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Feasibility of Mobile Telehealth for Health Literacy Enhancement via Nutritional Counseling during COVID-19

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ABSTRACT

Introduction: The COVID-19 pandemic has created numerous challenges, including widespread misinformation and limited access to reliable health resources. These issues have led to the proliferation of superstitions and impulsive decisions regarding drug and supplement use. This study focused on the development and feasibility evaluation of a nutritional teleconsultation system designed to address these challenges.

Methods: This cross-sectional study was conducted from April to May 2020 at the Mashhad University of Medical Sciences, Mashhad, Iran. After conducting a needs assessment, a nutritional teleconsultation system was developed. The usability and functionality testing led to iterative modifications. The system was piloted on clinical staff for a week, after which it was improved and made available to the public.

Results: Over 1,000 system logins were recorded, with 641 users completing questionnaires. Of these, 344 accessed consultation services. The majority of consultation users were aged 31–40 years, and hypertension was the most commonly reported underlying condition. Approximately 53% of users were Mashhad residents. Nutritional queries dominated during the pandemic, with 49.1% focusing on nutrition in the context of COVID-19, 32.0% addressing COVID-19 directly, and 7.5% solely about nutrition. Among combined nutrition and COVID-19 questions, the most common topics were diet (46.2%), immunity (28.4%), and supplementation (20.7%).

Conclusion: This study highlights the feasibility and public acceptance of telehealth solutions for nutritional consultation during crises. The findings underscore the need for ongoing public education on diet, immunity, and supplementation through diverse media channels to combat misinformation effectively.

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Introduction

In recent years, due to the increase of environmental, social, and health crises, preparation to face the crises is an indispensable part of crisis management strategies. In the last two decades, approximately more than one billion people have been affected by different crises, and more than 700,000 mortalities have been accounted for by natural disasters alone (1). In addition to inducing death and diseases, such crises lead to extremely destructive psychological, social, economic, and political effects that will remain for years. Iran is among countries at the highest risk of accidents in the world and is faced with a significant number of natural or human-made crises every year (2). On the other hand, the transmission of false information has become a challenge, and the current era is described as the era of fake news, which false information may spread rapidly during disease outbreaks and cause problems in the field of health, for example, the nutritional status of people and health affect society(3). Recent studies have shown that false or

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misleading health information may spread more easily than scientific knowledge through social media. The essential role of health misinformation in social media has recently been highlighted by the COVID-19 pandemic, as well as the need for quality and accuracy of health messages. The purpose of public health crisis management and disease caused by misinformation is highlighted. In fact, the lack of control over health information on social media is used as evidence for the current demand to regulate the quality and public availability of online information(4). Studies have shown that telehealth may have a significant impact on the development of health care in the future, improving access to health services, providing access to the right education, especially for citizens in remote or disadvantaged areas. and thereby improve health outcomes(5, 6).

Telehealth involves sending information from one region to another using electronic communication to improve the quality of health and treatment (7). Today, telehealth services are widely used in various health fields through cellphones (8). Employing technology in the health field has allowed users to access reliable information about healthy lifestyles and to use the advice of health experts regarding their problems. It has prevailed more after developing smartphones and their practical applications in recent years (2). The use of smartphones and the Internet has been almost twofold from 2013 to 2018 (9). The increasing use of smartphones has made them popular in accessing information and has led to the growth of practical applications in changing people's lifestyles. One benefit of cellphones in the health domain relates to nutrition, diet, weight control, and access to reliable information on healthy diets (10). Since the new circumstances (the Coronavirus crisis) have been unprecedented, there is no public access to appropriate information sources. This issue is more serious concerning proper nutrition methods. Many of public ambiguities and questions have remained unanswered due to the lacking access to resources and experts, and they seek answers to their questions through the superstitions spread in society.

Telehealth has become an essential resource during emergencies, such as the COVID-19 pandemic, offering several key features that improve healthcare delivery. Here are some of the most advantageous aspects:

✓**Swift Information Sharing**: Telehealth platforms can rapidly distribute crucial health information to patients and healthcare professionals. This encompasses updates on treatment protocols, vaccination details, and guidelines for managing specific conditions during a crisis. Research shows that timely access to information can significantly enhance patient outcomes and minimize misinformation(11).

