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ChatGPT as a Virtual Dietitian: Exploring Its Potential as a Tool for Improving Nutrition Knowledge

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Abstract: The field of health and medical sciences has witnessed a surge of published research exploring the applications of ChatGPT. However, there remains a dearth of knowledge regarding its specific potential and limitations within the domain of nutrition. Given the increasing prevalence of nutrition-related diseases, there is a critical need to prioritize the promotion of a comprehensive understanding of nutrition. This paper examines the potential utility of ChatGPT as a tool for improving nutrition knowledge. Specifically, it scrutinizes its characteristics in relation to personalized meal planning, dietary advice and guidance, food intake tracking, educational materials, and other commonly found features in nutrition applications. Additionally, it explores the potential of ChatGPT to support each stage of the Nutrition Care Process. Addressing the prevailing question of whether ChatGPT can replace healthcare professionals, this paper elucidates its substantial limitations within the context of nutrition practice and education. These limitations encompass factors such as incorrect responses, coordinated nutrition services, hands-on demonstration, physical examination, verbal and non-verbal cues, emotional and psychological aspects, real-time monitoring and feedback, wearable device integration, and ethical and privacy concerns have been highlighted. In summary, ChatGPT holds promise as a valuable tool for enhancing nutrition knowledge, but further research and development are needed to optimize its capabilities in this domain.

Keywords: nutrition; healthcare; ChatGPT; large language models; virtual dietitian

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1. Introduction

Nutrition knowledge refers to the comprehension of fundamental principles, concepts, and guidelines related to dietary choices and their impact on health. Individuals with adequate nutrition knowledge demonstrate the capacity to critically assess nutrition information through their understanding of dietary principles, nutritional guidelines, and appropriate portion sizes [1]. According to a systematic review [2], nutrition knowledge and dietary intake have a weak but significant positive association. This finding suggests that individuals who possess a greater understanding of nutrition tend to make more informed and healthier dietary choices. A subsequent inquiry conducted by Carbonneau et al. [3] indicated that nutrition knowledge appears to exert a more pronounced impact on promoting healthier dietary habits among individuals with lower educational attainment, despite the fact that these individuals possess comparatively lower levels of nutrition knowledge than their counterparts. From a public health standpoint, it highlights the importance of nutrition knowledge in shaping our dietary behaviors [4] as well as access to credible nutrition knowledge [5]. Sadegholvad et al. [6] asserted that a healthy eating pattern is linked to improved quality of life, increased life expectancy, and a diminished risk of nutrition-related chronic diseases. Therefore, health agencies, educational institutions, and healthcare practitioners prioritize the mission of augmenting the nutrition knowledge of the general population, as underscored by a multitude of studies, e.g., [7–9].

Despite various efforts and resources dedicated to this endeavor, the acquisition of sufficient nutritional knowledge continues to pose challenges. One prominent factor is the absence of formal education, which acts as a barrier to individuals making informed decisions regarding healthier dietary choices. Even healthcare professionals such as general practitioners [10] and physicians [11] have been observed to exhibit deficiencies in nutrition education, knowledge, training, and aptitude. This hurdle highlights the important role of dietitians and nutrition professionals in delivering expert guidance and support. However, individuals worldwide tend to be dependent on sources such as advice from family and friends, books, television, and online resources for their nutrition knowledge [5,12]. Many healthcare systems and communities likewise struggle to offer adequate resources and funding for dietetic services [13]. This deficiency further exacerbates the existing barriers (e.g., cost of nutrition services and limited access to registered dietitians) to obtaining personalized information [14,15]. Addressing this accessibility disparity is crucial to ensure equitable access to quality dietary guidance and promote overall health.

According to Garcia and Garcia [7], global efforts to implement dietary education programs for improving nutrition knowledge are still lacking due to the pervasiveness of nutrition-related problems. Some persistent issues include the rising rates of obesity, increasing prevalence of diet-related chronic diseases such as diabetes and heart disease, inadequate consumption of essential nutrients, and limited awareness of balanced and healthy eating habits among populations. This topic is a significant concern because the lack of nutritional knowledge and education has notable implications for public health outcomes and overall well-being [16]. Bhawra et al. [17] have emphasized the necessity for innovative approaches to address this problem. Salinari et al. [18] share a similar perspective, advocating for the potential of artificial intelligence (AI) technologies to accelerate the pursuit of improved health and well-being. They underscore the significance of AI in delivering precise tailored dietary recommendations and in advancing the creation of predictive and preventive guidelines for more effective health promotion and disease management. In a recent letter to the editor, Arslan (2023) has expressed optimism about the potential of ChatGPT in delivering personalized recommendations in the field of nutrition. However, there is still limited literature available on the utilization of ChatGPT in this domain. Therefore, this paper delves into the potential of ChatGPT as a tool for enhancing nutrition knowledge by answering the following research questions:

1. What are the features of nutrition applications that ChatGPT can or cannot emulate?
2. How can ChatGPT assist throughout each stage of the Nutrition Care Process?
3. Can ChatGPT effectively replace dietitians and nutrition professionals?

2. Background of the Study

2.1. Technological Innovations in the Healthcare Sector

The proliferation of technological innovations has been instrumental in strengthening the digital transformation of the healthcare sector [19]. These recent advancements have introduced a variety of novel health information technologies (HITs) that empower healthcare professionals to augment patient care and streamline operational processes. The literature acknowledges the profound influence of HIT, including telemedicine services [20], blockchain technology applications [21], deep-learning-based medical image analysis [22], three-dimensional bioprinting [23], digital game-based rehabilitation [24], and conversational chatbots [25]. Through the integration of HIT into day-to-day operations, healthcare professionals can leverage digital tools and platforms to enhance clinical decision making, streamline administrative tasks, and optimize resource allocation. More importantly, the transformative impact of HIT extends beyond individual patient interactions. It also facilitates the aggregation and analysis of data that can enable evidence-based practice and research [26]. Overall, the integration of HIT in healthcare holds tremendous potential for revolutionizing the industry and driving improved outcomes for patients.

