

Pregnancy Meal Planning and Nutrition Recommendation Using BERT, FLAN-T5 Transformers and Gemini Tool

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Abstract: Gemini AI provides personalized dietary guidance for pregnant women, where maternal nutrition plays a vital role in fetal development and maternal health. Traditional diet charts are often static and fail to consider individual factors such as trimester, dietary preferences, and medical conditions. This system adopts a hybrid AI approach by combining dataset-driven meal planning with transformer-based Natural Language Processing and generative AI. It consists of a Meal Planning Module that generates personalized diet schedules and a Chatbot Module that offers interactive guidance and support. The system uses BERT for understanding user queries, FLAN-T5 for generating responses, and Gemini AI for handling complex queries, while Lang Chain manages the interaction between models and maintains conversation context. Overall, the system enhances the accuracy of recommendations and user experience compared to traditional methods, supporting better nutrition management and informed dietary decisions during pregnancy.

Keywords: Pregnancy Nutrition, Meal Planning, Transformer Models, BERT, FLAN-T5, Gemini AI, Chatbot, Maternal Health, Personalized Diet Recommendations, Gestational Diabetes, Lang Chain.

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I. INTRODUCTION

Pregnancy Meal Planning and Food Recommendation System Using Transformer Models and Gemini AI focuses on the importance of maternal nutrition for the health of both mother and fetus. Adequate intake of nutrients such as proteins, vitamins, minerals, iron, calcium, and folic acid is essential for fetal development and reducing pregnancy complications [1][2]. Nutritional needs vary across trimesters, and poor diet can lead to issues like fetal growth restriction and maternal deficiencies [1][3].

Traditional nutrition guidance methods, including diet charts and online resources, are often static and lack personalization. They fail to consider factors such as regional preferences, meal patterns, and medical conditions like gestational diabetes, which are crucial for proper diet planning [2][4].

To overcome these limitations, the system uses a hybrid approach combining dataset-driven meal planning and transformer-based NLP. It includes a Meal Planning Module that generates personalized diets based on trimester, preferences, and health conditions, and a Chatbot Module that

provides interactive guidance. BERT is used for query understanding, while FLAN-T5 and Gemini generate responses. Lang Chain manages model interaction and context handling.

When a user submits a query, BERT detects intent and retrieves relevant data with the help of Lang Chain. FLAN-T5 handles general queries, and Gemini processes complex ones to provide detailed responses.

Research and global conferences emphasize the importance of maternal nutrition in improving pregnancy outcomes and addressing micronutrient deficiencies.

The paper is structured as follows: Section 1 introduces the study; Section 2 describes the categories of Pregnancy food; Section 3 Hybrid Technique; Section 4 explains the methodology and results; Section 5 concludes the study; Section 6 gives the future enhancements.

II. CATEGORIES OF PREGNANCY FOOD RECOMMENDATION

➤ *By Trimester*

- First Trimester: Focuses on reducing nausea and supporting early fetal development. Includes leafy greens, fruits, proteins, and folic acid foods; avoids harmful items like high mercury fish and caffeine [1][2].
- Second Trimester: Supports fetal growth and energy with iron, calcium, proteins, and healthy foods; limits sugar and processed food [1].
- Third Trimester: Promotes brain and weight development with protein, fiber, omega-3, and complex carbs; avoids spicy/oily foods [1][2].

➤ *By Seasonal Availability*

- Summer: Hydrating foods like cucumbers, melons, and coconut water [3].
- Winter: Nutrient-rich foods like root vegetables, nuts, and citrus fruits [3].
- Monsoon: Millets, sprouts, and leafy vegetables suitable for the season [3].

➤ *By Diabetes Condition*

- Preexisting Diabetes: Requires strict glucose control and personalized diet plans [5].
- Gestational Diabetes: Managed with balanced nutrition and controlled carbohydrate intake [5].

➤ *By Regional Type*

- North Indian: Chapati, dal, paneer, rice, and vegetables [3].
- South Indian: Idly, dosa, sambar, and rice-based meals [3].

III. HYBRID AI TECHNIQUE: BERT–FLAN T5–GEMINI–LANGCHAIN

The proposed system uses a Hybrid AI technique that combines multiple models to provide intelligent, context-aware responses in the chatbot module. This approach leverages the strengths of each AI model and orchestration framework:

- BERT for natural language understanding and intent detection.
- FLAN T5 for generating detailed responses from dataset context.
- Gemini AI for handling complex queries requiring advanced reasoning.
- Lang Chain for orchestrating the interaction between language models, datasets, and external AI services, enabling structured prompt chaining, context management, and integration of multiple AI models.