✓**Access to Specialists from A far**: In times of crisis, especially when physical access to healthcare facilities is restricted, telehealth allows patients to consult with specialists without the need for travel. This is particularly advantageous in rural or underserved regions where expert healthcare providers may not be readily available. Studies indicate that remote consultations can lead to effective diagnosis and management of health issues, ensuring patients receive prompt care(12).

✓**Improved Accessibility**: Telehealth eliminates geographical barriers, enabling individuals with mobility challenges or transportation issues to access healthcare services. This increased accessibility is crucial during crises when traditional healthcare systems may be overwhelmed or inaccessible (13).

✓**Boosted Patient Involvement**: Telehealth fosters patient engagement through intuitive platforms that empower individuals to take an active role in their healthcare. Patients can easily schedule appointments, access their medical records, and communicate with their providers, leading to better adherence to treatment plans and improved health outcomes(11).

In summary, telehealth's capacity for swift information sharing, remote access to specialists, robust communication channels, enhanced accessibility, cost efficiency, and increased patient involvement makes it an invaluable asset during crises. These features not only help mitigate the impact of emergencies on healthcare delivery but also contribute to building more resilient health systems for the future(11-13).

The COVID-19 pandemic has intensified pre-existing nutritional issues, particularly by increasing food insecurity and spreading misinformation regarding dietary choices. Research conducted by Gundersen and Ziliak indicates that the economic repercussions of the pandemic have led to a notable rise in food

insecurity, which has had a disproportionate impact on marginalized communities, limiting their access to healthy food options(14). "Nutrition teleconsultation" provides the opportunity for remote patient monitoring in remote areas and supports reducing costs, reduce patientand provider-travel time expanding access to services, continuity of care, and reducing geographic barriers. Gradually, nutrition telecare is increasingly used by professionals, and the creation of a systematic telecare protocol in this field seems necessary(15, 16). Providing nutrition services through telemedicine requires the provision of an infrastructure that does not impose high limits on service quality and allows telehealth to address mobility, usability, interoperability, intelligence, and adaptability in a systematic way(17). Telehealth and nutrition platforms may potentially help users improve household food security, modify child and family eating habits, and improve the effectiveness of nutrition and physical activity intervention(18-20). Physicians and specialists can communicate with patients, interpret specialized test results, and monitor disease progress when access to specialized care is unavailable or limited via telemedicine. Telemedicine can improve the effectiveness of professionals both in daily hospital operations and in critical situations where regional hospital systems and care facilities are pressured by sudden peaks in patient volume. This is while taking care of regular visitors of the health and treatment center at the same time(21).

Strategies in virtual nutrition include synchronous (phone calls or video conferencing) and asynchronous (e-mail, educational videos, or text messages) or combined approaches. Previous studies show that diet quality, increased consumption of fruits and vegetables, reduced consumption of highly processed foods, and weight loss, as well as encouragement to keep appointments and patient satisfaction have improved as a result of using these methods(15). However, it is important and necessary to create a basis for public understanding, awareness and readiness for the successful implementation and sustainable acceptance of this technology(22).Therefore, the purpose of this study was to develop and evaluate a teleconsultation system on nutrition-related questions with a focus on providing consultation to people about the prevention, immunity, and control of Coronavirus disease and also providing access to reliable information sources for public awareness and healthier food alternative during this crisis.

Materials & Methods

The present cross-sectional research was conducted in April-May 2020 at Mashhad University of Medical Sciences.

Need Assessment

In order to design a system that catered to the specific nutritional needs during the COVID-19 pandemic, a thorough needs assessment was conducted. A multidisciplinary team comprising nutritionists (n=2), health informatics specialists (n=2), and software developers (n=4) held several meetings to identify the core user needs. Open discussions were held within the team to identify the most frequently encountered issues during nutritional consultations in the early phases of the pandemic. These discussions revealed that during the COVID-19 pandemic, the public needed accurate, timely information regarding:

- Nutrition to boost immunity and prevent disease,
- Safe use of supplements, and
- Access to reliable nutritional advice through remote means due to quarantine measures.

Based on these needs, the following decisions were made:

➢ **User-driven Design:** A system allowing users to ask questions through text and attach images, which was based on the feedback that visual representation of food products, symptoms, or supplements was often essential for consultations.

➢ **Timeliness:** Users were concerned about getting timely advice, hence the system was designed to allow consultants to respond promptly (within a set timeframe, between 6 am and 12 pm), ensuring rapid consultation.