2.2. Novel Digital Technologies for Personalized Nutrition

Digital technologies are transforming the approach and implementation of personalized nutrition, which involves tailoring dietary recommendations and interventions to individual needs based on factors like genetics, lifestyle, preferences, and health goals. There is a growing recognition among experts that nutrition applications can be leveraged for behavior improvement, dietary intake assessment, and physical activity monitoring [27–29]. These applications typically incorporate extensive nutritional databases, enabling them to provide recipe suggestions and personalized recommendations aligned with individual goals, food preferences, and dietary restrictions. For instance, recommender systems (e.g., Virtual Dietitian [30]) can assist individuals in making personalized and evidence-based dietary decisions. In a recent systematic review, Abhari et al. [31] determined knowledge-based systems as one of the most prevalent types of recommender systems. This form of AI utilizes a repository of human expertise to support decision making.

2.3. Virtual Dietitian: A Knowledge-Driven Nutrition System

Offering online nutrition services is not an entirely new methodology. This trend is particularly noteworthy in the era of telemedicine, where remote consultations and virtual healthcare interactions have gained substantial traction [32]. The emergence of telenutrition has spurred the development of various online nutrition applications, one of which is Virtual Dietitian. This application is a nutrition knowledge-based system that employs a forward chaining algorithm to create personalized meal plans based on users' profiles, preferences, and dietary restrictions [33]. To function effectively as a recommender system, it leverages an extensive nutritional information database that contains a wide range of foods and their nutritional content. The system also employs a method of reasoning through inference rules. This intelligent reasoning process enables it to consider not only the raw data but also the nuanced relationships between different dietary factors. By doing so, it can provide users with highly customized meal plans that optimize their nutritional intake, all while adhering to their specific dietary preferences and restrictions. Such systems are what are currently available and popular in the nutrition field [34–37].

2.4. Current Research on Nutrition and ChatGPT

The emergence of ChatGPT as another novel AI technology represents a significant advancement in the field of nutrition. Unlike other nutrition applications, ChatGPT offers dynamic and interactive conversational capabilities to provide personalized and engaging nutrition education to individuals seeking guidance and information. For instance, while both ChatGPT and knowledge-based systems fall under the umbrella of AI, they have distinct differences in their underlying architectures and functionalities (see Table 1). In a recent letter to the editor, Arslan [38] expressed that ChatGPT presents promising prospects for delivering personalized recommendations in areas such as nutrition. However, the potential applications and limitations of ChatGPT within the domain of nutrition remain relatively unexplored. Existing publications predominantly focus on related medical and health sciences, such as microbiology [39], nursing [40], parasitology [41], radiology [42], and medicine [43]. Thus, further discussions are warranted to ascertain the potential applications and limitations of ChatGPT in the domain of nutrition.

Table 1. Difference between the characteristics of ChatGPT and knowledge-based systems.

Characteristics	ChatGPT	Knowledge-Based Systems
Computational approach	Data-driven	Knowledge-driven
Learning capability	Transfer learning	Explicit knowledge
Decision making	Contextual understanding	Rule-based Logic
User interaction	Human-like conversations	Guided knowledge queries
Use cases	Conversational applications	Expert systems

3. ChatGPT as a Nutrition Tool

Due to the limited research exploring the utilization of ChatGPT in the nutrition field, its viability as a tool in this domain remains uncertain. To establish a basis, this paper relied on insights from existing research conducted in other relevant disciplines. According to the proposition of Seetharaman [44], although ChatGPT may not possess an equivalent level of expertise as healthcare professionals, it holds the potential to serve as a valuable tool for individuals who lack professional expertise in the field. Zhu et al. [45] concurred with this notion, as their findings indicated that ChatGPT outperformed other large language models in terms of providing accurate medical information. A separate assessment conducted by Kung et al. [46] involved subjecting ChatGPT to the United States Medical Licensing Exam (USMLE). Despite lacking any specialized training, the findings revealed that ChatGPT achieved scores that were either at or close to the passing threshold for all three exams. These encouraging outcomes promote the possibility that ChatGPT could also exhibit promising performance in the nutrition domain. Nevertheless, additional evaluation is required to validate this proposition.

3.1. What Are the Features of Nutrition Applications That ChatGPT Can or Cannot Emulate?

People have long relied on nutrition applications to track their daily food intake, monitor macronutrient ratios, and access valuable information for nutrition education. These applications have played a significant role in helping people manage their dietary habits and make informed choices about their nutrition. With the advent of ChatGPT, there is now an opportunity to explore how this advanced language model can further enhance nutrition knowledge and contribute to the field. To initiate the discourse regarding its potential in improving nutrition knowledge, this paper explores common features of nutrition applications as references. Examining these features may serve as a basis for identifying areas where ChatGPT can contribute to the field of nutrition.

3.1.1. Verified Nutrition Database

Nutrition applications heavily rely on comprehensive databases that contain accurate information regarding the nutritional composition of different foods and ingredients. One illustrative example is the '*Plan-Cook-Eat*' application that utilized a combination of the Philippine Food Composition Table, My Food Data, FooDb, and USDA Food Composition Databases [47]. These nutrition databases serve as a crucial resource for analyzing dietary intake, providing personalized recommendations, and facilitating nutritional tracking. Consequently, users can search for specific foods and learn about their macro- and micronutrient compositions (e.g., *What is the nutritional value of 100 g of broccoli?*). Unfortunately, it is plausible that ChatGPT lacks a dedicated and verified nutrition database of its own and instead relies on various publicly available databases for nutritional information retrieval. This reliance on external sources may introduce limitations in terms of ensuring the accuracy and reliability of the nutritional data provided by the system.