By layering these models and frameworks, the system

ensures that both simple and complex pregnancy-related questions can be answered accurately, providing personalized guidance on nutrition, meal planning, and maternal health.

➤ *Steps Involved in the Hybrid AI Technique*

- Step 1: User submits a query.
- Step 2: Text is pre-processed and formatted.
- Step 3: BERT detects intent and context.
- Step 4: LangChain retrieves relevant dataset information.
- Step 5: FLAN-T5 generates responses if no direct answer exists.
- Step 6: Gemini AI handles complex queries.
- Step 7: Final response is delivered to the user.
- Step 8: Interactions are logged for improvement.

➤ *Chatbot Workflow*

The Chatbot Module provides an interactive interface for users to ask pregnancy-related queries and receive personalized guidance. It uses a Hybrid AI technique integrating BERT, FLAN-T5, Gemini AI, and Lang Chain to ensure accurate, context-aware responses.

- BERT analyses user queries for intent detection and semantic understanding, enabling the system to classify questions (e.g., nutrition advice, diabetes-safe foods, trimester-specific guidance).
- FLAN-T5 generates natural language responses when no direct dataset answer exists, ensuring informative and fluent replies.
- Gemini AI handles complex or ambiguous queries requiring advanced reasoning or multi-step explanations.
- Lang Chain manages the interaction between the AI models, structured datasets, and external services, enabling prompt chaining, context retrieval, and smooth coordination between BERT, FLAN-T5, and Gemini.

This hybrid approach allows the chatbot to handle both simple and complex questions, providing personalized dietary recommendations, health guidance, and pregnancy dos and don'ts.

➤ *Algorithm: Pregnant Nutrition Chatbot Workflow*

- *Input:*
User query related to pregnancy nutrition, meal planning, or health guidance
- *Output:*
Personalized response to the user
- *Steps:*
 - ✓ Step 1: User submits a query.
 - ✓ Step 2: Preprocess the query (clean, tokenize, encode).
 - ✓ Step 3: BERT detects intent and extracts context.
 - ✓ Step 4: Search datasets using Lang Chain; if answer exists → return response.
 - ✓ Step 5: If not, FLAN-T5 generates a natural language response.

- ✓ Step 6: For complex queries, route to Gemini AI for detailed answers.
- ✓ Step 7: Format and deliver the final response to the user.

➤ *Meal Planning Workflow*

The Meal Planning Module generates personalized diet plans for pregnant women based on trimester, region, diet type, number of meals, and health conditions like diabetes. Using curated nutrition datasets categorized by meal type and nutritional values, the module applies a hybrid AI approach. BERT interprets user inputs, FLAN-T5 refines recommendations, and Gemini AI ensures nutritional balance and LangChain coordinates the interaction between datasets and AI models. This produces personalized, culturally appropriate, and diabetes-aware meal plans.

• *Algorithm: Pregnant Nutrition Meal Planner Workflow*

✓ *Input:*

- Trimester (T)
- Region (R)
- Diet Type (D)
- Number of meals per day
- Health conditions (e.g., diabetes)

✓ *Output:*

✓ *STEPS:*

- Step1: Load pregnancy nutrition datasets.

- Step2: Collect user inputs (trimester, region, diet type, number of meals, health conditions).
- Step3: BERT analyses inputs to understand preferences and any natural language queries.
- Step4: Lang Chain coordinates the retrieval and filtering of relevant data from the nutrition datasets based on processed user inputs.
- Step5: Filter datasets based on processed user inputs.
- Step6: Categorize foods into meal types: breakfast, snacks, lunch, dinner.
- Step7: Select initial food items for each meal category.
- Step8: FLAN-T5 resolves any ambiguities and refines recommendations for clarity and completeness.
- Step9: Gemini AI performs nutritional analysis, validates balance, and enhances the meal plan.
- Step10: Generate the final personalized assisted meal plan.
- Step11: Display the meal plan to the user.

IV. METHODOLOGY AND EXPERIMENTAL RESULTS

The AI-Powered Pregnancy Nutrition Recommendation and Health Guidance System integrate structured datasets with transformer-based AI models to provide personalized meal plans and health support for pregnant women. Maternal nutrition is essential for fetal growth and maternal well-being, as nutrient requirements such as proteins, vitamins, and minerals increase significantly during pregnancy [6][7]. Poor diets can lead to risks like anemia, low birthweight, and developmental issues [6][8][9].