➢ **Categorization and Filtering of Questions:** Given the volume and nature of inquiries anticipated, consultants highlighted the need for a robust question-labeling system. This was implemented to streamline the categorization into relevant themes such as immunity, diet, supplementation, etc., which further guided the iterative development of the system's database architecture. Several primary labels were used for question labeling. Then, by an iterative and

incremental development and examination of the questions, the labels were completed, and the previously labeled questions were reviewed. Two categories of labels were used, one about *the relevance to the topic of interest* and the purpose of using the system, and the other *the topic of the question*. After the iterative process, the relevance label read "relevant", "relevant only to Corona", "relevant only to nutrition" and "irrelevant". The topic label included diet, immunity, supplementation, comorbidity, traditional medicine, stress control, prevention, children, symptoms, treatment, lactation, medication, pregnancy, and the elderly. Table 1 presents the descriptions of the topic labels.

Table 1. Question topic labels and their definition

Topic	Description
Diet	Proper nutrition during the Coronavirus crisis
Immunity	Proper nutrition to improve the immunity system during the Coronavirus crisis
Supplementation	Supplementation to reduce symptoms/ prevent the Coronavirus disease
Comorbidity	Proper nutrition during the Coronavirus crisis for people with a comorbidity
Traditional medicine	Nutrition according to the recommended alternative medicine during the Coronavirus crisis
Stress control	Proper nutrition during the Coronavirus crisis to control stress
Prevention	Proper nutrition to prevent Coronavirus disease
Children	Proper nutrition for children during the Coronavirus crisis
Symptoms	Proper nutrition during the Coronavirus crisis for patients with Coronavirus disease symptoms
Treatment	Proper nutrition for Coronavirus treatment
Lactation	Nutrition during the Coronavirus crisis for lactating women
Medication	Taking medications to relieve/prevent Coronavirus symptoms, drug-food interactions

System Development

The user-centered development method was used to develop the system. An iterative process of answering users' questions and fulfilling their needs was at the core of this approach. In this phase, through cooperating with the software development team, items such as system architecture, programming language, the database, and functions were determined so that the utilized resources and infrastructure could fulfill the needs of users. Therefore, it was decided to implement the system according to the following uses:

HTML, CSS, and JavaScript were used as client-side web programing languages. The programming language used on the server-side was C. The server-side database was MySQL, and also a native memory-based NoSQL was used to preserve the temporal cache of the information. Communication with the server was in JSON, Text, Html, and if necessary, a dedicated textual marked text structure like Markdown was used.

Usability Evaluation

Having developed the preliminary version of the system, the usability test was administered through some of the potential system users who had different educational levels. This test answers the question of how easy it is for users to use the system.

The think-aloud method was employed to do the test. In this way, some scenarios were designed to work with the system provided to users, and they were asked to express their thoughts loudly while working on the system for acting out the scenarios.

The following scenarios were designed to test core system functions:

1. Logging in and completing the demographic questionnaire,
2. Submitting a nutrition-related question along with an optional image attachment, and
3. Viewing the response from a nutritionist.

During the test, an evaluator observed the participants and recorded any usability issues. The feedback was then analyzed according to a predefined rubric focusing on:

- Ease of navigation,
- Clarity of instructions, and
- Efficiency in submitting questions and receiving responses.

Finally, a total of 5 participants were involved in the testing phase. The participants were selected to represent a range of ages, education levels, and technology proficiency, ensuring the system was intuitive for different user groups. This included individuals with varying levels of familiarity with smartphones and teleconsultation services, ranging from novice to experienced users.

The problems users faced while working with the system were recorded by the evaluator. Finally, after summarizing the recorded

problems, the system went redesigned.

Functionality Evaluation

The functioning of the system was tested by scenarios and simulated data in a laboratory to do the functionality test facing the significant volume of questions people asked and to evaluate the communication speed, communication quality, weakness, and system capabilities. After ensuring the functioning of the system in the laboratory, it was provided to the clinical staff of the University of Medical Sciences to ask their questions about the nutrition of patients with Coronavirus for a week. At the end of this phase, a survey was conducted of users. The analyzed results were presented to the development team to fix the defects.

Public Accessibility and Recruitment

To increase public awareness and accessibility, the system was primarily promoted through social networks affiliated with Mashhad University of Medical Sciences. Notifications were shared via WhatsApp groups, Telegram channels, and official university communication platforms. Additionally, announcements were made in local hospitals to inform the clinical staff and public about the system.