3.1.2. Personalized Meal Planner

Meal planning is an important process for ensuring a healthy and well-balanced diet. More importantly, customizing meals to accommodate individual preferences, dietary restrictions, and daily caloric requirements is crucial for improving adherence to a particular meal plan [33]. When ChatGPT is presented with this array of variables (as exemplified in the sample prompt below), it is more likely to generate personalized meal plans that cater to individual needs. Like other knowledge-based systems, ChatGPT can function as a robust recommender system with its advanced algorithms and language processing capabilities. This important feature helps users diversify their diet, discover new healthy recipes, and optimize their nutrient intake. It also promotes a better understanding of how to create well-rounded meals while accommodating dietary considerations. Nonetheless, it is noteworthy that ChatGPT does not have the capability to manage calendars or schedule tasks, which are important characteristics of a meal planner application.

Sample prompt: "I am looking for a personalized meal plan that can help me manage my weight while following a vegetarian diet. To maintain my weight, I need to eat 2500 calories per day. I usually eat three times a day. I prefer Filipino cuisine, but I have a peanut allergy. Suggest a meal plan that consists of breakfast, lunch, and dinner."

3.1.3. Food Intake Tracker

Monitoring food consumption also plays a vital role in sustaining a healthy lifestyle. Many nutrition applications, e.g., [48] incorporate this crucial feature to simplify daily intake tracking. This feature helps users understand their dietary patterns, identify potential nutrient imbalances, and make informed, health-conscious decisions regarding their food choices. Conversely, albeit capable of retaining and leveraging past conversations, the interface of ChatGPT does not adhere to the structure and functionality of a conventional food diary. For instance, it does not offer a calendar feature, making it less intuitive to navigate and review past food intake records. Unlike the user interface of Virtual Dietitian presented in Figure 1, ChatGPT lacks the functionality to easily confirm whether the suggested food from the meal plan has been consumed. This limitation in the ChatGPT interface can make it difficult for users to effectively monitor their food consumption.

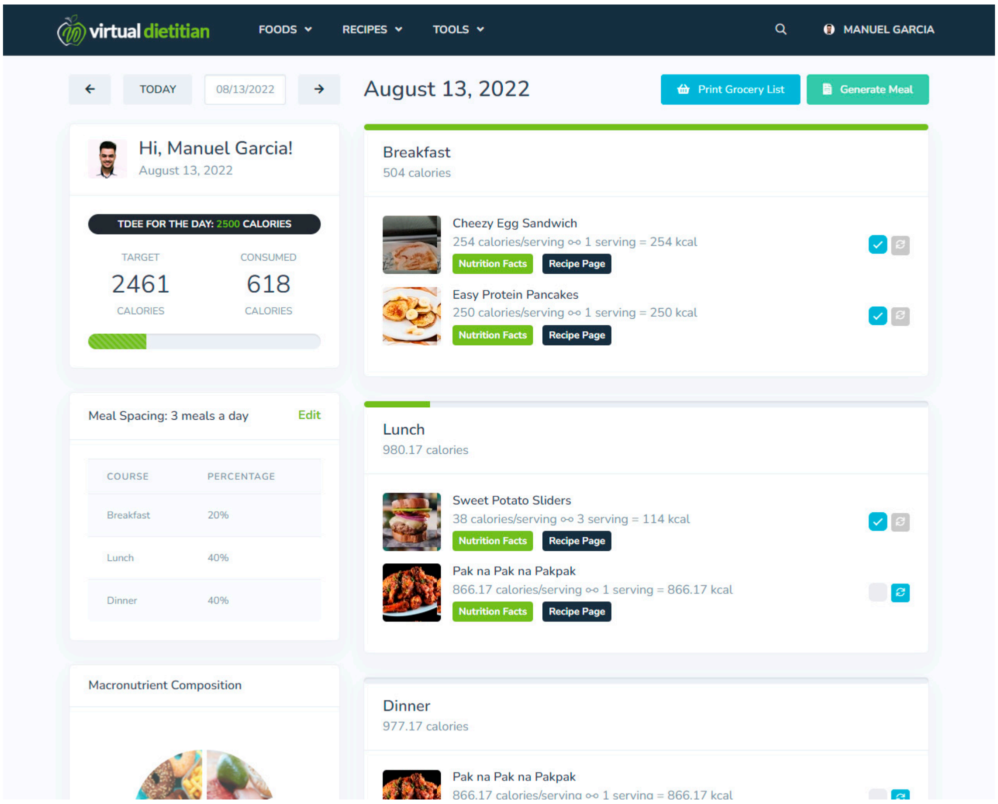

Figure 1. Food Diary Interface in the Virtual Dietitian Application.

3.1.4. Dietary Advice and Guidance

The capability of a nutrition tool to offer dietary advice and guidance is paramount in empowering individuals to engage in interactive discussions about their nutrition-related inquiries. Unfortunately, most existing nutrition applications lack this functionality due to their limited capacity to comprehend human language. ChatGPT demonstrates superiority in this regard owing to its conversational nature. Users can pose inquiries related to various food groups as well as the significance of specific nutrients or seek clarification regarding prevalent dietary misconceptions. This feature promotes nutrition education as it empowers users to engage in meaningful and informative discussions. Nevertheless, it is imperative to acknowledge persisting concerns regarding the accuracy of the advice offered, despite prior reports indicating positive outcomes. Ensuring the precision, reliability, and accuracy of health guidance remains a critical issue in AI-driven applications.

Sample prompt: "Can you explain the difference between saturated fats and unsaturated fats and provide recommendations on which types of fats are healthier to consume?"

3.1.5. Community and Support

Many nutrition applications attempt to cultivate a sense of community by providing forums, groups, and other social features where users can interact, share experiences, and seek advice. Despite its ability to communicate with users, it is important to acknowledge that ChatGPT may not fully replicate the immersive nature of such real-world communities. These communities inherently possess unique social dynamics and the ability to bring together individuals with diverse perspectives and experiences. Interacting with others in these communities allows for the exchange of firsthand knowledge, personal anecdotes, and collective wisdom. This feature can be invaluable in navigating the complexities of nutrition by providing an opportunity to learn from others. As pointed out by Michalski et al. [49], having weaker community belonging is detrimental because it is associated with poorer general and mental health across various life stages (18 and above years old).