	A	B	C	D	E	F	G	H	I
1	Day	Meal Type	Food	Regional T	Food Type	Trimester			
2	Friday	Breakfast	Pineapple	North India	Veg	Trimester 1			
3	Friday	Breakfast	Muskmele	North India	Veg	Trimester 1			
4	Friday	Breakfast	Pear	North India	Veg	Trimester 1			
5	Friday	Breakfast	Boiled Egg	North India	Non-Veg	Trimester 1			
6	Friday	Breakfast	Amla Juice	North India	Veg	Trimester 1			
7	Friday	Lunch	Steamed M	North India	Veg	Trimester 1			
8	Friday	Lunch	Carrot and	North India	Veg	Trimester 1			
9	Friday	Lunch	Chicken C	North India	Non-Veg	Trimester 1			
10	Friday	Snack	Roasted C	North India	Veg	Trimester 1			
11	Friday	Snack	Lotus Sten	North India	Veg	Trimester 1			
12	Friday	Snack	Pearl Mille	North India	Veg	Trimester 1			
13	Friday	Snack	Boiled Egg	North India	Non-Veg	Trimester 1			
14	Friday	Dinner	Vegetable	North India	Veg	Trimester 1			
15	Friday	Dinner	Chapati wi	North India	Veg	Trimester 1			
16	Friday	Dinner	Grilled Fis	North India	Non-Veg	Trimester 1			
17	Saturday	Breakfast	Mixed Frui	North India	Veg	Trimester 1			
18	Saturday	Breakfast	Banana	North India	Veg	Trimester 1			
19	Saturday	Breakfast	Pomegran.	North India	Veg	Trimester 1			
20	Saturday	Breakfast	Scramblec	North India	Non-Veg	Trimester 1			
21	Saturday	Lunch	Vegetable	North India	Veg	Trimester 1			

Fig 1 AI-Structured Dataset for Pregnancy Nutrition Meal Planner and Chatbot Based on Trimester

The Meal Planning Module uses curated datasets categorized by meal types and nutritional values. Based on user inputs such as trimester, region, diet type, meal frequency, and health conditions, the system filters data and generates personalized meal plans using rule-based selection

[7][9]. This approach is more adaptive than traditional static diet charts [6][9].

Datasets are split into training (80%) and testing (20%) sets to ensure model accuracy and generalization [6][9]. The

system applies a hybrid AI approach where BERT interprets user input and detects intent [10], FLAN-T5 refines responses and resolves ambiguities, and Gemini AI ensures nutritional balance and optimization.

The Chatbot Module follows the same pipeline. BERT analyses queries, datasets provide direct answers when available, FLAN-T5 generates responses for general queries, and Gemini AI handles complex reasoning. Lang Chain coordinates model interaction and context management.

The confusion matrix shows strong classification performance across meal types. The system effectively generates personalized meal plans considering trimester needs, regional preferences, and diabetes conditions [7][9][11]. It also adapts to incomplete inputs and ensures culturally relevant recommendations.

User feedback highlights improved usability and clarity, confirming the effectiveness of BERT, FLAN-T5, and Gemini AI integration [8][11]. The system is scalable, allowing easy integration of new datasets, with Lang Chain enabling modular and efficient AI workflows [6][10].

Visualization techniques such as tables and charts are used to present meal plans, nutrient distribution, and performance metrics, making the system results easy to interpret and actionable for users [7][9][11].

- ✓ Accuracy: 82.2%
- ✓ Precision: 0.93 (Breakfast), 0.79 (Dinner), 0.77 (Lunch), 0.82 (Snack)
- ✓ Recall: 0.80 (Breakfast), 0.85 (Dinner), 0.88 (Lunch), 0.76 (Snack)
- ✓ F1-Score: 0.86 (Breakfast), 0.82 (Dinner), 0.82 (Lunch), 0.79 (Snack)
- ✓ Weighted F1-Score: 0.82

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To better interpret the results, the system employs visualization techniques including tabular outputs for meal schedules and charts illustrating nutrient distributions across meals. Performance metrics such as accuracy, precision, recall, and F1-score are also displayed for each meal category,

enabling comprehensive evaluation of the Meal Planning Module and hybrid AI pipeline. These visual representations help in understanding the distribution of recommended foods, nutrient adequacy, and model effectiveness, making the results easier to analyse and actionable for users [7][9][11].