During this process, one challenge was ensuring access to individuals outside of the Mashhad area. Although the system was developed and initially promoted in Mashhad, it was accessible to users from other provinces. Over 32% of users were from other provinces, indicating a broader uptake beyond Mashhad. However, due to limited initial promotion and infrastructure, system access was not as widespread. In the next phase, more robust recruitment strategies—such as collaborations with other regional health centers—will be necessary to ensure broader coverage.

Security and Privacy Considerations

In this program, the confidentiality of the information provided by individuals was respected. The authorization and authentication of users to access the application were controlled. Patient identification information such as name, surname, and national ID number were neither requested nor registered. The questions were provided to experts in a way that they could not identify the patients. Also, access to information for anonymous people was denied because the data were encrypted during transmission.

Statistical Analysis

The data were analyzed using descriptive statistics using SPSS version 26. Frequencies and percentages were calculated for categorical variables such as age groups, underlying conditions, and the types of questions submitted (e.g., diet, immunity, supplementation). For continuous variables like age, means and standard deviations were used to summarize the data.

Results

User Engagement

The system was used by people from April 3 to May 21, 2020. During this period, nine nutritionists, who were university faculty members, answered users' questions. A total of 1006 logins were recorded, with 743 being new users. 641 users completed the demographic questionnaire upon logging in. Out of these, 344 individuals sought counseling and asked questions, all of which were answered by nutritionists.

The user could access the system through a hyperlink. On the home page, users were asked to enter their phone number, which acted as their username to maintain history for re-access (Figure 1). Once logged in, a questionnaire was provided that included questions about gender, age, underlying diseases, and place of residence (Figure 2). Users could then submit their questions and attach a file if needed (Figure 3). Instructions were provided to users that the system was designed to answer nutrition-related questions during the Coronavirus crisis. Responses were provided by nutritionists within 24 hours (Figure 4).

