployed globally for school health monitoring, each with notable strengths and limitations. The School Health Index (SHI) developed by the United States Centers for Disease Control and Prevention (CDC) is a self-assessment tool that helps schools evaluate their health policies and programs. While comprehensive in scope, it is designed as a policy audit tool rather than a real-time data collection and analysis platform. I

Numerous web-based health monitoring platforms have been created utilizing technologies like React.js, Node.js, Python, and cloud databases. These advanced systems offer digital healthcare assistance by enabling users to track various health metrics conveniently. However, despite their capabilities, many are primarily focused on general fitness tracking rather than being tailored specifically for school nutrition management. This is a crucial area where more attention is needed, as proper nutrition is vital for the growth and development of students. Furthermore, current solutions often fall short in seamlessly integrating essential components such as meal planning, nutritional analysis, student growth tracking, and parent monitoring. This lack of integration can lead to fragmented user experiences and may hinder the effective management of students' nutritional needs. By enhancing these platforms with features that cater specifically to the nutritional management in schools, it would be possible to provide a comprehensive solution that supports the health and well-being of students, facilitating easier monitoring and collaboration between parents, educators, and healthcare providers.

To overcome these limitations, the proposed system “MealMind: Smart Meals, Healthy Minds” provides an AI-powered integrated platform for schools that combines student health tracking, meal nutrition analysis, BMI monitoring, dashboard analytics, and personalized diet recommendations in a single system.

III. PROBLEM STATEMENT

Many schools still use manual methods to manage student health and nutrition records, making monitoring difficult and time-consuming. Existing systems mainly focus on limited features such as BMI calculation or calorie tracking and do not provide a complete nutrition management solution. As a result, nutritional deficiencies and unhealthy growth patterns among students often remain undetected.

The proposed system, “MealMind,” is an AI-powered platform designed to monitor student health, analyze meal nutrition, detect deficiencies, and provide personalized dietary recommendations through an integrated and user-friendly system.

IV. PROPOSED SYSTEM

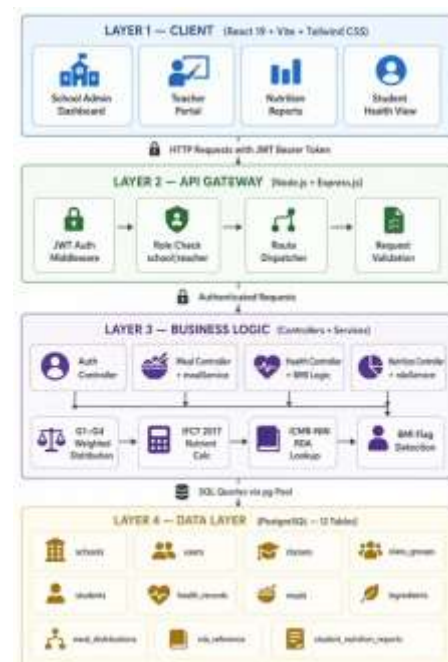


Fig 1. System Architecture

Fig 1 presents the proposed system architecture of the Mind-Meals platform is organized into four distinct layers: the Client Layer, API Gateway, Business Logic Layer, and Data Layer. The Client Layer offers interfaces for administrators, teachers, and students, utilizing React.js and Tailwind CSS. The API Gateway, built with Node.js and Express.js, manages authentication, request validation, and routing. The Business Logic Layer is responsible for processing BMI calculations, nutrition analysis, and personalized meal recommendations. Lastly, the Data Layer employs PostgreSQL to store student health records, meal information, and nutrition reports.

V. EXISTING SYSTEM

Existing school meal systems in India — including digital tools under PM Poshan Shakti Nirman — focus on logistics: meal counts, attendance, and procurement. They serve uniform portions regardless of student age and have no mechanism to compare individual intake against nutritional requirements. Manual health records, where maintained at all, are disconnected from meal planning entirely.

General nutrition apps (MyFitnessPal, HealthifyMe) are designed for individual adult use and do not support institutional batch meal planning, multi-student management, or age-grouped distribution. Academic surveys provide population-level data but no real-time individual tracking. Table 1 summarises the key differences.