➤ *Methodology for Chatbot:*

The Chatbot Module of the AI-Powered Pregnancy Nutrition Recommendation System provides interactive and personalized guidance on nutrition, food safety, and trimester-specific diets for pregnant women [6][7]. It uses a hybrid AI approach that combines structured nutritional datasets with transformer-based models to deliver accurate and context-aware responses [7][9]. Users can ask natural language questions, and the system interprets them to generate relevant, tailored answers [6][8]. The chatbot is integrated with datasets containing food categories based on meal type, nutritional values, trimester suitability, and seasonal recommendations [6][9].

BERT is used for natural language understanding and intent detection, identifying the query type and retrieving direct answers from datasets when available, ensuring high precision [10][7][9]. For queries that are ambiguous or require more detail, FLAN-T5 refines responses by generating clear, coherent, and user-friendly explanations [10].

Gemini AI handles complex or multi-step queries by performing deeper reasoning and ensuring recommendations are nutritionally accurate and safe, considering conditions like diabetes and regional preferences [11].

Lang Chain manages the interaction between all models, coordinating BERT, dataset retrieval, FLAN-T5, and Gemini while maintaining conversation context and user preferences across multiple interactions [7][10].

The chatbot is closely integrated with structured nutrition datasets, ensuring recommendations are scientifically grounded and nutritionally appropriate [6][9]. It dynamically adapts outputs based on user inputs such as diet type, region, and health conditions.

The hybrid AI approach enables robust reasoning, where BERT detects intent, FLAN-T5 generates responses, and Gemini validates and enhances them, with Lang Chain ensuring smooth coordination [10][11][7].

Experimental results show high accuracy in understanding queries, generating precise responses, and handling complex questions. User feedback confirms that the chatbot provides reliable, clear, and culturally appropriate pregnancy nutrition guidance [7][9][11].

➤ *Methodology For Meal Planning Module:*

The Meal Planning Module of the AI-Powered Pregnancy Nutrition Recommendation and Health Guidance System is designed to generate personalized dietary plans for pregnant women based on factors such as trimester, regional preferences, diet type, number of meals, and health conditions

like diabetes [6][7]. It uses structured nutritional datasets where foods are categorized by meal type—breakfast, lunch, snacks, and dinner—and annotated with nutritional values and trimester suitability, ensuring balanced and culturally appropriate meal plans [7][9].

Upon receiving user inputs, the system filters the dataset to select suitable food items based on dietary preferences and health conditions [7][9]. A rule-based selection process then organizes these foods into meals according to nutritional guidelines, ensuring adequate energy and micronutrient intake for each trimester [6][9]. For diabetes cases, the system modifies or substitutes foods to maintain glycaemic control without compromising nutritional balance [7][9].

To enhance personalization, a hybrid AI approach is applied. BERT interprets natural language inputs, detects preferences, and identifies dietary needs [10]. FLAN-T5 refines recommendations by expanding and clarifying meal suggestions, while Gemini evaluates and optimizes meal plans to ensure proper macro- and micronutrient balance [10][11]. This integration enables the generation of personalized and scientifically grounded meal plans.

The hybrid methodology ensures adaptability by handling incomplete or ambiguous inputs while maintaining cultural relevance [7][10][11]. Lang Chain orchestrates model interactions and maintains context across sessions, ensuring consistency in recommendations [7][10]. Pilot testing and user feedback confirm high satisfaction with the accuracy, clarity, and personalization of the generated meal plans [8][9].

V. RESULTS AND SYSTEM FUNCTIONALITY

The proposed AI-powered pregnancy nutrition recommendation and health guidance system provides personalized dietary plans and health information for pregnant women. It integrates structured nutritional datasets, machine learning models, and natural language processing techniques to generate meal plans and answer pregnancy-related queries. Proper maternal nutrition is essential for fetal development and maternal health, as requirements for protein, iron, folic acid, calcium, and vitamins increase significantly during pregnancy. Adequate nutrition helps reduce risks such as anemia, gestational diabetes, and low birth weight, making personalized guidance crucial [12].

The system consists of two main modules: the Meal Planning Module and the Intelligent Question Answering Module. The Meal Planning Module generates customized diet plans based on inputs such as number of days, regional preference, diet type, trimester, number of meals per day, and medical conditions like diabetes. It filters datasets to produce structured meal schedules including breakfast, lunch, dinner, and snacks. Seasonal factors are also considered to ensure fresh, nutrient-rich, and contextually appropriate food recommendations [12].