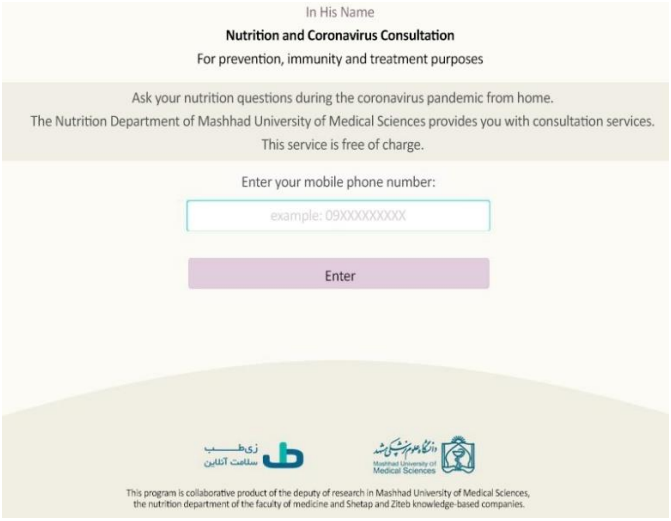

Figure 1. Login page

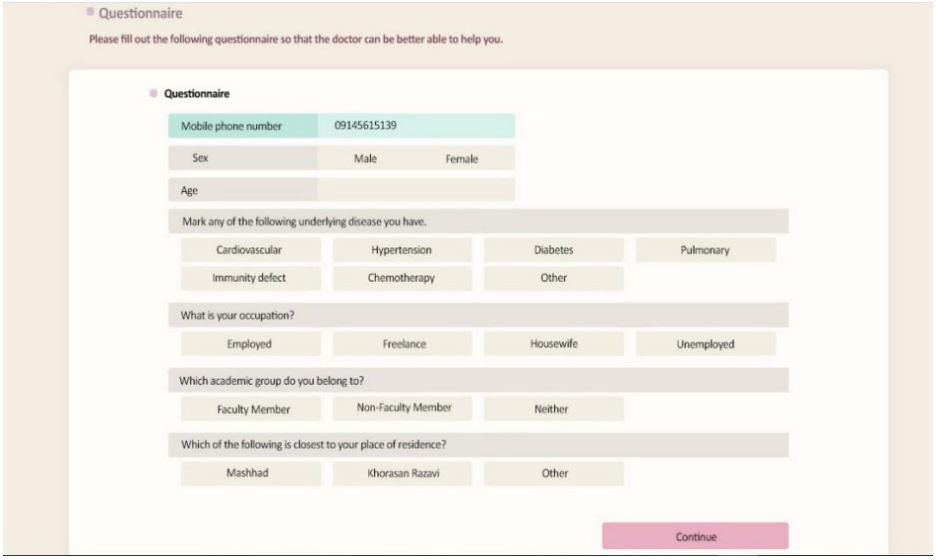

Figure 2. Patient demographic information questionnaire

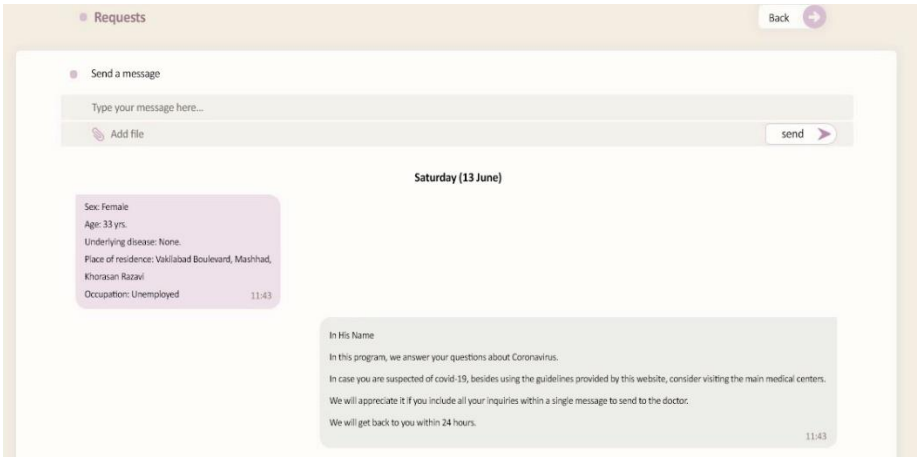

Figure 3. Where to ask questions and attach a file

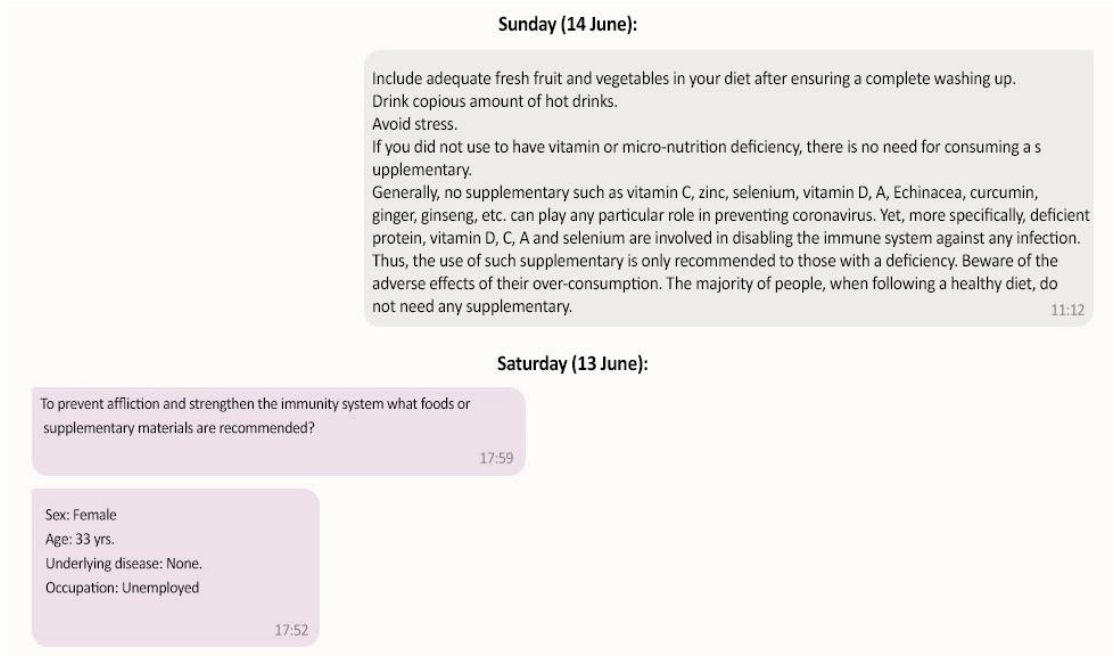

Figure 4. Nutritionist's answer to the user's question

Demographic Data

The average age of the system users was 36.9 ± 11.0 years, while the average age of those who asked questions was 37.9 ± 11.0 years. The most common age group for both users and consultants was 31-40 years (40.6% and 38.4%, respectively). The most common underlying disease in both groups was hypertension (Table 2).