3.1.6. Assessment Tools and Calculators

Assessment tools and calculators are also essential features of nutrition applications because they provide users with personalized insights, guidance, and a quantifiable understanding of their dietary habits. These tools can evaluate nutrient intake, identify deficiencies or excesses, and suggest appropriate adjustments. Additionally, they assist users in determining their daily calorie requirements, macronutrient distribution, and body mass index. ChatGPT possesses the capability to emulate these functions by replicating the underlying algorithms and formulas used in assessment tools and calculators. For example, ChatGPT can calculate the Total Daily Energy Expenditure by considering parameters such as height, weight, age, gender, and activity level, as shown in the given prompt:

Sample prompt: "I am interested in knowing the number of calories I burn in a day. Here are my details: I am 31 years old, male, with a height of 177 cm and a weight of 92 kg. Additionally, I would describe my activity level as very active. While you are at it, how much food should I eat in day to safely lose weight?"

3.1.7. Tips and Reminders

Nutrition applications commonly include a feature that sends daily tips and reminders to their users, aiming to inform and motivate them to adopt healthier choices and improve their nutrition [50]. These automated messages serve as gentle prompts and constant sources of inspiration to support individuals in their pursuit of better eating habits. These daily tips and reminders are invaluable in several ways. Firstly, they act as timely prompts that keep nutrition at the forefront of users' minds. This consistent reinforcement encourages users to make conscious choices throughout the day, gradually steering them toward more nutritious options. Secondly, these messages often contain practical advice, actionable recommendations, and insights into healthier eating practices. They empower users with the knowledge needed to make informed dietary decisions. However, it is important to acknowledge that ChatGPT operates differently from a conventional nutrition tool. Unlike applications that can send direct notifications and reminders, ChatGPT functions as a conversational AI tool. Nonetheless, users can leverage its capabilities to obtain strategies and supplementary information about maintaining a healthy lifestyle.

Sample prompt: "Can you suggest healthy options for satisfying sweet cravings?"

3.1.8. Nutrition Education Materials

Interactive lessons and modules that provide users with in-depth information about various aspects of nutrition are another prevalent feature. Nutrition tools often have the technical infrastructure and innovative features to actively engage their users. They go beyond mere dissemination of information by incorporating interactive elements that encourage user participation. These might include quizzes, assignments, and self-assessments, all aimed at reinforcing the learning process. As users progress through these modules, they not only gain knowledge but also develop practical skills related to nutrition. On the other hand, ChatGPT offers a distinct approach to learning and information dissemination. While it may not have a direct interface with nutrition education materials, it serves as an accessible learning platform in its own capacity. Users can engage with ChatGPT by posing questions, seeking clarification, and requesting information related to nutrition or any other subject matter. Its strength lies in its ability to provide quick and responsive answers to user queries. For instance, users can ask questions such as "*What are some good dietary sources of omega-3 fatty acids?*" and receive immediate responses. This interaction fosters a dynamic and individualized learning experience.

3.2. How Can ChatGPT Assist throughout Each Stage of the Nutrition Care Process?

Dietitians and nutrition professionals frequently employ the Nutrition Care Process (NCP) in providing individualized care to their clients [33]. As presented in Figure 2, this systematic methodology encompasses a series of steps, such as (1) nutrition assessment, (2) nutrition diagnosis, (3) nutrition intervention, and (4) nutrition monitoring and evaluation. ChatGPT can play a valuable role in assisting with various aspects of the NCP.

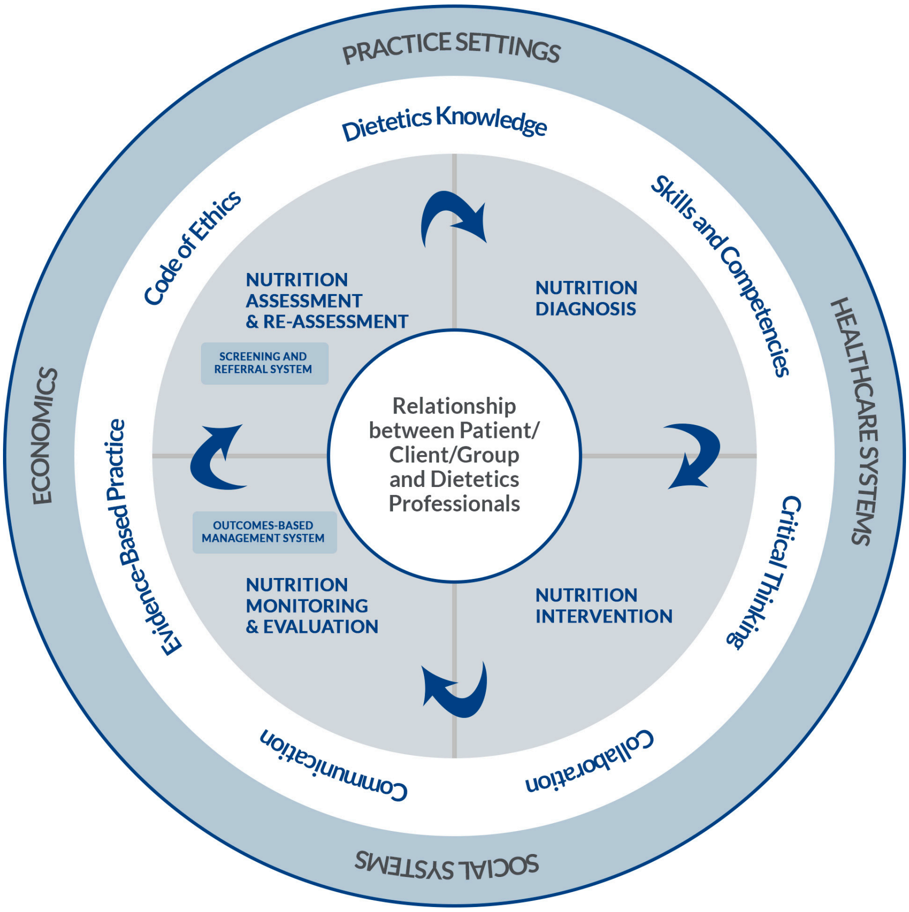

Figure 2. The Nutrition Care Process and Model.