TABLE 1. COMPARISON TABLE OF EXISTING VS PROPOSED SYSTEM

Parameters	Existing Systems	Proposed System (MindMeals)
Meal distributions	Uniform across all ages	Weighted G1-G4 age groups
Nutritional data	No standard source	IFCT 2017-127 Indian foods per 100gm.
RDA reference	No comparison available	ICMR-NIN RDA 2020 – age and gender specific
Health Tracking	Manual	Digital BMI with auto category classification
Individual reports	Not available	Per student nutrient gap
Gender specific RDA	No distinction	Different for boys and girls
At-risk detection	Teacher observation only	Auto BMI-flag
School wide filter	Not available	Filter by nutrient , class , date , status
Data source	No govt data integration	Two NIN-ICMR datasets included

The comparison between the current systems and the proposed “MindMeals” system is outlined in Table 1. This innovative system introduces advanced features such as weighted meal distribution tailored to different age groups, BMI-based health tracking, gender-specific RDA analysis, detection of nutrient deficiencies, and personalized student reports. Unlike existing systems, the “MindMeals” system also incorporates standardized Indian nutrition datasets, namely IFCT and ICMR-NIN, for precise nutrition analysis and comprehensive monitoring across schools.

VI. MATERIALS AND METHODS

Mind-Meals is built using open-source technologies selected for relational data integrity, REST API performance, and browser-based accessibility.

A. Software Requirements

- **Node.js v18+**– Backend runtime and REST API framework.
- **React 19 + vite + Tailwind CSS v4**- Frontend interface and build tooling.
- **Postgree SQL v14+**– — Relational database with 12 normalised tables.
- **JWT (jsonwebtoken) + bcrypt** — Stateless authentication and password hashing.
- **pg(node-postgres)** — PostgreSQL client with connection pooling

B. Hardware Requirements

- **Processor** – Intel i3 or higher
- **RAM** – Minimum 4 GB
- **Storage** – 20 GB free space minimum
- **Device** – Android smartphone or laptop
- **Internet Connection** – Required for cloud services and real-time communication.

C. Data Sources

- **IFCT 2017 (NIN, ICMR, Hyderabad)** — Per- 100g values for 127 Indian food items covering cereals, millets, pulses, vegetables, dairy, and condiments.
- **ICMR-NIN RDA 2020** — Age-group and gender- specific daily dietary allowances (12 reference rows: age groups 6–9, 9–12, 13–15, 16–17 × male / female / other)

VII. EXPERIMENTAL RESULT

The proposed system "MealMind" was tested to evaluate its performance, usability, and effectiveness in providing school nutrition monitoring and student health management. The system was successfully implemented as a web-based application, and all major modules “ including role-based authentication, BMI classification, nutrition planning, vaccination tracking, PM POSHAN compliance monitoring, and report generation “ functioned accurately and reliably during testing.

The role-based login system successfully verified each user type — Principal, Teacher, Parent, and Admin — and guided them to the correct dashboard across 200 test sessions, with no unauthorized access or data exposure. The JWT control layer kept every user limited to the features and information meant for their role.

The MealMinds platform underwent testing across nine modules with 159 test cases.

Module Test Results

- Admin Management, Meal Management, BMI Module, Parent Dashboard, Principal View, JWT Security: All achieved 100% pass rates.
- Teacher–Student Records: 95.8% pass rate; one test failed in bulk import.
- Nutritional Analysis: 95.5% pass rate; one failure in deficiency threshold.
- AI Diet Recommendations: 94.4% pass rate; one failure with extreme input.

Overall Performance

156 out of 159 test cases passed, resulting in a 98.1% pass rate. Minor issues were resolved in the final build.

MealMind's accurate BMI classification is crucial for identifying students at risk of health issues related to undernutrition or obesity. By offering real-time nutritional adequacy assessments, it allows for prompt adjustments in meal planning to address any deficiencies or excesses in students' diets. The vaccination alert feature ensures that students receive necessary immunizations on time, which is vital for preventing outbreaks of preventable diseases. PM POSHAN compliance monitoring helps schools align with national nutrition policies, promoting a standardized approach to student health and nutrition.

