

A Preliminary Analysis of AI Chatbots for Individualized Nutrition Advice

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Abstract—The rapid development of AI chatbots receives increasing recognition in different applications. Nutrition is an important topic because the general public values health. A lot of general nutrition advice can be found on the Internet. However, many people or patients desire individualized nutrition advice from dietitians. Given the availability of various free or low-cost AI chatbots, attention is drawn to individualized nutrition advice using AI chatbots. This research studied three common AI chatbots: ChatGPT-3.5, YouChat, and Microsoft Bing. The results of selected prompts are investigated and compared. Comments from dietitians on the limitations of AI chatbots are also shared. Further research is needed to investigate the design of prompts, i.e., asking appropriate questions with a good level of detail to the AI chatbots and having follow-up conversations to obtain better individualized nutrition advice.

Keywords—AI chatbot, Microsoft Bing, ChatGPT, nutrition advice, nutritional science, YouChat

I. INTRODUCTION

An Artificial Intelligence (AI) chatbot is a software application or web interface that provides a natural language conversation with a user. The global market revenue of chatbots was projected from 191 to 1250 million USD between 2016 and 2025, contributing to an increment of 555% [1]. ChatGPT is leading the industry among different AI chatbots, covering 20% of users based on statistics in 2022 [2]. Before the release of ChatGPT and other pioneer AI chatbots, AI chatbots existed in various forms, such as virtual assistants and customer support chatbots. Virtual assistants, such as Apple's Siri, Microsoft's Cortana, and Google Assistant, were early examples of AI chatbots that provide personalised assistance to users. They combined speech recognition, natural language understanding, and machine learning algorithms to interpret user queries and perform tasks such as setting reminders, searching for information, and making recommendations. Customer service chatbots such as Chatfuel and IBM Watson Assistant are examples of AI chatbots providing customer support in messaging platforms, banking, and telecommunications [3]. They handled basic customer queries and provided information about products and services, but their capabilities and sophistication were relatively limited compared to the advances seen in recent years.

People care (or are being reminded to care) about their health and eating habits and often seek professional nutrition advice from dietitians and medical doctors. Choosing Hong Kong as an example, the consultation fee of the first appointment with a dietitian significantly increases from 135 HKD (government-funded hospitals) [4] to 280-1380 HKD (private hospitals or clinics) [5]. The former suffers from a long waiting time for appointments, whereas the latter is costly. Dietitians from private hospitals or clinics may suggest a medium-term to long-term consultation package to keep track of the diet of patients that may last for multiple months. Patients can receive more frequent (e.g., one to two hours per week) and higher-quality consultations in such cases. However, various limitations are observed when using this method of consultation. (i) high cost of consultation package, (ii) some patients are too busy or physically challenged to visit hospitals or clinics, and (iii) patients cannot receive immediate response in non-consultation periods. As a result, AI chatbots were investigated in our research to evaluate the performance of individualized nutrition advice (also known as personalized nutrition advice) that is believed to take advantage of low-cost, anytime, and anywhere nutrition advice. Among different AI chatbots, our work considers Microsoft Bing, ChatGPT, and YouChat based on their recognition in various applications [6,7].

Our research contributions are two-fold: (i) analysis and comparison of results of three AI chatbots, namely Microsoft Bing, ChatGPT-3.5, and YouChat, and (ii) investigation of the characteristics of three AI chatbots for individualized nutrition advice.

Section II presents a literature review on individualized nutrition advice. The methodology of the selected three chatbots is illustrated in Section III. It is followed by the performance evaluation, analysis, and comparison of the chatbots in Section IV. Finally, a conclusion is drawn by discussing potential future research directions.

II. LITERATURE REVIEW

Although AI chatbot-based individualized nutrition advice is the main theme of this research work, the professional and individualized nutrition advice by dietitians is worth studying. This provides insights into asking valid questions to AI

chatbots and forms a foundation for comparing advice between AI chatbots and dietitians.

A. Individualized Nutrition Advice by Dietitians

A systematic review of randomized controlled trials was conducted for research studies in 2009-2020 [8]. It revealed that personalized nutrition significantly helped improve the quality of the dietary intake of patients or customers. Another study [9] mentioned that personal dietary choices were important in oncology care based on patient feedback. Apart from individualized nutrition, dietitians were expected to provide clear and practical advice. In view of the robust requirements of nutrition advice, personalized nutrition usually comes along with precision nutrition, which involves analyzing dietary, food, and nutrient patterns before advising [10]. When professionals would like to propose dietary guidelines, the committee should consider the trade-off and balance between personalized nutrition and population nutrition [11].

One recent study [12] highlighted the possibility of worsened health inequality in personalized nutrition approaches because most people receive general recommendations. Thus, a conceptual framework was proposed to offer adaptations for personalized nutrition.