3.2.1. Nutrition Assessment

The NCP begins with the collection and interpretation of pertinent information concerning an individual's current nutritional status, clinical history, physical condition, and other physiological and pathological factors. This initial assessment serves as a foundation for understanding the individual's specific nutritional requirements and identifying any existing or potential nutrition-related issues. The data obtained during this phase encompasses various elements, such as anthropometric measurements (e.g., height and weight), biochemical data, clinical observations, and dietary intake assessments (commonly referred to as the ABCD method). According to the guidelines provided by the American Society for Parenteral and Enteral Nutrition (ASPEN), a comprehensive nutritional assessment encompasses a thorough clinical examination (i.e., comprising a detailed history and physical examination), anthropometric measurements, diagnostic tests, and dietary assessments [51]. Some examples of how ChatGPT can assist in this phase are as follows.

- Answer questions about specific nutrients, their functions, and dietary sources.
- Provide general information on dietary guidelines and recommendations.
- Assess individual nutrition needs based on factors such as age, sex, and activity level.
- Offer dietary assessment tools and calculators to estimate nutrient intake.
- Provide guidance on assessing body composition and interpreting results.
- Explain common nutrition-related health conditions or risk factors.

3.2.2. Nutrition Diagnosis

Following the assessment, dietitians and nutrition professionals proceed to identify and describe specific nutritional problems or issues. They formulate a clear and concise diagnosis, which serves as the foundation for developing an appropriate intervention plan for the subsequent phase. These diagnoses are formulated using standardized terminology (e.g., International Dietetics and Nutrition Terminology) or other widely recognized classification systems. The comprehensive nature of these systematic frameworks ensures that dietitians consider various factors when formulating diagnoses and intervention plans. Some examples of how ChatGPT can assist in this phase are as follows.

- Provide sample evidence-based nutrition diagnoses for common health conditions.
- Assist in identifying nutrition-related problems based on the assessment findings.
- Explain the significance of nutrition diagnoses in developing intervention plans.
- Help identify potential comorbidities that may influence the nutrition diagnosis.
- Offer guidance on documenting nutrition diagnoses in a standardized format.
- Assist in identifying nutrition-related risk factors for specific populations.

3.2.3. Nutrition Intervention

After the nutrition diagnoses have been established, dietitians and nutrition professionals proceed to create a comprehensive plan aimed at addressing the identified issues. This plan encompasses specific nutrition interventions, goals, and strategies that are tailored to meet the unique needs of the individual. The interventions employed may involve various approaches, such as dietary modifications, personalized meal planning, nutrition education, and counseling. In some cases, collaboration with other healthcare professionals (e.g., physicians and other specialists) is necessary to ensure comprehensive care. Collaborative practice in nutrition and dietetics plays a pivotal role in promoting the achievement of a healthier and more fiscally responsible healthcare system because it fosters interdisciplinary cooperation, enhances the quality of patient care, and optimizes resource utilization [52]. Some examples of how ChatGPT can assist in this phase are as follows.

- Offer general dietary recommendations for various health conditions or goals.
- Recommend personalized meal plans based on specific dietary needs or preferences.
- Provide tips for modifying recipes to improve nutritional content.
- Suggest behavior change techniques that can support adherence to interventions.
- Give guidance on portion control and meal frequency for weight management.
- Suggest resources for finding nutritionally balanced recipes and meal ideas.

3.2.4. Nutrition Monitoring and Evaluation

In the final step of the NCP, dietitians and nutrition professionals undertake the crucial task of assessing and monitoring the effectiveness of the implemented nutrition intervention over time. This process involves collecting relevant data to evaluate whether the established goals and objectives are being achieved and making necessary adjustments to the intervention plan as required. Regular follow-ups and consistent communication with the individual are pivotal parts of the protocol (Figure 3) for tracking progress, addressing any concerns, and providing ongoing support. This continuous monitoring ensures that the intervention plan remains tailored to the individual's evolving needs. Nonetheless, in practice, patients and their family members often receive insufficient education regarding proper nutrition care [53]. In this phase, ChatGPT can assist in the following ways.

- Provide guidance in setting measurable goals related to nutrition interventions.
- Offer tools for tracking food intake, physical activity, and other lifestyle factors.
- Assist in analyzing nutrition-related data collected during monitoring.
- Explain how to interpret changes in laboratory results related to interventions.
- Assist in identifying potential challenges or barriers to achieving nutrition goals.
- Offer resources for conducting follow-up assessments and adjusting interventions.

Figure 3. Sample Nutrition Intervention Protocol generated by the Virtual Dietitian Application.

3.3. Can ChatGPT Effectively Replace Dietitians and Nutrition Professionals?

Numerous recent publications in the field of medical and health sciences have consistently explored whether ChatGPT can serve as a substitute for healthcare professionals. While the debate regarding AI's role in healthcare continues, the consensus among researchers and experts leans towards the assertion that ChatGPT cannot fully substitute for these skilled professionals, and there are several compelling reasons for this stance. One of the primary reasons lies in the unique expertise, training, and experience that dietitians and nutrition professionals contribute to their practice. For instance, Cheng et al. [54] have aptly pointed out that the depth of knowledge possessed by a qualified infectious disease doctor is unparalleled. These professionals have completed rigorous formal education and underwent years of training to specialize in preventing, diagnosing, and treating infectious diseases. Similarly, Frank et al. [55] concurred in the field of rheumatology, emphasizing that the critical thinking, expertise, and experience that rheumatologists possess cannot be adequately substituted by ChatGPT. These capabilities, which include clinical training and the ability to exercise clinical judgment, are intricately attached to human expertise. Furthermore, the essence of human interaction and empathy plays a significant role in the healthcare profession, including dietetics and nutrition counseling. Dietitians and nutrition professionals not only provide personalized dietary recommendations but also offer emotional support and motivation to individuals on their wellness journeys. These aspects of care are deeply rooted in the human touch, making their role distinct and irreplaceable [56]. Following these viewpoints, it is similarly asserted in this paper that ChatGPT cannot serve as a replacement for dietitians and nutrition professionals.

