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Original Article

NextGen AI Framework for Adaptive Lifestyle and Nutrition Analytics in Diabetic Care

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Abstract

Diabetes management is often guided by generalized diet plans, which are time-consuming, inflexible, and ineffective for personalized care. Managing multiple lifestyle factors such as physical activity, sleep duration, and stress level further complicates nutritional planning when conventional methods are used. This paper presents a NextGen AI Framework for Adaptive Lifestyle and Nutrition Analytics in Diabetic Care to automate personalized dietary recommendations. The proposed system predicts individualized macronutrient requirements by analyzing lifestyle inputs through machine learning techniques and maps the predicted values to Indian food datasets to provide culturally relevant recommendations. In addition, the framework delivers real-time visualization through an interactive dashboard, thereby improving usability and interpretability. The proposed approach reduces dependence on static meal plans, enhances personalization, and offers an efficient and reliable solution for modern diabetes nutrition management.

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Keywords

Diabetes care, personalized nutrition, machine learning, Random Forest Regression, lifestyle analytics, adaptive diet recommendation, healthcare AI, Streamlit dashboard

Introduction

Diabetes care requires continuous monitoring of lifestyle behavior and careful nutrition planning. This process typically involves tracking physical activity, sleep duration, stress level, and daily food intake. Since these lifestyle patterns may vary significantly from one individual to another and may also change over time, maintaining an appropriate diet becomes difficult with manual planning. Most existing diet support systems provide generalized meal plans that do not adapt to individual needs. As a result, conventional approaches often lead to inaccurate guidance, poor adherence, and increased effort for diabetic individuals.

To address these limitations, this paper proposes a NextGen AI Framework for Adaptive Lifestyle and Nutrition Analytics in Diabetic Care. The framework automatically analyzes lifestyle inputs and predicts personalized nutrient requirements using machine learning techniques. It then generates adaptive dietary recommendations based on Indian food datasets and presents the results through an interactive dashboard. In this way, the system imitates the reasoning process of a human nutrition planner while delivering faster, more consistent, and more accurate recommendations. By dynamically updating recommendations as lifestyle patterns change, the framework supports improved diabetes management through adaptive and data-driven nutrition planning

Objective

The primary objective of this work is to develop an AI-driven framework for adaptive lifestyle and nutrition analytics to support personalized diabetic care. The system is designed to analyze key lifestyle factors such as physical activity, sleep duration, and stress level in order to predict individualized macronutrient requirements. A further objective is to integrate Indian food datasets so that dietary recommendations remain culturally relevant and practical for users. The framework also aims to provide real-time visualization through an interactive dashboard, allowing users and healthcare providers to understand nutritional insights more effectively. Overall, the proposed system seeks to reduce reliance on generalized diet plans, improve personalization, and promote data-driven preventive healthcare.

Problem Statement

People with diabetes face significant challenges in managing daily nutrition because most existing systems fail to provide adaptive and personalized dietary guidance. Current nutrition support tools often rely on static meal plans and do not sufficiently account for critical lifestyle factors such as activity level, sleep duration, and stress. These systems also lack robust AI-driven predictive capability, which reduces their effectiveness in supporting individualized care. Further-more, many available solutions do not adapt in real time to changing lifestyle patterns, making it difficult

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for users to maintain consistent dietary control. The limited integration of lifestyle analytics with machine learning further restricts personalization and practical usability. Therefore, there is a need for an intelligent adaptive nutrition system that can dynamically analyze lifestyle data and predict individualized nutrient requirements for proactive diabetes care.

Literature Review

CLifestyle and nutrition management are fundamental aspects of diabetes care. Traditionally, dietary guidance has been delivered through generalized meal plans or simple nutrition tracking applications that require substantial manual effort from users. These conventional approaches suffer from several limitations, including inaccurate nutrient estimation, inadequate personalization, and failure to incorporate dynamic lifestyle factors such as physical activity, sleep, and stress. As the diabetic population continues to grow, the complexity of maintaining individualized nutrition plans also increases.