B. Individualized Nutrition Advice by AI Chatbots

A research work [13] studied ChatGPT (Version 3.5) and its potential applications in nutrition, benefits to the nutrition care process, and ability compared to professionals. The results suggested that it could be used as a complementary tool instead of a replacement for professionals. However, attention should be drawn to the usage of ChatGPT because it may suggest harmful diets that lead to severe impacts on people with food allergies [14]. Ponzo et al. [15] investigated ChatGPT 3.5 on its ability to provide nutrition advice to patients with various non-communicable diseases. The alignment between chatbot-based advice and guidelines ranged from 55.5% (sarcopenia) to 73.3% (nonalcoholic fatty liver disease). Yet, most of the existing works utilized ChatGPT. The research of AI chatbots for individualized nutrition advice is an emergent topic that requires further investigation of its requirements from a user perspective. Therefore, interviews with 18 volunteers were carried out to discuss the design and requirements of the website (embedded AI chatbots) for nutrition advice to youngsters [16].

In [17], researchers compared the performance of Microsoft Bing, Bard, ChatGPT 3.5, and ChatGPT 4 in classifying 240 low- and high-potassium and phosphorus foods. Results showed that ChatGPT 4 yielded 99% accuracy in high-potassium foods, whereas Bing was perfect for determining high-phosphorus foods. Between ChatGPT 3.5 and ChatGPT 4, the former worked better in high-phosphorous foods than in high-potassium foods.

To fill the gap of unexplored research, our research will analyze and compare the results of three AI chatbots, Microsoft Bing, ChatGPT, and YouChat, from general usage of individualized nutrition advice.

III. METHODOLOGY

In this research, three AI chatbots, namely ChatGPT-3.5, Microsoft Bing, and YouChat. ChatGPT is the most popular among individuals who do not follow AI chatbot trends have heard about ChatGPT. The AI chatbot is known for its wealth

of STEM knowledge, which allows it to generate reliable plans. The problem with ChatGPT is that it lacks internet connectivity and relies on only up-to-date data until September 2021. The resource cannot be known from where, and the user may get outdated information. In this study, ChatGPT-3.5 was selected because it is the newest version of ChatGPT and provides free access. The second selected chatbot, Microsoft Bing, was first released in February 2023. Microsoft Bing operates on ChatGPT-4, the latest iteration of OpenAI's language model systems. Its major advantage over ChatGPT is that it answers questions by searching the Internet and returning answers with source URLs. The third selection is YouChat, which functions similarly to Microsoft Bing by linking to the internet and citing Google resources. YouChat run on ChatGPT-3. Therefore, the comparison between three AI chatbots evaluates the transition of ChatGPT from version 3 to 3.5 to 4.

Among different topics of nutrition advice, meal plan advice for weight loss is considered one of the most common topics during clinical consultations. To effectively design questions for the meal plan advice, several models featuring varying job roles, work schedules, and meals per day are used. In the primary plan, four model types are created. These models include civilian men, physical labourers, housewives, and sellers. The job models are decided based on the workload per day. The objective is to assess how well these chatbots could adapt their recommendations based on various user conditions, including job, number of meals per day, number of workdays, sex, food style, and calories per day.

Table I summarizes the settings of prompts for the requests "Design a meal plan for weight loss based on the following conditions:".

TABLE I. SETTINGS OF PROMPTS FOR MEAL PLAN ADVICE FOR WEIGHT LOSS

User conditions	Examples
Job	[civilian man/physical labour/housewife/seller]
Meals per day	[breakfast/lunch/dinner]
Workdays	[some workdays and some holidays]
Sex	[female/male]
Food style	[Asian/Hong Kong/Chinese]
Calories per day	[1500/2000] kcal
Flavour	[weak/strong]

IV. RESULTS AND DISCUSSION

The results and discussion focus on the selected prompts (due to limited pages) and views of dietitians.

A. Results of Selected Prompts

All three chatbots were prompted from November to December 2023. Here are the selected results of the prompts:

Selected Prompt 1 (ChatGPT-3.5): design a meal plan for weight loss based on the following conditions. job: civilian man. meals per day: lunch and dinner. workdays: 5 workdays and 2 weekend days. sex: male. food style: Asian.

Results:

////Certainly! Here's a sample Asian-inspired meal plan for weight loss based on your conditions:

****Note:**** This meal plan assumes a daily caloric intake of approximately 1,800-2,000 calories, which may vary depending on your specific needs. Adjust portion sizes and calorie counts according to your goals and consult

with a healthcare professional or registered dietitian for personalized advice.

****Monday:****

- Lunch: Grilled chicken breast with stir-fried mixed vegetables (broccoli, carrots, bell peppers) in a light soy sauce, served with brown rice.
- Dinner: Baked salmon with steamed bok choy and a side of quinoa.