From a technical standpoint, the primary reason why ChatGPT cannot fully replace experts is that it is not specifically designed as a nutrition application. As previously discussed, nutrition knowledge-based systems possess certain functionalities that either do not exist or are not fully replicated by ChatGPT. Even these specialized nutrition applications have not been able to entirely supplant the expertise of professionals in the field, and so it is reasonable to deduce that ChatGPT is similarly constrained in its capacity. Instead of viewing ChatGPT as a comprehensive substitute, it should be regarded as a valuable supplementary tool. Expert validation and consultation remain crucial in ensuring accurate and reliable information for optimal care and guidance. As noted by scholars [39] in medical education, human oversight remains crucial for ChatGPT to serve as a meaningful learning platform. Sanmarchi et al. [57] share a similar opinion that blindly accepting AI-generated answers may pose significant risks to the integrity of scientific endeavors. Therefore, it is crucial to acknowledge that ChatGPT also has its own set of limitations.

3.3.1. Incorrect Responses

Despite its extensive dataset, ChatGPT is not immune to the generation of incorrect or outdated information. For instance, Niszczota and Rybicka [58] investigated the credibility of dietary advice provided by ChatGPT. Their findings uncovered instances where ChatGPT formulated diets that could be potentially unsafe. Other responses inaccurately specified food quantities and energy values. This particular limitation further underscores the importance of cautious interpretation, human validation, and expert judgment [39,59]. Meanwhile, the dependence of ChatGPT on user-provided information may cause these incorrect responses. This situation can occur when the prompts supplied by users are either inaccurate or incomplete. Therefore, it is advisable to consult experts in the field and exercise personal judgment when making decisions based on the content generated by ChatGPT. This approach helps mitigate the risk of relying on potentially erroneous information and ensures a more accurate and reliable outcome in nutrition and dietary matters.

3.3.2. Real-Time Monitoring and Feedback

Due to its inherent reliance on text-based communication and web-based platform, a significant limitation of ChatGPT is its inability to perform real-time monitoring and feedback. Unlike other mobile nutrition applications designed for proactive engagement, ChatGPT relies on users to initiate interactions. These dependencies indicate delayed responses, a lack of contextual awareness, and the absence of mechanisms to track user engagement or provide immediate interventions. Consequently, it falls short in delivering immediate and dynamic support comparable to real-time human interactions or dedicated monitoring devices. On the other hand, nutrition applications are strategically designed to offer push notifications as a means of real-time engagement [60]. These apps can send timely reminders to users, encouraging them to record their meals, stay hydrated, or engage in physical activity. Other mobile applications use algorithms that analyze user data, such as dietary habits and exercise routines, to create personalized push notifications [61]. For example, if a user consistently logs high-calorie meals, the app may send a notification suggesting healthier alternatives. This proactive approach fosters a continuous connection between users and the application as well as provides immediate feedback to help individuals make better dietary choices and maintain their nutritional goals.

3.3.3. Coordinated Nutrition Services

In complex cases involving multiple concurrent medical conditions, intricate medication regimens, or specialized dietary requirements, ChatGPT may not have the capacity to provide comprehensive and tailored nutrition guidance. These situations often require the involvement of coordinated nutrition services that collaborate with a multidisciplinary team of specialized professionals [62]. For instance, a patient with concurrent diabetes, hypertension, and renal disease who is taking multiple medications with varying interactions and has specific dietary restrictions would require comprehensive nutrition guidance which may be beyond the capabilities of ChatGPT. In such cases, coordinated nutrition services would involve a registered dietitian working closely with the patient's primary care physician, endocrinologist, nephrologist, and potentially other specialists. This collaborative approach ensures that the patient receives tailored and well-coordinated nutrition guidance to effectively manage their health conditions [53].

3.3.4. Hands-On Demonstration

The hands-on approach creates a tangible connection between theory and practice. It allows users to observe, interact, and experience firsthand the practical aspects of nutrition. Unfortunately, ChatGPT cannot physically demonstrate any tasks that require a direct manipulation of objects. For instance, it cannot provide hands-on guidance for meal preparation techniques, portion control, or cooking skills, which are valuable aspects of nutrition education and behavior change [30]. As identified by Ali et al. [63], hands-on demonstrations are an effective way to teach nutritional concepts. This limitation prevents users from actively engaging their senses, which are crucial for understanding food qualities and developing informed dietary habits. It is also unable to demonstrate how to properly measure anthropometric parameters, such as height, weight, or body composition. These measurements are fundamental in assessing an individual's nutritional status, determining appropriate dietary interventions, and monitoring progress over time.

3.3.5. Physical Examination

In the nutrition assessment phase of the NCP, a nutrition-focused physical examination (NFPE) is considered a vital process. As Hummell and Cummings [64] astutely noted, in addition to the typical anthropometric measurements and patient's general appearance, pertinent aspects for a NFPE encompass evaluations of muscle mass, the condition of fingernails, the presence of edema or ascites, handgrip strength, subcutaneous fat reserves, hair quality, skin health, ocular characteristics, oral cavity condition, signs of muscle atrophy, and other relevant parameters. Unfortunately, ChatGPT is unable to perform physical examinations due to the absence of a video camera and video processing features. This inherent constraint prevents ChatGPT from assessing crucial aspects, such as body composition and detecting nutritional deficiencies. Consequently, its ability to provide precise and accurate nutrition recommendations is compromised. Until ChatGPT integrates this feature, traditional NFPEs remain essential for a comprehensive nutrition assessment.