Out of 641 system users, 1 individual (0.15%) mentioned 5 comorbidities, 5 individuals (0.78%) mentioned 3, 17 individuals (2.65%) mentioned 2, and 182 individuals (28.4%) mentioned only one comorbid disease.

A total of 436 users (68.02%) did not report any underlying disease. Among those who asked questions, 63.08% did not report any disease, while the remaining had varying comorbid conditions as follows: 3 individuals (0.78%) mentioned 3, 13 individuals (3.78%) mentioned 2, and 111 individuals (32.27%) mentioned only one comorbid disease.

Among all users who sought consultations, 53% were Mashhad residents (Figure 5).

Question Categories

A total of 344 questions were submitted. 49.1% of the questions were related to nutrition during the Coronavirus crisis, 32.0% focused solely on Coronavirus, and 7.5% pertained only to nutrition (Figure 5).

Figure 6 lists the frequency of question topics labeled by nutritionists. Since a question could cover multiple topics, the total exceeds the number of unique questions. After excluding nonsense questions, 199 questions addressed a single topic, while others covered multiple. The most common topics were Diet (46.2%), Symptoms of the disease (26.2%), and Immunity and supplementation were also frequently mentioned (20.7%).

Among the 169 questions specifically related to both COVID-19 and nutrition, the top three topics were diet (46.2%), immunity (28.4%), and supplementation (20.7%).

Table 2. Demographic characteristics and users' comorbidities

Variables		People who completed the questionnaire (n=641) Frequency (percent)	People who asked for consultation (n=344) Frequency (percent)
Sex	Male	293 (45.71%)	170 (49.41%)
	Female	341 (53.20%)	173 (50.30%)
	Unknown	7 (1.09%)	1 (0.29%)
Age (years)	14-20	19 (3.0%)	13 (3.8%)
	21-30	169 (26.4%)	81 (23.5%)
	31-40	260 (40.6%)	132 (38.4%)
	41-50	129 (20.1%)	78 (22.7%)
	51-60	44 (6.9%)	28 (8.1%)
	61-70	16 (2.5%)	12 (3.5%)
	71-80	2 (0.3%)	0
	81-90	2 (0.3%)	0
Location	Mashhad	339 (53.0%)	183 (53.2%)
	Suburbs of Mashhad	97 (15.0%)	50 (14.5%)
	Other	205 (32.0%)	111 (32.3%)
Cardiovascular disease		13 (2.03%)	10 (2.91%)
Hypertension		48 (7.49%)	28 (8.14%)
Diabetes		30 (4.68%)	17 (4.94%)
Pulmonary disease		19 (2.96%)	11 (3.20%)
Immune deficiency disorders		20 (3.12%)	19 (5.52%)
Chemotherapy		8 (1.24%)	6 (1.74%)
Other diseases		98 (15.29)	55 (16%)