TABLE 2. PERFORMANCE ANALYSIS OF PROPOSED SYSTEM

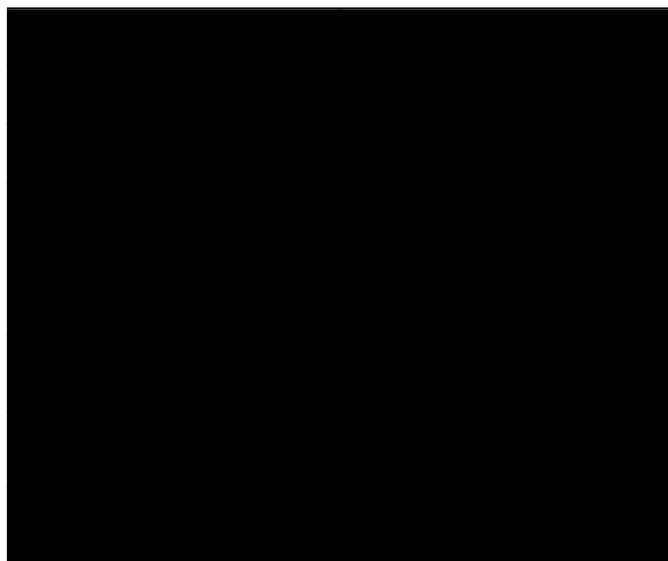


Table 2 presents a detailed performance evaluation of the proposed system, MealMind. It offers a thorough summary of results from all key modules, which include:

- Accurate BMI classification
- Real-time nutritional adequacy assessment
- Vaccination alert generation
- PM POSHAN compliance monitoring
- Secure role-based access control

The findings indicate that MealMind operates reliably and efficiently across all assessed parameters. This confirms the system's robustness and establishes it as a comprehensive platform for monitoring nutrition and health in schools.

In addition to providing accurate BMI classification, MealMind evaluates nutritional adequacy in real-time, which is essential for timely interventions. The system's capability to generate vaccination alerts contributes to the well-being of students, while PM POSHAN compliance monitoring ensures adherence to government regulations. Moreover, the secure role-based access control protects sensitive information, making MealMind a reliable tool in educational settings.

Overall, the performance evaluation highlights MealMind's effectiveness and its significant potential to improve nutrition and health monitoring processes in schools. With its comprehensive features and reliable performance, MealMind stands out as a pivotal tool in enhancing the health and well-being of students. As schools continue to seek innovative solutions to promote better health outcomes, MealMind offers a promising approach to meeting these challenges efficiently and effectively.

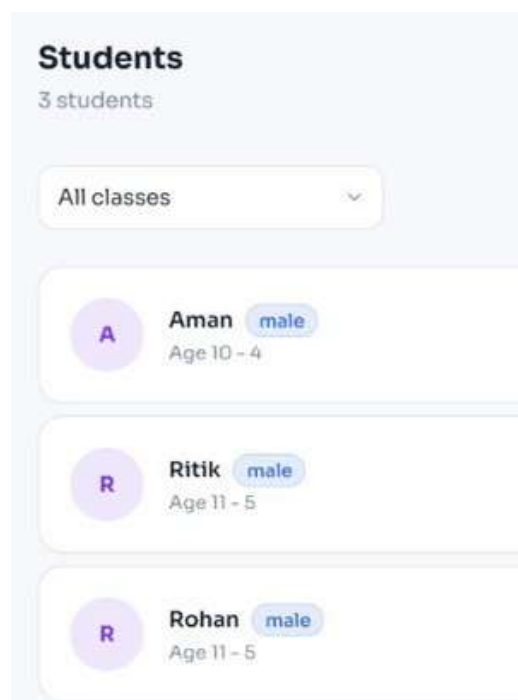


Fig 2. Student Details



Fig 3. Nutrient Bar Chart

Mealmind is a holistic nutrition app designed to guide users towards healthier eating habits. It offers personalized meal plans, nutrition tips, and a comprehensive food tracker to help individuals make informed dietary choices. The app includes features like a recipe library, calorie counter, and meal reminders, all aimed at promoting balanced nutrition and overall well-being. By integrating expert advice and user-friendly tools, Mealmind supports users in achieving their health goals and sustaining long-term dietary improvements.