For text understanding and food classification, the system initially attempted to use BERT for contextual language representation [15]. However, due to technical issues with the Torch framework, TF-IDF was used instead to convert food descriptions into numerical vectors for model training.

```

Loading datasets...

Initial Dataset Shape: (2650, 4)

Cleaned Dataset Shape: (868, 4)

Balancing classes...

Balanced Dataset Shape: (1320, 4)

Meal Distribution

Meal Type
Lunch      330
Snack      330
Breakfast  330
Dinner     330
Name: count, dtype: int64

Generating TF-IDF features...

Training Models...

C:\Users\DELL\AppData\Roaming\Python\Python311\site-packages\sklearn\svm\_classes.py:32: FutureWarning: The default value of 'dual' will change from 'True' to 'auto' in 1.5. Set the value of 'dual' explicitly to suppress the warning.
  warnings.warn(

==== MODEL RESULTS ====
Training Accuracy: 85.8 %
Test Accuracy: 82.2 %

--- Classification Report ---

              precision    recall  f1-score   support

Breakfast    0.93     0.80     0.86         66
Dinner       0.79     0.85     0.82         66
Lunch        0.77     0.88     0.82         66
Snack        0.82     0.76     0.79         66

 accuracy          0.82         264
 macro avg         0.83     0.82     0.82         264
 weighted avg     0.83     0.82     0.82         264