Recent studies have explored artificial intelligence for glucose prediction, dietary recommendation, and healthcare analytics. Food recommender systems for diabetes management have been systematically reviewed in recent literature, demonstrating the increasing relevance of intelligent decision support in dietary planning [1]. AI-based food recognition and diet guidance systems have further shown the potential of machine learning in diabetes care [2]. Deep learning and explainable AI methods have also been investigated for personalized nutrition recommendation aligned with health guidelines [3], [8]. In addition, adaptive nutrition recommendation systems using lifestyle and health data have emerged as promising approaches for chronic disease management [4], [5], [9], [10]. Despite these advances, limited research has focused on integrated adaptive nutrition frameworks that combine real-time lifestyle analytics, personalized macronutrient forecasting, and culturally relevant dietary mapping in a unified platform. Most existing works focus either on medical prediction or on static diet recommendation without incorporating dynamic lifestyle inputs. This gap motivates the present work, which aims to develop an adaptive AI-driven framework capable of automatically responding to lifestyle changes and producing personalized nutrition recommendations for diabetes care.

Proposed Solution

To address the limitations of traditional diabetic diet planning, this paper proposes a NextGen AI Framework for Adaptive Lifestyle and Nutrition Analytics in Diabetic Care. The framework employs machine learning, specifically Random Forest Regression, to analyze lifestyle parameters such as physical activity, sleep duration, and stress level for predicting individualized macronutrient requirements. The predicted nutrient values are then mapped to Indian food datasets to generate culturally relevant dietary recommendations.

An interactive Streamlit-based dashboard is incorporated to present real-time predictions and visual insights, enabling users to make informed decisions about their diet. The framework dynamically adapts to changes in lifestyle behavior, thereby reducing dependence on static meal plans and enhancing personalization. By combining predictive analytics, dietary mapping, and visualization, the proposed solution supports data-driven preventive healthcare and improved diabetes management.

Methodology

The methodology adopted in this work follows the same logical steps that a human nutrition planner would typically use, but in an automated and intelligent manner. First, the system collects required user information, including physical activity level, sleep duration, and stress level. This stage corresponds to lifestyle monitoring prior to diet planning.

Next, the framework analyzes all lifestyle inputs and relevant nutritional parameters. Activity patterns, rest quality, and stress conditions are evaluated to determine personalized nutrient requirements. Instead of relying on manual judgment, the framework uses machine learning techniques to process the input features systematically and reduce the possibility of inaccurate recommendations.

After lifestyle analysis, the system predicts macronutrient needs, including carbohydrates, proteins, and fats, in an organized and adaptive way. The trained Random Forest Regression model performs the prediction task, while Indian food datasets are used to generate suitable dietary recommendations. Whenever lifestyle changes occur, such as reduced sleep or altered activity levels, the system updates the predictions without requiring the entire process to be restarted.

Finally, the framework presents nutrient predictions and ranked food recommendations through an interactive dashboard accessible to users and healthcare professionals. Over time, the system can be extended to improve its predictive performance through continual learning, thereby making the overall methodology more robust, adaptive, and practical for real-world diabetes nutrition management.

Rule-Based Methodology

In the rule-based component, the framework applies fixed nutritional guidelines commonly used in diabetic diet planning. Rules such as balanced carbohydrate intake, adequate protein levels, and controlled fat consumption are incorporated to ensure that generated recommendations satisfy baseline health requirements. This stage provides consistency and acts as an initial safeguard before recommendations are delivered.

Constraint-Based Methodology

In the constraint-based component, lifestyle and nutritional conditions are modeled as constraints. For example, carbohydrate intake must remain within healthy limits, and nutrient balance must reflect the user's activity level, sleep duration, and stress condition. The framework evaluates these constraints before finalizing each recommendation, ensuring that the resulting diet plan remains practical and clinically relevant.

Optimization Methodology

The optimization component focuses on distributing nutrients efficiently. Rather than overemphasizing or underutilizing specific nutrients, the system balances carbohydrates, proteins, and fats according to individual lifestyle patterns. This enables the framework to reduce nutritional imbalance while maximizing the usefulness of predicted macronutrient values.