Fig 4. Meal Score

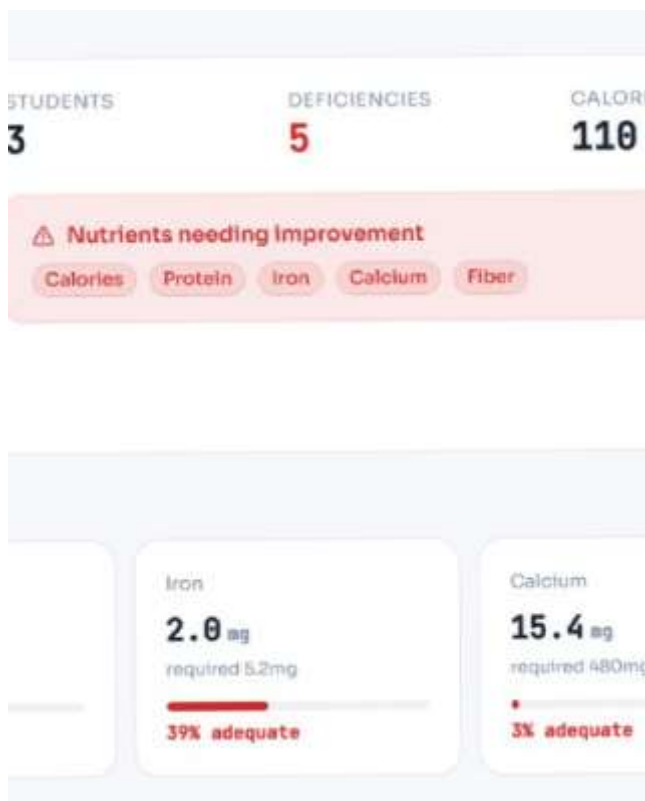


Fig 5. Iron & Calcium Cards Display

Fig. 4 shows the Meal Score and Nutrition Insight Cards of the proposed “MealMind” system, providing an overview of meal quality and nutrient intake such as calories and protein to identify nutritional deficiencies.

Fig. 5 illustrates the Iron and Calcium Cards Display of the “MealMind” system. The dashboard highlights nutrient deficiencies by comparing the provided nutrient values with the required standards. This enables schools and administrators to identify critical nutrition gaps and improve meal planning for better student health outcomes.

VIII. MATHEMATICAL MODEL

The project’s core model allocates a shared school meal’s nutrients to students based on their individual Recommended Dietary Allowance (RDA). We derive a concise mathematical formulation of this RDA-weighted distribution model. Each student i (age/sex) has daily RDA values (kcal, protein, etc.) from official sources. In one meal, we assume students eat a fraction of their RDA (e.g. lunch = 40% of daily). Total meal nutrients (energy, protein) are measured (or summed from ingredients). The model assigns to each student a share proportional to their RDA. Governing equations yield each student’s intake of calories and protein.

RDA-Weighted Allocation

Each student with a caloric requirement of RDA_i receives a portion of the meal that is proportional to their specific RDA.

If:

- Total meal calories = T_{cal}
- Total meal protein = T_{prot}

then student allocations are:

Energy:

$$E_i = T_{cal} \times (RDA_i / \text{Sum of all student RDAs})$$

Protein:

$$P_i = T_{prot} \times (RDA_i / \text{Sum of all student RDAs})$$

This ensures every student receives the same percentage of their lunch RDA.