```

Fig 2 Food Suitability Prediction Using Bert Model

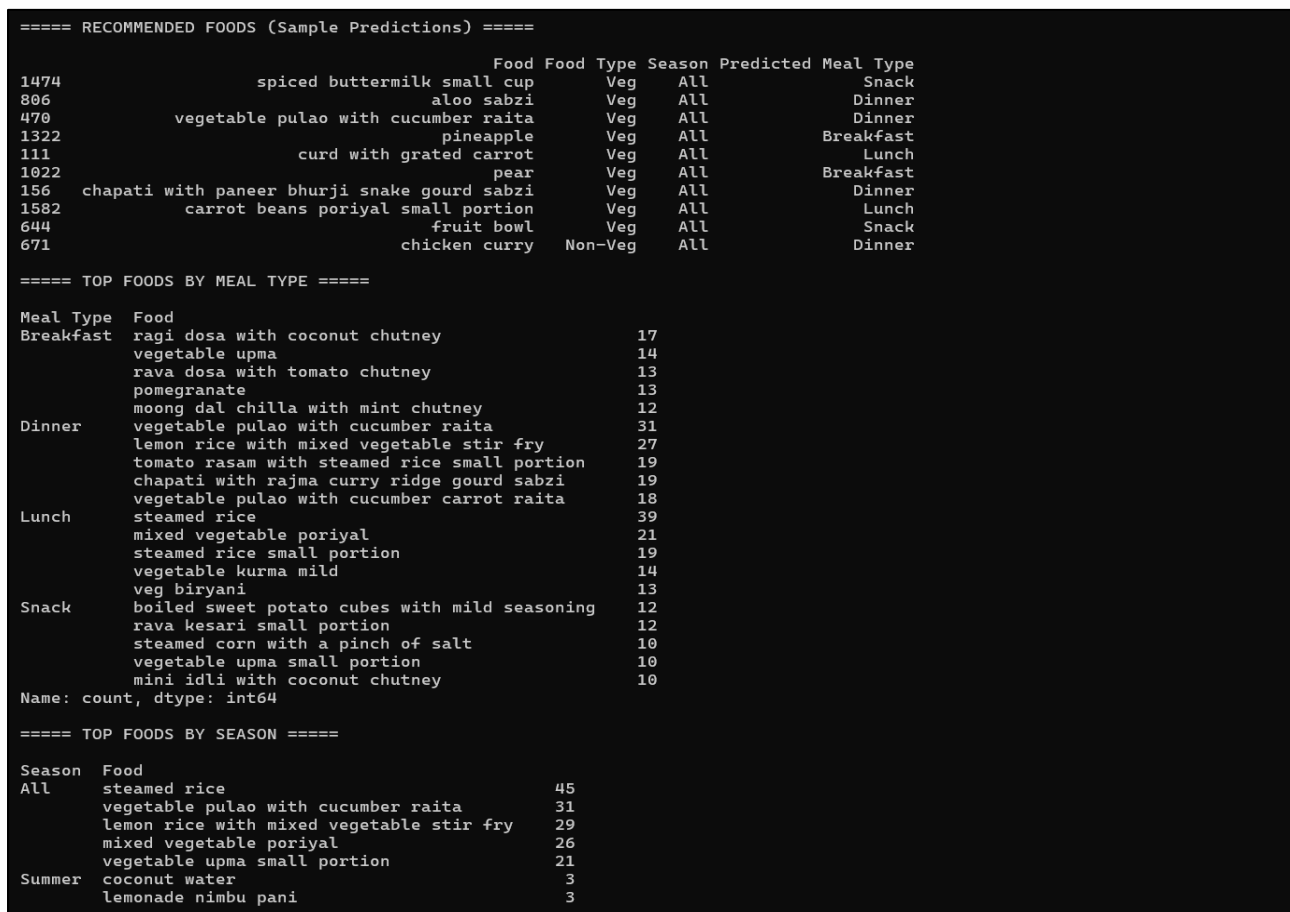


Fig 3 Food Suitability Prediction Using Bert Model

Using TF-IDF features, a machine learning model was trained to classify foods into meal categories. The model achieved 85.8% training accuracy and 82.2% test accuracy, with cross-validation accuracy around 82%, indicating stable performance. It generated practical recommendations such as fruits for breakfast, rice-based meals for lunch, balanced dinners, and healthy snacks, ensuring nutritional adequacy while considering seasonal and diabetes-related constraints.

The system also includes an intelligent chatbot that answers queries related to nutrition, seasonal diets, diabetes management, and food safety. For diabetes, it recommends low-glycemic foods, balanced carbohydrates, and fiber-rich options to maintain blood glucose levels [13]. It also provides food safety guidance, such as avoiding raw foods and high-mercury fish during pregnancy [14].

The chatbot uses transformer-based models like BERT and FLAN-T5 for understanding and response generation [15][16], while Gemini AI handles complex queries by providing detailed and context-aware answers [17].

Overall, by combining machine learning, NLP, and structured datasets, the system delivers personalized meal plans, seasonal dietary recommendations, and diabetes-aware guidance, supporting better maternal nutrition and pregnancy care.

➤ Chatbot Interaction Results

The chatbot module was developed as an intelligent conversational component to provide interactive pregnancy

nutrition guidance and health information. It combines structured nutritional datasets, rule-based logic, and natural language processing techniques to understand user queries and generate informative responses. The chatbot processes user input to identify the main topic, such as nutrition, food safety, hydration, seasonal recommendations, or diabetes management, and then retrieves relevant dataset information or generates responses using AI reasoning. Rule-based mechanisms ensure medically safe outputs, especially for sensitive conditions like diabetes.

The chatbot was evaluated using multiple pregnancy-related queries, demonstrating its ability to generate accurate and relevant responses. For example, when asked “Is fish safe during pregnancy?”, it explains benefits, safe fish types, cooking practices, and items to avoid. Similarly, for “What foods should I avoid in early pregnancy?”, it recommends avoiding raw or undercooked foods, unpasteurized dairy, alcohol, and excess caffeine, aligning with standard guidelines. It also handles hydration queries by suggesting an intake of 8–12 cups of water per day.

The system shows advanced interaction for diabetes-related queries by asking follow-up questions to identify whether the condition is pre-existing or gestational diabetes. Based on this, it provides personalized dietary guidance, including foods like moong dal chilla, bajra roti, roasted makhana, vegetable khichdi, and cucumber raita, along with advice on low-glycaemic diets, regular meals, and limiting fried foods to manage blood glucose levels.

The chatbot supports a wide range of queries, including nutrition, trimester-based diets, diabetes management, food safety, seasonal foods, hydration, and foods to avoid. It uses a hybrid approach combining dataset-based recommendations, rule-based safety checks, and AI models. Dataset information ensures structured guidance, rule-based

logic ensures safety, and generative AI models like Gemini provide natural, context-aware explanations. Overall, the chatbot delivers personalized, reliable, and practical pregnancy nutrition guidance, demonstrating the effectiveness of the AI-powered system.