3.3.6. Verbal and Non-Verbal Cues

During a comprehensive physical checkup, healthcare professionals pay close attention to both verbal and non-verbal signals as they play crucial roles in gathering valuable information. Verbal cues involve the information that clients communicate regarding their dietary habits, food preferences, eating routines, and any nutrition-related symptoms or concerns. On the other hand, non-verbal cues, such as body language, facial expressions, gestures, and tone of voice, offer supplementary insights into the emotional state, comfort level, and attitudes of the client towards food and nutrition. For instance, a client's verbal commitment to healthy eating may contradict their nervous body language, suggesting hidden influences (e.g., social pressures or emotional concerns) that demand nuanced interpretation. Unfortunately, ChatGPT cannot understand such cues in real-time conversations. This limitation prevents ChatGPT from accurately assessing any underlying factors that may influence an individual's nutrition-related behaviors and choices.

3.3.7. Emotional and Psychological Aspects

Another notable constraint of ChatGPT is its limited capacity to effectively address emotional and psychological factors, which often demand a more empathetic and human approach [59]. For instance, individuals may struggle with issues such as stress, emotional eating, or disordered eating patterns, which necessitate a sensitive and understanding response. Research conducted by Cardoso et al. [65] underscores the value of individuals sharing their personal experiences and recognizing the intricate connection between emotions and dietary behaviors. Unfortunately, ChatGPT may not possess the same level of emotional support, empathy, and rapport-building capabilities as professionals do during nutrition counseling or interventions. Human professionals can leverage their empathetic skills to establish trust, offer emotional support, and tailor recommendations to an individual's unique emotional and psychological needs, which is a level of interpersonal engagement that remains beyond the current capabilities of AI-driven platforms [66].

3.3.8. Wearable Device Integration

Numerous nutrition applications allow for the integration of wearable devices to collect real-time data on physical activity levels, vital signs, and other health metrics [48]. This seamless integration enables users to track their progress, gain insights into their overall health and wellness, and make informed decisions about their nutrition and lifestyle. For instance, a user with a wearable fitness tracker might be able to receive real-time feedback on their daily steps, heart rate, or calories burned through a nutrition app integrated with such a device. The app can tailor dietary recommendations based on this data, promoting healthier choices and better alignment with the user's fitness goals. However, as ChatGPT operates as a text-based model, it cannot directly interact with or interpret data from wearable devices. This limitation prevents ChatGPT from leveraging real-time information and offering tailored feedback based on physiological data.

3.3.9. Data Visualization

Another limitation of ChatGPT is the ability to display data using graphs, charts, and dynamic visuals. Nutrition apps often provide intuitive visual reports that display data on a user's dietary habits, exercise routines, and health metrics over time. These visual representations empower users to grasp their progress more effectively and make data-driven decisions regarding their nutrition and fitness goals. ChatGPT, on the other hand, primarily relies on text-based communication, making it challenging to offer such visual reporting capabilities. This limitation is pivotal because visual feedback can be a powerful motivator, allowing users to see their achievements and areas for improvement instantly.

3.3.10. Ethical and Privacy Concerns

Numerous healthcare studies, e.g., [67–69], express concerns about the ethical implications and raise privacy issues that are also applicable to the nutrition domain. Unlike human professionals, ChatGPT lacks the innate ethical awareness and sensitivity required to responsibly manage personal information. Nevertheless, engaging with ChatGPT involves divulging personal health data, dietary habits, and other sensitive information to ensure accurate nutrition-related guidance. For instance, when individuals interact with ChatGPT to discuss their dietary habits, allergies, or health conditions, they entrust this information to the system. Consequently, ensuring the privacy and security of this data becomes crucial to protect individuals' confidentiality and maintain the trust of users in the system. Such measures may include data encryption, access controls, and compliance with relevant data protection regulations to assure users that their personal information is handled responsibly and ethically. It is noteworthy that this necessity for stringent data protection measures is not unique to ChatGPT. Other nutrition apps face a parallel demand for safeguarding user information [70]. To maintain the trust of their user base and adhere to privacy standards, these nutrition applications also need to implement robust data security practices, including encryption, user authentication, and compliance with data protection regulations, such as GDPR or HIPAA, whenever applicable.

4. Discussion, Implications, and Limitations

The unveiling of ChatGPT in November 2022 by OpenAI marked a significant milestone in the field of natural language processing and AI. This momentous event not only highlighted the cutting-edge advancements in AI technology but also set a new standard for the capabilities of language models. With an extraordinary 100 million monthly active users achieved in less than a year, ChatGPT surpassed TikTok as the fastest-growing user base in history. The unparalleled appeal of ChatGPT, stemming from its human-like text generation, user-friendly interface, and vast knowledge base, has led to its rapid adoption by a wide user base [45,59,71]. Moreover, its advent has unlocked a multitude of possibilities, spanning from academic research to the practical application of its capabilities across a diverse spectrum of industries. Within the healthcare sector, the emergence of ChatGPT ignited fervent discussions concerning its potential benefits and inherent challenges. It became a subject of significant interest and exploration among researchers from diverse medical specialties, including microbiology [39], nursing [40], parasitology [41], radiology [42], and medicine [43]. Unfortunately, there remains a paucity of literature addressing the utilization of ChatGPT within the field of nutrition and dietetics. This paper aims to contribute to the existing body of research by exploring the potential applications, challenges, and opportunities presented by ChatGPT in this research discipline.

Nutrition science occupies a central role in healthcare as it provides essential insights into the intricate interplay between dietary choices and human health. As experts increasingly recognize the importance of technology integration in this discipline, there is a growing need to explore how advancements in AI generative technology can synergize with the insights offered by nutrition science to enhance nutrition knowledge among the general population. Following the initial exploration, it is apparent that there are features of typical nutrition applications that ChatGPT can replicate to varying degrees while also recognizing certain processes that it cannot fully simulate. As an example, ChatGPT excels in its capacity to carry out computations similar to those found in other nutrition applications. It can efficiently calculate various nutritional values, including but not limited to total daily energy expenditure, body mass index, calorie counts, macronutrient compositions, and dietary reference intake information. However, it is important to note that there are features where ChatGPT's performance is partial in comparison to dedicated nutrition apps. While it can provide tips and reminders related to dietary choices and health, it falls short of being able to engage proactively with users in the same manner as specialized nutrition apps do. Furthermore, there are areas where ChatGPT surpasses traditional nutrition applications. For instance, it has the capability to offer dietary advice and guidance, which is often absent in existing nutrition applications due to their limited capacity to comprehend and respond effectively to human language. Overall, the observation that ChatGPT can outperform nutrition applications in certain features, match them in others, and only partially fulfill some functions underscores its potential utility within the nutrition and healthcare landscape. Expectedly, however, it is important to note that ChatGPT, while valuable in this context, cannot entirely replace dedicated nutrition applications.