Adaptive Learning Methodology

The adaptive learning component improves prediction quality by learning from previous nutrition prediction behavior and observed lifestyle patterns. If an earlier recommendation is found to be suboptimal, the system can be enhanced to avoid similar inaccuracies in future predictions. This mechanism reflects the way human expertise improves through repeated experience.

Hybrid Intelligence Methodology

The proposed framework combines rule-based logic, constraint evaluation, optimization, and adaptive learning into a hybrid intelligence approach. Instead of depending on a single strategy, the system integrates the strengths of multiple methods to improve nutrition prediction accuracy, flexibility, and reliability. This combination makes the framework more suitable for real-world diabetes care applications.

Automated Workflow

The entire process, from lifestyle input collection to nutrient prediction and recommendation generation, is automated. Once a user enters the required information, the framework performs analysis and generates personalized dietary suggestions without manual intervention. This reduces effort, saves time, and improves usability.

System Architecture

The architecture of the proposed framework is modular and layered in order to ensure scalability, reliability, and ease of maintenance. Each module performs a specific function and exchanges information with other modules through clearly defined interfaces.

The major components of the system are summarized as follows:

User Interface Module

The user interface provides secure access to the system and allows users to enter lifestyle information such as activity level, sleep duration, and stress level. It also enables the display of predicted nutrient values and personalized food recommendations through an interactive dashboard.

Lifestyle Data Management Module

This module stores user lifestyle information, including physical activity, sleep hours, and stress indicators. Data are maintained in a centralized repository for consistency and efficient retrieval.

Nutrition Dataset Module

The nutrition dataset module maintains Indian food data, including carbohydrate, protein, and fat values. This ensures that recommended foods remain both nutritionally meaningful and culturally relevant.

Rule and Constraint Engine

This engine contains predefined nutritional rules and lifestyle-based dietary constraints. It validates whether generated recommendations satisfy health-oriented boundaries and dietary balance requirements.

Machine Learning Engine

The machine learning engine uses Random Forest Regression to analyze lifestyle inputs and predict personalized macronutrient requirements. It serves as the intelligent core of the proposed system.

Recommendation Engine

The recommendation engine maps predicted nutrient requirements to appropriate food items. It receives outputs from the machine learning engine and ensures that the final recommendations comply with all dietary rules and constraints.

Validation Module

The validation module checks prediction outputs and generated recommendations for inconsistencies, invalid cases, or rule violations. If issues are detected, feedback is passed back to the recommendation engine for correction.

Visualization Module

This module generates nutrient charts, lifestyle analytics, and ranked food recommendation displays. Results are presented through an interactive Streamlit dashboard.

Database

The database stores lifestyle inputs, food dataset values, prediction results, and recommendation records required by the framework.

Architectural Flow

The overall processing flow of the framework can be summarized as follows:

User → Lifestyle Data Input → Rule and Constraint Engine → Machine Learning Engine → Recommendation Engine → Validation → Visualization

This modular architecture supports efficient processing, adaptability, and future extensibility.

Results

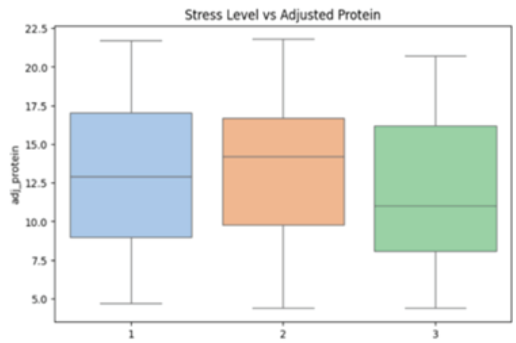
The proposed framework was evaluated using multiple lifestyle input scenarios representing realistic diabetic care conditions. The datasets varied in activity levels, sleep duration, stress level, and dietary patterns. Experimental observations showed that the system consistently generated personalized macronutrient predictions for carbohydrates, proteins, and fats without invalid nutrient estimation or missing recommendations.