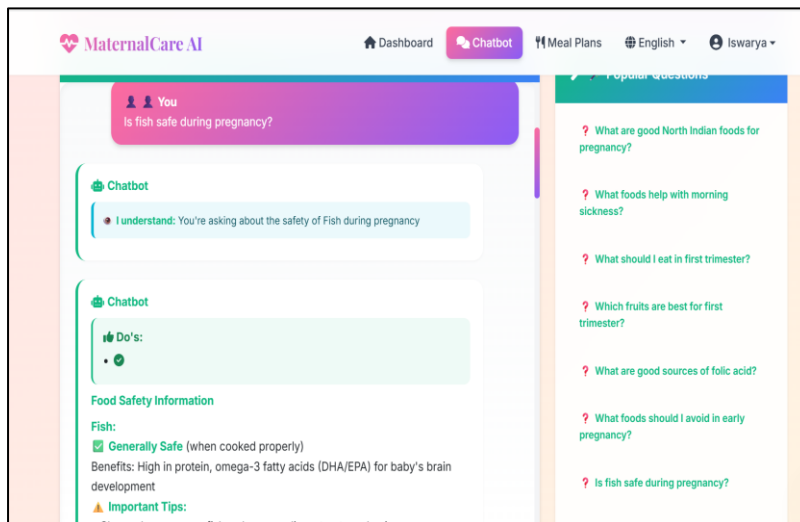


Fig 4 Food Safety Queries

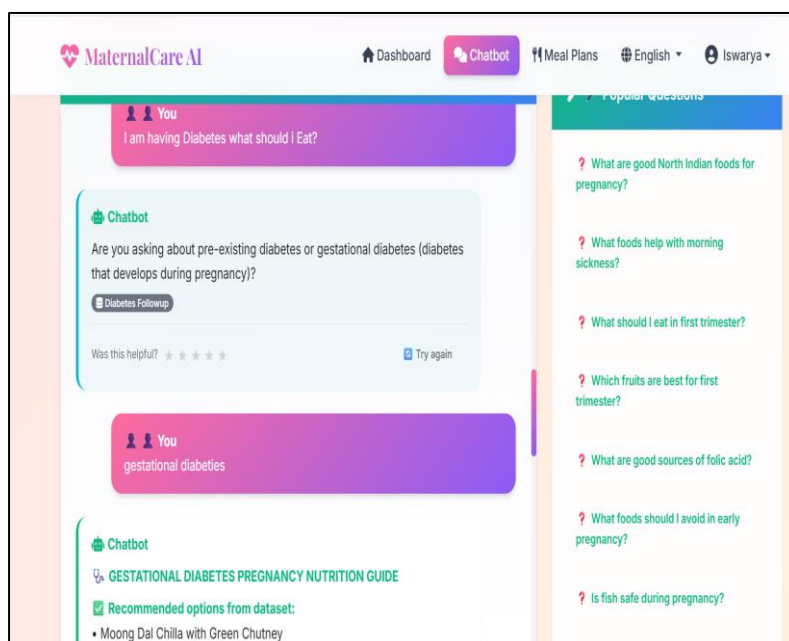


Fig 5 Diabetes Queries

➤ *Meal Planning Results*

The meal planning module was evaluated by generating personalized diet plans based on user inputs such as number of days, regional preference, diet type, pregnancy trimester, number of meals per day, and medical conditions like diabetes. For example, when configured for a 7-day North Indian, non-vegetarian diet for the first trimester with five meals per day and gestational diabetes, the system generated a structured weekly meal plan. The plan included balanced meals for breakfast, snacks, lunch, and dinner, with recommendations such as fruits, vegetable dishes, chapati with paneer, khichdi, boiled eggs, grilled fish, rice with dal,

and chicken curry. Each item was selected from the dataset and ensured to be safe and nutritious for the selected pregnancy stage.

The results show that the system can dynamically generate personalized meal plans based on varying user preferences and health conditions. By combining dataset-driven recommendations with rule-based filtering for trimester and conditions like gestational diabetes, the system produces diverse meal plans instead of a fixed schedule. This ensures that users receive varied, safe, and nutritionally appropriate dietary recommendations throughout pregnancy.

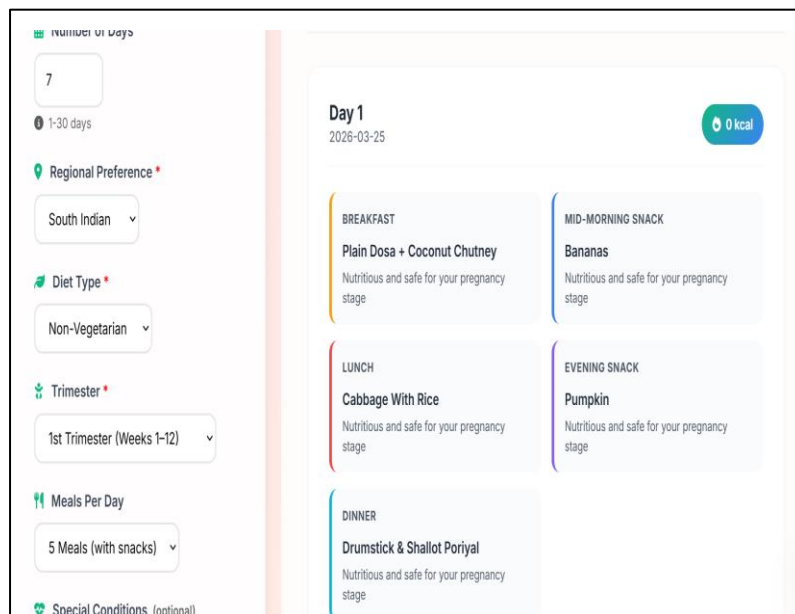


Fig 6 Meal Planning Module Schedule

VI. CONCLUSION

This study proposed an AI-powered pregnancy nutrition recommendation and health guidance system that provides personalized dietary support for pregnant women. The system integrates structured nutritional datasets, machine learning techniques, and natural language processing to generate customized meal plans based on user inputs such as trimester, regional preference, diet type, meal frequency, and medical conditions like gestational diabetes.

