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Precision Nutrition Management in Continuous Care: Leveraging AI for User-Reported Dietary Data Analysis

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Abstract. A As health technology advances, this study aims to develop an innovative nutritional intake management system that integrates artificial intelligence technology and social media software to achieve precise analysis of patient-generated data and comprehensive management in continuous care. Our system is built on the Line Bot platform, allowing users to easily and intuitively obtain detailed analyses of their individual nutritional intake by reporting dietary information. While users report their dietary habits through the Line Bot, our AI model conducts real-time analysis of nutrient intake, providing personalized nutritional recommendations. This instantaneous feedback not only enhances user engagement in nutritional management but also aids in establishing healthy habits. Additionally, through integration with social media software, our system facilitates information sharing and community support among users, promoting the exchange of nutritional knowledge and mutual assistance. This study further explores the specific needs of patients with chronic diseases, collecting individual data on chronic conditions and total nutritional intake. Based on the nutritional intake guidelines proposed by the Health Promotion Administration in Taiwan, more precise nutritional management recommendations are provided to meet the unique health needs of each patient. This study introduces a comprehensive, patient-generated data-based approach for precision nutrition management in continuous care. By integrating artificial intelligence, social media software, and data analysis, our system not only offers effective tools for monitoring and managing patients' nutritional intake but also fosters interaction and support among patients, driving the implementation of continuous care practices.

Keywords. Artificial Intelligence, Nutrition Management, Patient-Centered Care

1. Introduction

Nutrition intake control plays a crucial role in disease control and management. The relationship between nutrition and health is well-established, and proper nutrition is essential for preventing, managing, and treating various diseases.

Nutrient-rich foods help support immune function, making the body more resilient to infections and reducing the risk of illness[8; 11]. Adequate nutrition, including a balanced diet rich in vitamins, minerals, and other essential nutrients, contributes to overall health and helps prevent the onset of many chronic diseases such as heart disease, diabetes, and certain cancers[4]. Many chronic diseases, such as diabetes, hypertension, and cardiovascular diseases, require careful management of nutrition intake. Controlling factors like sodium, sugar, and saturated fats can help manage and control these conditions. For individuals with diabetes, monitoring and controlling carbohydrate intake are critical for managing blood sugar levels. Balanced meals and portion control contribute to better blood glucose control. Controlling sodium intake is important for managing blood pressure. A diet rich in fruits, vegetables, and whole grains, and low in processed foods, can help regulate blood pressure levels[14].
In terms of disease management, Certain inflammatory conditions, can be influenced by dietary choices. Anti-inflammatory foods, such as those rich in omega-3 fatty acids, can help reduce inflammation and alleviate symptoms[2; 3]. Proper nutrition can enhance the efficacy of medications. Some Medications may require specific dietary considerations, and adherence to these guidelines can optimize treatment outcomes.

Adequate nutrition like protein, vitamins, and minerals play key roles in tissue repair and immune function. Well-balanced nutrition contributes to an improved quality of life. It can enhance energy levels, mental well-being, and overall vitality, which are essential aspects of disease management and prevention[12].

Precision nutrition intake control is a fundamental component of disease control. It not only helps prevent the onset of diseases but also plays a pivotal role in managing existing health conditions, supporting treatment, and improving overall well-being. Working with healthcare professionals, including registered dietitians, can provide personalized guidance for individuals with specific health concerns.

2. Literature review

A study analyzing the functional features of popular commercial mobile applications related to diet and nutrition on Google Play Store and the App Store in the areas of dietary intake assessment and tracking revealed that out of the 13 applications included in the analysis, 9 (69%) had a food diary recording function. These applications relied on fixed meal times and utilized either text input (100%) or barcode scanning (78%) to select food items. The ability to input portion sizes was limited to text selection only. Additionally, 33% and 67% of the applications, respectively, had features for adding recipes and collecting water intake. The study also noted that diet diary applications primarily focus on the energy balance between dietary intake and physical activity. Therefore, the emphasis in dietary intake assessment was on calories (100%) and macronutrients (89%), with only a subset of products (44%) estimating the intake of micronutrients[6].

The traditional methods for assessing dietary intake, such as paper-based or interview-based dietary records, 24-hour dietary recall, and food frequency questionnaires, are still commonly used and considered gold standard approaches. However, these methods also suffer from potential issues like recall bias, limitations in food composition databases, and challenges related to research personnel and time costs[10; 13; 15].

It is noteworthy that the ubiquity of smartphones, their long-term portability, real-time recording features such as barcode or image scanning, online data collection and information download capabilities, and connectivity with external devices for additional data recording contribute to mobile applications possessing the mentioned characteristics. Furthermore, certain applications have developed features such as built-in regularly updated food lists or automatic suggestions for food item selection, providing a more convenient platform for dietary recording[5; 7; 15].