****Tuesday:****

- Lunch: Shrimp and vegetable stir-fry (snow peas, carrots, mushrooms) with cauliflower rice.
- Dinner: Teriyaki tofu with stir-fried broccoli and brown rice.

****Wednesday:****

- Lunch: Beef and broccoli stir-fry with brown rice.
- Dinner: Grilled chicken skewers with a side of mixed greens and a light sesame dressing.

****Thursday:****

- Lunch: Soba noodle salad with grilled shrimp, cucumber, carrots, and sesame dressing.
- Dinner: Vegetable curry with tofu and cauliflower rice.

****Friday:****

- Lunch: Grilled chicken breast with a side of mixed greens, cherry tomatoes, and a light sesame dressing.
- Dinner: Stir-fried tofu with mixed vegetables (bell peppers, snap peas, carrots) in a light soy sauce, served with quinoa.

****Saturday:****

- Lunch: Vegetable and tofu stir-fry (broccoli, bok choy, mushrooms) with whole wheat noodles.
- Dinner: Miso-glazed cod fillet with steamed asparagus and a side of brown rice.

****Sunday:****

- Lunch: Grilled shrimp with a side of steamed broccoli and brown rice.
- Dinner: Chicken and vegetable stir-fry (snow peas, carrots, onions) with cauliflower rice.

Remember to drink plenty of water throughout the day and listen to your body's hunger and fullness cues. Including regular physical activity along with a balanced meal plan can further support your weight loss goals.

Selected Prompt 2 (YouChat): design a meal plan for weight loss based on the following conditions. job: civilian man. meals per day: lunch and dinner. workdays: 6 workdays and 1 weekend day. sex: male. food style: Chinese. Calories per day: 2000 kcal.

Results:

Meal Plan for Weight Loss

Based on the information provided, here is a sample meal plan for weight loss for a civilian man following a Chinese food style. The meal plan includes lunch and dinner for 6 workdays and 1 weekend day, with a target of 2000 calories per day.

****Please note that this is a general meal plan and may need to be adjusted based on individual preferences, dietary restrictions, and specific nutritional needs. It is always recommended to consult with a healthcare professional or registered dietitian before starting any weight loss program.****

Workdays (Lunch and Dinner)

****Lunch:****

- Steamed chicken with vegetables
- Brown rice
- Vegetable stir-fry
- Steamed broccoli

- Green tea

****Dinner:****

- Grilled fish (such as salmon or tilapia)
- Stir-fried tofu with mixed vegetables
- Steamed bok choy
- Vegetable soup
- Jasmine tea

Weekend Day (Lunch and Dinner)

****Lunch:****

- Shrimp and vegetable stir-fry
- Quinoa
- Steamed asparagus
- Hot and sour soup
- Oolong tea

****Dinner:****

- Beef and broccoli stir-fry
- Steamed brown rice
- Stir-fried mushrooms and snow peas
- Egg drop soup
- Chrysanthemum tea

Additional Tips for Weight Loss

- ****Portion Control:**** Pay attention to portion sizes and try to eat smaller, balanced meals throughout the day.

- ****Include Protein:**** Include lean sources of protein, such as chicken, fish, tofu, and shrimp, in your meals to help keep you feeling full and satisfied.

- ****Choose Whole Grains:**** Opt for whole grains like brown rice and quinoa instead of refined grains to increase fiber intake and promote satiety.

- ****Load Up on Vegetables:**** Include a variety of colorful vegetables in your meals to add volume, nutrients, and fiber without adding excessive calories.

- ****Limit Added Sugars and Sodium:**** Be mindful of added sugars and sodium in sauces, dressings, and condiments. Opt for homemade or low-sodium options when possible.

- ****Stay Hydrated:**** Drink plenty of water throughout the day to stay hydrated and help control appetite.

- ****Incorporate Physical Activity:**** Along with a healthy meal plan, regular physical activity is essential for weight loss. Aim for at least 150 minutes of moderate-intensity aerobic activity per week, along with strength training exercises.

Remember, consistency and balance are key when it comes to weight loss. It's important to create a sustainable and enjoyable meal plan that fits your lifestyle and preferences.

Selected Prompt 3 (Microsoft Bing): design a meal plan for weight loss based on the following conditions. job: housewife. meals per day: breakfast, lunch, and dinner. workdays: 7 days for housework. sex: female. food style: Chinese. Calories per day: 1500 kcal. Flavour: Weak.

Results:

As a housewife, you might have a busy schedule, and it's important to maintain a healthy diet to keep up with your daily activities. Based on your requirements, I suggest following the ****7-day Chinese healthy meal plan**** by Diabetes Canada ¹. This meal plan includes traditional Chinese dishes, as well as some non-traditional options and snacks. It features diabetes-friendly foods, such as low-glycemic-index carbohydrates and healthy fats like canola oil. The meal plan is designed for individuals with and without diabetes and provides approximately 1500 calories per day ¹.