The system also includes a chatbot module that answers pregnancy-related questions on topics such as nutrition, food safety, hydration, seasonal diets, and diabetes management. By combining dataset-based recommendations, rule-based logic, and AI models such as Gemini developed by Google, the system provides informative and context-aware responses.

Overall, the system demonstrates the potential of artificial intelligence to support maternal health by delivering personalized meal planning and accessible pregnancy nutrition guidance.

FUTURE ENHANCEMENT

The proposed system can be further improved by introducing multi-language support, which would allow users

from different regions to interact with the chatbot in their preferred language. This would make the system more accessible and user-friendly, especially for pregnant women who may feel more comfortable receiving health guidance in their native language. Supporting multiple languages can also help expand the usability of the system across different geographical locations and cultural dietary practices.

Another important enhancement involves improving the accuracy and depth of the chatbot's responses. This can be achieved by integrating more advanced AI models and expanding the nutritional datasets used by the system. With improved datasets and stronger language models, the chatbot could provide more precise dietary recommendations, better explanations for health-related queries, and more personalized nutrition guidance for different pregnancy stages and medical conditions.

In addition, future versions of the system could include image classification capabilities. This feature would allow users to upload images of food items, and the system would automatically identify the food and provide information about its nutritional value and safety during pregnancy. Such functionality could help users quickly determine whether certain foods are suitable during pregnancy, making the system more interactive and practical for everyday use.

REFERENCES

- [1]. S. Jain, A. Maheshwari, and S. K. Jain, "Maternal Nutrition and Fetal/Infant Development," *Clinical Perinatology*, vol. 49, no. 2, pp. 313–330, 2022. <https://pubmed.ncbi.nlm.nih.gov/35659089/>
- [2]. "Nutrition during Pregnancy and Birth Outcomes," *Annals of Nutrition and Metabolism*. <https://karger.com/article/doi/10.1159/000541205>
- [3]. "Associations between maternal dietary intake and nutritional status with fetal growth," *BMC Nutrition*. <https://bmcnutr.biomedcentral.com/articles/10.1186/s40795-024-00885-3>
- [4]. "Maternal Nutrition: Key to Healthy Pregnancy and Development," *Journal of Nutrition Science Research*. <https://www.omicsonline.org/open-access/maternal-nutrition-key-to-healthy-pregnancy-and-development-138542.html>
- [5]. "Gestational Diabetes Diet," *MedlinePlus Medical Encyclopedia*. <https://medlineplus.gov/ency/article/007430.htm>

- [6]. Maternal Nutrition Fact Sheet, World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/maternal-nutrition>
- [7]. Maternal diet and pregnancy outcomes research article, National Center for Biotechnology Information. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7611234/>
- [8]. Maternal nutrition and fetal growth study, National Center for Biotechnology Information. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7071227/>
- [9]. Maternal nutrition and pregnancy health research, Frontiers in Nutrition. <https://www.frontiersin.org/articles/10.3389/fnut.2021.648584/full>
- [10]. BERT: Bidirectional Encoder Representations from Transformers by Jacob Devlin et al. <https://arxiv.org/abs/1810.04805>
- [11]. Introducing Gemini AI model by Google DeepMind. <https://www.deepmind.com/research/publications/introducing-gemini>
- [12]. Maternal Nutrition Guidelines, World Health Organization. <https://www.who.int/health-topics/maternal-nutrition>
- [13]. Gestational Diabetes Information, American Diabetes Association. <https://diabetes.org/about-diabetes/gestational-diabetes>
- [14]. Pregnancy Food Safety Guidelines, U.S. Food and Drug Administration. <https://www.fda.gov/food/people-risk-foodborne-illness/food-safety-pregnant-women>
- [15]. FLAN-T5: Instruction-Tuned Language Models research by Google Research. <https://arxiv.org/abs/2210.11416>
- [16]. Gemini AI documentation by Google. <https://ai.google.dev/gemini-api/docs>