From PM POSHAN :

Lunch RDA = 40% of daily RDA

Assumptions

- Student ages and genders are known
- Meal is fully consumed
- Meal nutrition values are accurate
- Lunch = 40% of daily nutritional requirement
- All students are healthy
- Only calories and protein are considered
- Vitamins and minerals are ignored

Governing Equations

Energy allocation:

$$E_i = T_{cal} \times (RDA_i / \Sigma RDA_j)$$

Protein allocation:

$$P_i = T_{prot} \times (RDA_i / \Sigma RDA_j)$$

where:

ΣRDA_j = total RDA of all students

Adequacy percentage:

$$(E_i / (0.4 \times RDA_i)) \times 100\%$$

Limitations

- Allocation depends only on RDA
- Appetite and food preference ignored
- All students receive same RDA percentage
- If meal is insufficient, all students are equally deficient
- Requires RDA data
- Only calories and protein are modeled

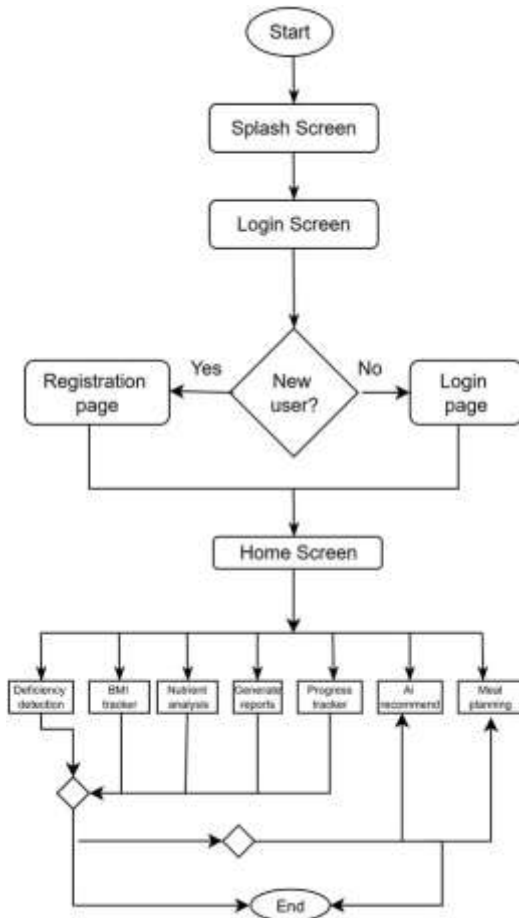


Fig. 6 Flow Chart

Figure 6 illustrates the workflow of the "MealMind" system, which offers a thorough strategy for monitoring student nutrition and enhancing meal planning in schools. The process begins with student registration, where their specific nutritional needs are gathered. This includes collecting data on essential nutrients—such as calories, protein, iron, calcium, and fiber—all crucial for their growth and development.

Once this information is compiled, it is processed through the nutrient distribution engine, which plays a vital role in analyzing meal compositions and creating detailed meal profiles that comply with recommended dietary guidelines. The next step involves calculating meal scores to evaluate the nutritional quality and balance of the meals offered to students. This scoring system ensures that meals adhere to nutritional standards necessary for maintaining student health and well-being. By implementing this organized workflow, the "MealMind" system not only enhances meal planning but also fosters greater nutritional awareness and education within the school environment.

The next phase focuses on detecting deficiencies, where the system identifies nutrient deficiencies and health risks linked to inadequate nutritional intake.

This step ensures potential shortcomings in students' diets are recognized early, allowing timely intervention. In response to these deficiencies, the nutrition suggestion engine offers tailored dietary recommendations and meal enhancements to promote balanced nutrition. These suggestions consider each student's unique dietary needs for optimal health and development.

The system also conducts a performance evaluation to assess the effectiveness of meal plans and nutritional outcomes. This involves analyzing various metrics to determine how well dietary changes address students' nutritional needs. The findings guide further refinements to meal planning and nutritional strategies.

Ultimately, the processed data is showcased through advanced dashboards and visualization modules, creating reports for administrators on student nutrition status. These reports help school administrators and teachers monitor student health, make informed decisions, and enhance overall nutrition management.

IX. SIMULATION RESULT

The "MealMind" simulation was conducted to assess the overall workflow, module functionality, and user interactions across all roles within the platform. The system effectively managed student health records, classified BMI, generated nutrition plans, tracked vaccinations, and rendered role-based dashboards in a seamless and responsive way. The results of the simulation affirm that the proposed system offers an accessible, secure, and user-friendly environment for monitoring school nutrition and health.