Here is a sample meal plan for one day:

| **Meal** | **Food** |

|-----|-----|

| Breakfast | 1 cup (250 mL) cooked rice vermicelli in soup using shredded bok choy (44 g carbohydrates) |

| Lunch | 9 pieces steamed dumplings and choy sum (45 g carbohydrates) |

| Dinner | 1 cup (250 mL) cooked rice, steamed chicken with shiitake mushroom and Chinese cabbage (45 g carbohydrates) |

You can repeat this meal plan for the next six days. The meal plan also includes some non-traditional options and snacks that you can choose from ¹.

Please note that this is just a suggestion, and it's important to consult a registered dietitian before making any significant changes to your diet.

I hope this helps!

Sources: Conversion with Bing 27/11/2023

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(5) Search Result. <https://www.pennutrition.com/searchresult.aspx?terms=7-day>.

(6) Chinese meal plan DC FINAL CHINESE Feb 2021 (1)[1] - Diabetes Canada. <https://www.diabetes.ca/DiabetesCanadaWebsite/media/Managing-My-Diabetes/7-day-Chinese-healthy-meal-plan.pdf>.

Here are the observations of three AI chatbots:

(i) ChatGPT 3.5: It serves as the standard AI chatbot in this research. It fulfils the basic requirements for responding and demonstrates satisfactory performance in generating appropriate answers. It shows a good ability to give advice and plan. However, it lacks a function to link back to the resource to check the reliability of the response.

(ii) YouChat: It introduces an additional feature by incorporating a search engine to display the source of the information used to provide the response. This functionality allows the chatbot to provide more comprehensive and accurate responses by accessing relevant data sources. It improves the chatbot's ability to deliver reliable information to the user. However, YouChat may consider the information from the shopping page and social media; it sometimes generates responses without any reference and cannot check the reliability of responses.

(iii) Microsoft Bing: Similar to YouChat, Microsoft Bing utilizes a search engine to gather information related to users' inquiries. However, it outperforms YouChat by displaying the sources of the information used to provide each response. Furthermore, Microsoft Bing does not use low relative resources as the base of responses. This feature creates transparency and allows users to verify the credibility of the information provided.

The differences in their characteristics highlight their capabilities and functionalities. YouChat's and Microsoft Bing's additional feature of displaying the data source further

emphasizes the importance of transparency and credibility in the information provided by the chatbot. Microsoft Bing's strategy for resource selection also increases the reliability of responses.

B. Views of Dietitians

From the perspective of dietitians, there are several key limitations in the results of the selected prompts:

- To provide a dietary plan, it is important to understand the health background and medical history of a person. However, AI chatbots encounter difficulty in fully understanding this tedious information. Thus, generating individualized nutrition advice and comprehensive plans that fit the variability of every single day among each person is still ongoing research for AI chatbots.
- Regarding the results of the prompts of ChatGPT-3.5 and YouChat, the exact portion of each food in the proposed meal is not specifically stated, whereas Microsoft Bing advises some information. In clinical practice, the general public usually has ideas about dish choices but not the portion of foods. It is highly possible that either over-eating or under-eating each kind of food occurs, thus leading to an imbalance of nutrient adsorption. For example, meal plans in Selected Prompt 3 (Microsoft Bing) emphasizes the amount of carbohydrates while not stating the protein source. Inadequate protein intake at each meal, especially at breakfast and lunch, can lead to muscle atrophy in the long term [18]. In addition, housewives are usually busy with housework and taking care of children. It is commonly observed in clinical practice that middle-aged housewives having simple meals with limited protein at breakfast and lunch are at a higher risk of muscle wasting and osteoporosis [19].
- It can be seen from the results of the prompts that AI chatbots lack flexibility in food choices. People may only obtain a few meal plan ideas. However, dietitians will advise patients on the amount of each food group and teach them the food exchange among each group to allow variability. By analogy to "Give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime", the importance of a dietitian is to provide individualized advice and enhance people's knowledge and skills on healthy eating principles.

V. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

This paper investigated the performance of three AI chatbots, ChatGPT-3.5, YouChat, and Microsoft Bing, in recommending meal plans for individualized nutrition advice. Due to limited pages, the results of some selected prompts were presented and compared. The research team also sought dietitian advice to comment on the suggested meal plans by AI chatbots and shared the limitations.

Several future research directions are recommended: (i) Analyze the performance of AI chatbots with follow-up conversations, (ii) Collect feedback from the general public, patients, and medical personnel via questionnaires to give scores for answers of AI chatbots, (iii) Extend the applications from individualized nutrition advice to more food and nutritional sciences topics, (iv) Include more AI chatbots for analysis, and (v) provide tips to write good prompts.

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