The framework also produced balanced nutrition sug-gestions by combining lifestyle analytics with Indian food datasets. In comparison with traditional static diet planning approaches, which generally require manual tracking and provide generalized guidance, the proposed system delivered adaptive recommendations within a significantly shorter response time. This demonstrates the computational efficiency of the automated framework.

Repeated testing further indicated stable behavior, as identical lifestyle inputs produced consistent outputs across multiple runs. These findings suggest that the integration of machine learning, rule-based constraints, optimization, and adaptive processing improves personalization, reliability, and robustness in diabetic nutrition recommendation.

Discussion

The experimental findings highlight the value of integrating



machine learning with lifestyle analytics for personalized nutrition management in diabetes care. The use of Random Forest Regression, in combination with rule-based constraints, optimization strategies, and adaptive learning concepts, enables accurate prediction of macronutrient requirements while accounting for variations in activity, sleep, and stress.

Compared to traditional static diet systems, the proposed framework offers improved personalization and adaptability by producing real-time recommendations through an interactive dashboard. The consistency of results across repeated evaluations indicates that the framework is stable and dependable. Although the current implementation is based primarily on simulated or controlled lifestyle inputs, future work can strengthen the system by incorporating real-world patient records, wearable sensor data, and glucose monitoring information. Such extensions would further improve accuracy, scalability, and clinical usefulness.

Conclusion

This paper presented a NextGen AI Framework for Adaptive Lifestyle and Nutrition Analytics in Diabetic Care for delivering personalized dietary recommendations using machine learning techniques. By analyzing lifestyle factors such as physical activity, sleep duration, and stress level, the proposed system predicts individualized macronutrient requirements and maps them to Indian food datasets for culturally relevant guidance. The integration of Random Forest Regression, adaptive analytics, and an interactive dashboard enables real-time visualization and dynamic nutrition planning.

The experimental evaluation indicates improved personalization, efficiency, and reliability when compared with traditional static diet planning approaches. Overall, the proposed framework supports data-driven preventive healthcare and offers a practical approach for modern diabetes management.

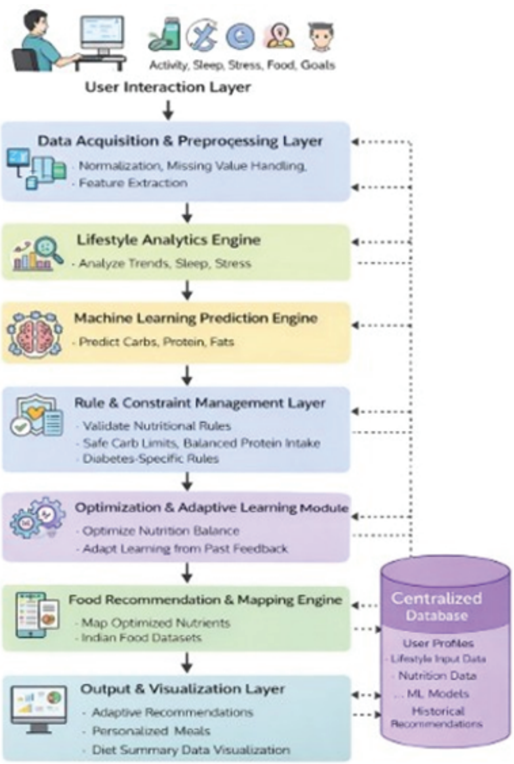


Fig. 1: System architecture of the proposed adaptive lifestyle and nutrition analytics framework.

Table 1. *Illustrative comparison between static diet systems and the Proposed framework*

Feature	Static Sys-tems	Proposed Frame-work
Personalization	Limited	High
Lifestyle Adaptation	No	Yes
Real-Time Update	No	Yes
Cultural Food Mapping	Limited	Yes
Dashboard Visualization	Basic	Interactive

Future work

Future enhancements can focus on integrating real-time health data from wearable devices, continuous glucose monitoring systems, and electronic health records. Additional work may also include extending the food database, improving explainability of the machine learning predictions, and validating the framework on larger real-world diabetic populations.

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