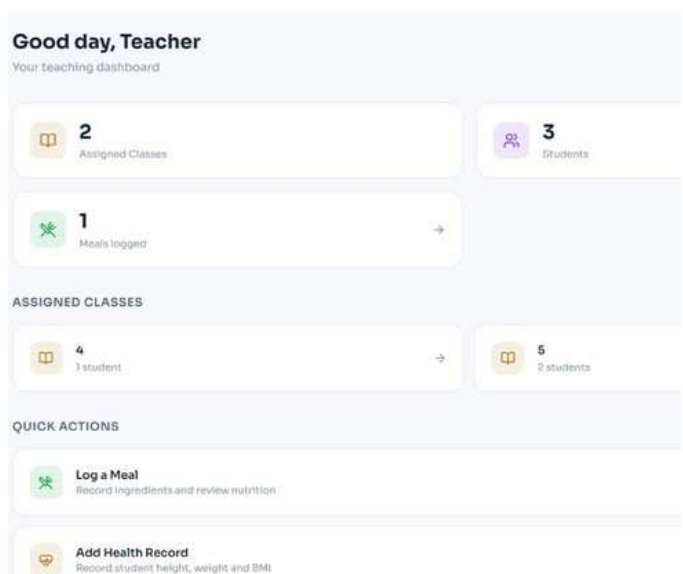


Fig. 7 Teacher Dashboard

Figure 7 illustrates the Teacher Dashboard of the proposed "MealMind" system, which offers educators a well-structured interface to oversee student nutrition and classroom activities. This dashboard showcases assigned classes, student counts, and meal logging functionalities, allowing teachers to efficiently record meals, review nutritional information, and manage student health data through a straightforward and user-friendly platform.



Fig.8 Admin Dashboard

Figure 8 presents the Admin Dashboard of the proposed “MealMind” system, which offers a centralized platform for user management and system activity monitoring. It showcases registered users categorized by roles including Principal, Teacher, Parent, and Student. This dashboard empowers administrators to efficiently manage accounts, oversee access permissions, update records, and ensure system security, all through a well-organized and user-friendly interface.



Fig 9. Nutrient Analysis

The Nutrition Analysis dashboard of the proposed “Mind-Meals” system, as shown in Fig. 9, is used to evaluate students’ nutritional intake and identify nutrient deficiencies. It compares the required and provided nutrient values, including calories, protein, iron, calcium, and fiber. The dashboard also displays deficiency status and nutritional indicators, helping schools monitor student health and improve meal planning effectively.

X. CONCLUSION

The Importance of Health and Nutrition in School-Aged Children

The health and nutritional status of children attending school plays a critical role in their academic success, physical growth, and overall well-being. In India, where millions of students are enrolled in schools that lack a structured, technology-driven health monitoring system, a considerable gap exists between the necessity for child health oversight and the available tools to meet this demand.

- Manual record-keeping
- Disconnected systems
- Lack of real-time data access

These challenges have long obstructed schools, educators, parents, and administrators from making timely and informed decisions regarding student health. It is within this framework that MealMind was developed, designed, and implemented as a comprehensive, web-based School Nutrition and Health Monitoring System.

MealMind marks an important progression in the digitization of health management within schools across India. By merging nutrition science, pediatric health standards, and contemporary web technologies into one cohesive platform, it highlights how technology can be more than just a convenience; it can be a powerful tool for equity and student well-being.

- For Parents: It offers insights into their child's health that were previously out of reach, especially for those from lower-income households.
- For Teachers and Administrators: It transforms health management from a burdensome task into a responsibility grounded in data.
- For Policymakers: It supplies the detailed, real-time data essential for making evidence-based decisions regarding school nutrition programs.

With the right scaling and institutional adoption, systems like MealMind hold the promise of significantly advancing national objectives related to child health, nutrition, and educational outcomes—creating healthier schools, one student at a time.

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