In the context of the NCP, ChatGPT has the capability to assist both dietitians and regular users in various stages. Although, for regular users, it is of utmost importance that expert validation and consultation be sought when making significant dietary decisions. For dietitians, ChatGPT can help as a tool that can streamline their workflow and provide quick access to nutritional information and calculations. Like in other health specialties, e.g., [40,54,68], it can assist in creating customized meal plans, dietary recommendations, and educational content for clients, allowing dietitians to focus on more complex and specialized aspects of their practice. As emphasized in the field of emergency medicine [71], ChatGPT serves as a dependable "triage" aide during critical medical situations, offering prompt, understandable guidance within a minute. This functionality stands as a valuable platform for both patients and healthcare practitioners as it potentially leads to time and resource savings while ensuring the provision of suitable and secure recommendations. Nevertheless, for dietitians and even other healthcare professionals, it is fundamental to use ChatGPT as a supplementary resource rather than a sole source of information. Expert judgment and critical evaluation should always be exercised to ensure the accuracy and appropriateness of the guidance and information provided, considering the unique needs and circumstances of everyone under their care. As warned by other scholars [72], a notable drawback lies in the potential for ChatGPT to disseminate inaccurate healthcare information or misleading content. This concern stems from the necessity for the model to distinguish between credible and unreliable sources of information [73]. The challenge of discerning the trustworthiness of sources presents a critical issue, as the model must possess the capacity to differentiate between credible, evidence-based healthcare knowledge and unverified or deceptive content. Addressing this challenge is paramount to ensure the responsible use of AI technologies in nutrition and healthcare in general.

While ChatGPT exhibits promising potential in offering valuable insights and sharing nutrition knowledge, a valid argument can be made against its role as a substitute for the expertise of a registered dietitian, especially when confronted with intricate dietary requirements or medical conditions. Other experts in various health-related fields share a similar viewpoint [54,67,74,75]. When we take a broader view of the current applications in medical practice, it is apparent that AI has already become an integral part of healthcare services, all the while not supplanting the role of medical professionals. For instance, the influence of AI in healthcare is discernible through its application in decision support systems designed to aid in the interpretation of medical imaging [22]. Thus, there is an ongoing challenge in the field of nutrition and healthcare in general, which is to strike the right balance between harnessing the advantages of AI technologies and preserving the critical role played by dietitians and human healthcare providers. From a technical standpoint, ChatGPT's inadequacy to fully replace experts in the field of nutrition becomes apparent when we consider the myriad elements integral to this domain. Examples include its potential for providing incorrect responses, the need for coordinated and personalized nutrition services, the value of hands-on demonstrations, the ability to conduct physical examinations, interpreting both verbal and non-verbal cues, addressing emotional and psychological aspects, offering real-time monitoring and feedback, integrating data from wearable devices, providing visual information, and dealing with ethical and privacy concerns. These facets lay emphasis on the nuanced expertise provided by human professionals and the distinct attributes that nutrition applications contribute to the healthcare landscape, which goes beyond the capabilities of AI-driven models like ChatGPT.

This paper has several limitations that need to be acknowledged and could serve as key areas for future studies. Firstly, the limited existing research on ChatGPT in the context of nutrition poses a challenge as it restricts the pool of available references and precedents in this emerging field. The main emphasis of this paper was consequently directed towards the technical aspects of nutrition applications and ChatGPT. To enrich future research in this domain, it is advisable to complement these technical insights by conducting interviews with experienced dietitians. Such interviews would provide invaluable qualitative data, offering insights into the practical application of nutrition knowledge, the nuances of patient interactions, and the multifaceted nature of dietary guidance. This combination of technical analysis and expert interviews could result in a more comprehensive and holistic understanding of the intersection between technology and nutritional expertise in healthcare. Furthermore, while it is intriguing to consider ChatGPT's potential as a tool for generating scientific knowledge, it is important to clarify that this paper is centered on how the broader public can enhance their nutrition knowledge through its utilization. Following this context, nutrition science is a dynamic field with ongoing research. Thus, the data cutoff of ChatGPT means that the model will not have access to the latest scientific studies, dietary trends, or emerging knowledge. Users might miss out on crucial insights and innovations and might receive recommendations that are no longer considered best practices. Finally, this paper is restricted to the analysis of the current version of ChatGPT, specifically the free version, and its language model (GPT-3.5). It is noteworthy that other applications enhanced by ChatGPT or ChatGPT powered by plugins were not included in this analysis. This limitation implies that the findings may not encompass the full range of possibilities offered by the broader ChatGPT ecosystem, which include diverse applications and extensions. Future research could explore these expanded applications to gain a more thorough understanding of ChatGPT's potential in various contexts.

5. Conclusions

This paper highlights the potential of utilizing ChatGPT as a tool to enhance nutrition knowledge. ChatGPT can replicate certain features commonly found in nutrition applications and can excel in certain conversational tasks. However, it is important to note that ChatGPT is not specifically designed as a nutrition application. This flaw indicates that there are inherent limitations to its capabilities that are essential considerations within the context of nutrition education. While ChatGPT can offer guidance and furnish valuable information for certain tasks within the NCP, it does not supplant the expertise and comprehensive support provided by dietitians and nutrition professionals. Therefore, the role of ChatGPT should be seen as a complementary tool rather than a standalone replacement within the field of nutrition. Overall, ChatGPT holds promise as a valuable contributor to the enhancement of nutrition knowledge, although further research and development efforts are needed to optimize its capabilities and expand its role within the field of nutrition. Such endeavors are expected to encourage a dynamic synergy between technology and human expertise to best serve the needs of both professionals and the general public.

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