A nutritional support system has been developed by Leipold et al.[9], providing feedback on patients' dietary behaviors and adapting to behavioral changes through various persuasive elements such as self-monitoring, personalization, reflection implementation, recommendations, or tracking. Despite the significant advantages that automated food/diet recommendation systems can offer compared to human nutritionists, they also face a range of limitations, including issues related to usability, efficiency, effectiveness, and satisfaction. Another study elucidates that the system should be intelligent enough to predict patients' physical health conditions, their social activities, and records. They employ deep learning methods to comprehend the active engine executing the health recommendation system within the big data analytics application[1].

3. Materials and Methods

The focal point of the entire reporting framework lies in the development of the model, the integration of User-Reported data, and the architecture for nutritional recommendations. The AI food analysis model is built using a language model coupled with associative algorithms. By employing text parsing, the model accurately discerns recipes, utilizing recipe data for the determination of nutritional components in the ingredients. Finally, it provides feedback on nutritional intake data and recommends optimal intake results. Utilizing widely-used social media platforms as a medium aims to expedite the User-Reported framework.

Developing an AI software integrated with a LINE bot involves the following research process:

(1.) Requirement Gathering and Analysis:

- Define the scenarios, target user groups, and user needs for the LINE bot. Specify the scope of AI analysis, including dietary menu intake, ingredient analysis, nutritional calculation, feedback mechanisms, and user recommendations.
- Design the overall system architecture, including LINE bot interface, database structure, and backend processing flow.
- Ensure system security, stability, and scalability.

(2.) AI Model Construction:

- Build an AI model for analyzing dietary menus, covering menu content parsing, ingredient recognition, nutritional calculation, etc.
- Integrate the model training and inference processes for rapid and accurate user input processing.

(3.) Nutritional Calculation and Feedback Mechanism:

- Implement AI model analysis of dietary menu intake, including ingredient identification and nutritional calculation.

- Design a feedback mechanism to provide users with detailed information on nutritional intake, such as nutrient composition and calorie content.
- 6 Categories food item will be calculated: 1. Grains and Grain Products, 2. Vegetables, 3. Fruits, 4. Protein Foods, 5. Dairy, and 6. Fats and Nuts

(4.) Testing and Optimization:

- Conduct functional testing to ensure the correct operation of each module.
- Gather user feedback and optimize the system's user experience, adjusting the accuracy and performance of the AI model.

(5.) Ongoing Maintenance and Improvement:

- Monitor system operation and address potential issues and errors.
- Regularly update the software, introducing new features, and optimizing system performance.

4. Results

The artificial intelligence model can then analyze recipe and ingredient content. This research model incorporates four different algorithms, including 1. Okapi BM25, 2. TF-IDF, 3. Levenshtein, and 4. Jaccard. These algorithms are integrated and designed as a hybrid artificial intelligence system for the intelligent assessment of recipes and ingredients. After obtaining user dietary data, such as "I had half a portion kale for lunch today," it is transformed into "Kale - 0.5 portion." by AI model.

For response reporting, LINE serves as the platform. The bot tool structure allows users to send messages through LINE, which are received by the LINE Platform. The messages are then forwarded to the developer's LINE Bot for logical processing. After executing the logic, the LINE Bot responds to the LINE Platform using the Messaging API provided by LINE, and finally, the response is sent back to the user.

Figure 1. Line Bot User Interface and Analysis Result

(Left-Line Bot Confirmed Meal, a; Right-AI Model Calculate to 6 Categories food Item)

Conclusion and Discussion

This research represents a significant step forward in personalized healthcare. By integrating artificial intelligence into the analysis of user-reported dietary data, this innovative approach enables precise and tailored nutrition management. The use of

advanced algorithms, including Okapi BM25, TF-IDF, Levenshtein, and Jaccard, within a hybrid AI system ensures comprehensive and accurate assessment of recipes and food ingredients. The utilization of the LINE platform enhances accessibility and user engagement, providing a seamless interaction for individuals seeking personalized nutrition guidance. The LINE bot's ability to integrate with external databases and synchronize data with the main platform ensures a holistic approach to continuous care and system interoperability. Moreover, empowering users, especially the elderly, to customize the LINE bot's icon adds a layer of personalization, enhancing the overall user experience. This research not only addresses the challenges of traditional dietary assessment methods but also demonstrates the potential for AI-driven solutions in continuous care. The combination of AI, user-reported data, and precision analytics offers a comprehensive approach to nutrition management. It not only monitors and manages nutritional intake effectively but also fosters interaction and support among users, fostering the practical application of continuous care in the realm of nutrition and well-being. In the next step of this research will focus on how the tool can be used for a specific population and then considering the needs of that population is suggested.

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