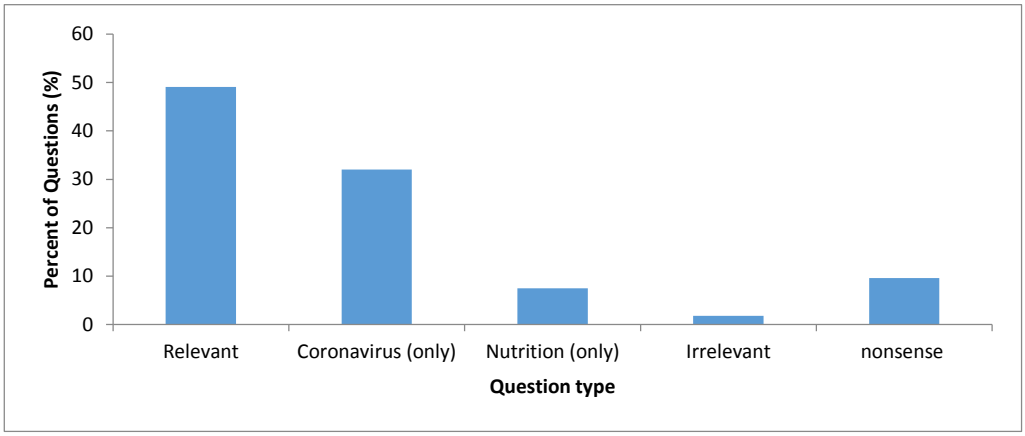

Figure 5. Percentage of questions based on relevance

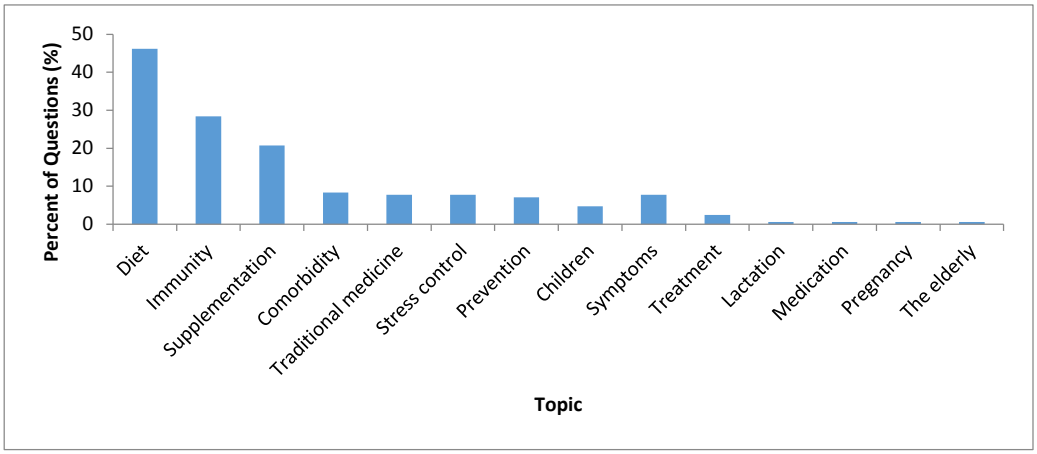

Figure 6. Percentage of questions based on the topic

Discussion

Implications for Telehealth

A major challenge during the Coronavirus crisis was the lack of awareness regarding proper nutrition. The present study provided valuable insights into the use of web-based applications to deliver essential nutritional consultation during the pandemic. This study was conducted when most businesses, private clinics, and counseling centers were closed down, and it was highly recommended to stay at home. The success of this project demonstrates the effectiveness of telemedicine or teleconsultation in similar crises, as it allowed continuous access to health services despite these closures.

The study represents the first phase in the development and feasibility of a system designed to address nutrition questions during the pandemic. In the early stages of the Coronavirus pandemic in Iran, 641 users completed the embedded questionnaire, with half of these users proceeding to ask questions and receive consultations from nutritionists. Despite limited promotion through social networks related to Mashhad University of Medical Sciences, the system received significant engagement, indicating public interest and acceptance of telehealth solutions. These findings suggest that such systems can be expanded with improved infrastructure to reach broader audiences and play a critical role in future health crises.

Implications of Nutrition-Related Inquiries

The fact that 49.1% of the questions submitted were related to nutrition during the pandemic reflects the public's urgent need for reliable nutritional guidance, particularly regarding immunity and the prevention of illness. The widespread misinformation surrounding diet and supplements during this time likely contributed to this demand. The system's ability to address these concerns highlights the importance of telehealth in providing trustworthy, timely advice during health crises. The findings suggest that addressing public health fears through accurate, expert-guided teleconsultation can help prevent misinformation from leading to harmful health behaviors.

User Engagement and Demographics

The system was primarily accessed by users in the 31-40 years age group, representing 40.6% of all users. This age group is typically more technologically adept and engaged with online health resources, which may explain their higher participation rate. The average age of system users was 36.9 ± 11.0 years, and most individuals who asked questions were between 31-40 years. The system also attracted individuals from other provinces, with 32% of users coming from outside Razavi Khorasan province, indicating the potential for national scalability. However, the system's promotion through social networks affiliated with the university may have limited its reach to certain demographics, particularly older adults or individuals in more rural areas.

Fear, Anxiety, and Nutritional Behavior

Fear and anxiety about the Coronavirus played a significant role in shaping the type of inquiries received. Many of the questions centered around immunity and supplementation (20.7%), driven by the public's concerns over preventing infection through dietary adjustments. The persistent focus on immunity, even months into the pandemic, highlights the public's belief in nutrition as a preventive measure. Previous studies have shown that during times of uncertainty, individuals tend to gravitate toward dietary and lifestyle changes believed to boost immunity. For example, the rush to take supplements without proper guidance can lead to overuse and related health issues.

These psychological factors influence dietary behaviors, as individuals experiencing fear or anxiety may seek out information on how to protect themselves. The high proportion of questions related to immunity (28.4%) and diet (46.2%) demonstrates this trend. This is consistent with findings from previous health crises where anxiety prompted people to turn to dietary changes and self-prescribed supplementation. Similarly, studies have shown that mobile applications can help monitor patients' physical and psychological conditions during the COVID-19 pandemic, addressing both their mental health and nutritional concerns (7-10).

Statistical Findings and User Understanding

Only 11.4% of the questions were deemed irrelevant or nonsense, indicating that most users understood the system's purpose and functionality. This low percentage suggests that the system successfully conveyed its intended use to users, who asked questions mostly aligned with its goals. However, the presence of some

irrelevant questions also points to a need for clearer communication on the system's capabilities, possibly through more detailed guidelines on the login page or an initial onboarding process that clarifies what types of questions the system can address.

Barriers to Broader Implementation

The mention of consultation costs and the need for insurance coverage highlights a critical barrier to the broader implementation of telehealth systems. As telemedicine becomes more widely used, issues of cost and access must be addressed to ensure equitable access (11). Literature on telemedicine adoption has shown that financial barriers can deter low-income individuals from accessing these services, which could exacerbate health disparities (12-15).

Limitations

Several limitations impacted the study. One significant limitation was the system's restricted promotion through networks tied to Mashhad University of Medical Sciences. This limited promotion likely resulted in a user base that skewed towards the university's affiliates or those already engaged with its health services. This could have influenced both the demographics of users and the types of questions asked. Additionally, while the system successfully catered to urban and tech-savvy populations, its accessibility to older adults and rural populations remains uncertain.

Another limitation was the lack of a fee structure for consultations during the feasibility phase. While the system was offered for free, scaling it for broader use would necessitate financial sustainability, likely through insurance coverage or service fees. Incorporating such a payment structure could present a barrier to some users, and future implementations would need to address these economic challenges.

The lack of personalized data collection, such as height and weight to calculate BMI, also limited the system's ability to provide tailored nutritional advice. More comprehensive data collection, including patients' medical histories, would enable more customized and effective consultations. This issue should be addressed in future iterations of the system.

Recommendations for Future Research

Future research should focus on expanding the system's reach to a more diverse user base by partnering with regional health authorities and launching targeted outreach efforts, particularly in rural and underserved communities. Additionally, integrating telehealth systems with existing public health campaigns could enhance public health literacy and increase engagement. Given the high levels of fear and anxiety influencing dietary behavior, future iterations of the system should include mental health support to help users make more informed decisions about their nutrition and supplement use during crises.

Conclusion

The present study successfully demonstrated the feasibility of a teleconsultation system for nutritional counseling during the Coronavirus pandemic. The system's high engagement rate and the large proportion of nutrition-related inquiries indicate the public's demand for reliable, evidence-based guidance during health crises. Moving forward, telehealth systems like this one could be expanded and integrated into public health initiatives, with the potential to play a vital role in ensuring the continuity of care during future emergencies. By addressing the challenges of accessibility, cost, and tailored consultations, telehealth could become a permanent fixture in public health strategies.

Declarations

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Mashhad University of Medical Sciences and Medical School (Ethical code: IR.MUMS.REC.1399.006). Informed consent was obtained verbally from participants upon entering the study, ensuring that their participation was voluntary and confidential.

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets enabling this research are not publicly available due to privacy or ethical restrictions but are available from the corresponding author on reasonable request.

Conflict of Interests

The authors declare that they have no competing interests.

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in study design, data collection, analysis, decision to publish, interpretation, or preparation of the manuscript. The corresponding author will have full access to all the data in the study and will have final responsibility for the decision to submit for publication.

Authors' Contributions

RR and SE conceived the study idea and design. RR, KK and MN designed the plan of study implementation. SA, RR, MN and SE designed and developed the system. NF and MA analyzed the data. SA, NF and MA drafted the manuscript. All authors have been involved in critically revising the manuscript. All authors read and approved the final manuscript.

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Abbreviations

Not applicable.

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