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Determining the information requirements of a smartphone-based nutritional education application for dialysis patients

Maryam Zaman[1], Seyed Ali Fatemi Aghda[2,3]*, Parisa Javadian[4], Shadi Hazhir[5], Priya Roma Shantusha Gopalrai[6]

[1]Department of Health Information Management, School of Health Management and Information Sciences, Iran University of Medical Sciences, Tehran, Iran
[2]Student Research and Technology Committee, School of Health Management and Information Sciences, Iran University of Medical Sciences, Tehran, Iran
[3]Research Center for Health Technology Assessment and Medical Informatics, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[4]Department of Internal Medicine, School of Medicine, Shahrekord University of Medical Sciences, Shahrekord, Iran
[5]Student Research Committee, Department of Health Information Technology and Management, School of Allied Medical Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[6]Data Science Department, Quan Techno Support BV, Amsterdam, Netherlands

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**** Corresponding author:***
Seyed Ali Fatemi Aghda

Student Research and Technology Committee, School of Health Management and Information Sciences, Iran University of Medical Sciences, Tehran, Iran

Email: afatamy@gmail.com

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A B S T R A C T

Introduction: Chronic kidney patients undergoing dialysis face numerous nutritional challenges. Nutritional education can significantly aid these patients in their self-care and improve health outcomes. This study aimed to determine the necessary educational content for designing a smartphone-based nutritional education application for dialysis patients.

Material and Methods: This applied study was conducted using a descriptive method, after reviewing previous studies, a questionnaire was developed. This questionnaire, the validity and reliability of which were confirmed by experts, included five section. The study population consisted of nephrology specialists and subspecialists, 18 of whom were randomly and purposefully selected from the nephrology clinics of hospitals affiliated with Iran University of Medical Sciences and Shahrekord. Data analysis was performed using descriptive statistics and SPSS version 21 software.

Results: The educational content was included in five main section: the "Demographic Information" included age, history of kidney failure, cause of chronic kidney disease; the "Physical Parameters" included dry weight, pre-dialysis weight, BMI; the "Clinical Tests" included albumin, phosphorus, potassium tests; the "Vital Nutrients" included protein, sodium, milk and dairy products; and the "Food Groups" included meat and its substitutes, bread and cereals, and approved vegetables. The level of education and marital status from the demographic information section and height from the physical parameters section were not approved.

Conclusion: Given that the necessary requirements for designing a nutritional educational application specifically for hemodialysis patients have been accurately determined in collaboration with relevant experts, the design and implementation of a mobile application can play a significant role in raising patient awareness. This application, by providing personalized nutritional information, not only helps improve patients' quality of life but can also have a positive impact on their treatment process and better disease management.

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INTRODUCTION

The human body has two kidneys located behind the peritoneal cavity, which play a vital role in the body's metabolism and the removal of waste products resulting from the body's metabolism. The main function of the kidneys is to regulate the balance of

salt, water, other ions, and trace elements such as calcium, phosphorus, magnesium, potassium, chlorine, and acids [1]. However, diabetes and high blood pressure are the main causes of chronic kidney disease [2]. Chronic kidney disease (CKD) is defined as persistent and irreversible kidney damage, in which the kidney loses its ability to filter waste products from the blood. The glomerular filtration rate (GFR) is the best criterion for measuring kidney function, which is assessed by the blood creatinine test result. Kidney function is divided into five stages based on the GFR: normal, mild, moderate, severe chronic kidney failure, and end-stage [3]. Chronic kidney disease is a progressive disease that affects more than 10% of the general population worldwide, which is more than 800 million people [4].

According to Zali, the head of Shahid Beheshti University of Medical Sciences in 2023, there are about 47,000 dialysis patients in Iran, which is expected to double in the next five years [5]. Global Burden of Disease (GBD) estimates showed that kidney diseases are responsible for 2,993,000 years of life lost (YLL) and 38,104,000 disability-adjusted life years (DALYs) lost worldwide [6]. End-stage kidney disease can be treated with renal replacement therapy (RRT) such as transplantation and dialysis, which includes hemodialysis and peritoneal dialysis [7, 8]. Approximately 78% of chronic kidney patients are undergoing dialysis. While about 89% of these people are undergoing hemodialysis and only 11% of these patients are undergoing peritoneal dialysis [9].

The high cost of renal replacement therapy creates an economic and ethical dilemma for those responsible for funding treatment programs for patients with end-stage kidney disease [10]. Hemodialysis is a long process in which body fluids and waste materials pass through a membrane as a filter instead of passing through the kidney [11]. The main goal of RRT treatment is to increase the life expectancy of patients and improve their quality of life. Some patients may continue to live for several years with dialysis, however, the overall health status, adherence to medical advice, a healthy lifestyle, and the type of nutrition can have a significant impact on the life expectancy of dialysis patients [12].

During the hemodialysis process, the diet is specific and somewhat restrictive [13]. An important problem that hemodialysis patients face is malnutrition with a global prevalence of 28 to 54 percent [14]. The onset of this issue begins with the adoption of a low-protein diet to limit the progression of end-stage renal failure during the long period of dialysis treatment [15]. Maintaining adequate intake of minerals such as potassium, phosphorus, and calcium, as well as adequate protein and energy intake, is essential to prevent malnutrition and prevent dialysis-related complications such as heart failure, metabolic bone disorders, and mortality [16]. Prescription a complex diet and prescribing specific fluids for end-stage renal disease patients receiving hemodialysis is challenging [17]. Hemodialysis patients constantly experience the adverse effects of a Test-and-Error approach and insufficient understanding of the treatment regimen, and their quality of life often deteriorates due to the self-management burdens of the diet [17, 18]. Furthermore, adherence to dietary guidelines in hemodialysis patients is very poor [19]. For example, the prevalence of hemodialysis patients who consume less protein than the recommended amount is between 41-98% [20].

Therefore, there is a strong need to adopt educational approaches and interventions to change behavior and increase adherence to a specific diet in hemodialysis patients [21]. Education is a key component of care and treatment management for chronic patients, especially chronic kidney patients, which is necessary in all stages of the disease treatment [22]. The goal of education is to provide useful information to these individuals and increase their awareness in all aspects of the disease and change their lifestyle. Considering the complexity of this disease, especially during dialysis, it is necessary for patients to be aware of the limitations of food consumption and the impact of dietary changes on the course of the disease [23]. Although patient education is considered a valuable method in promoting dietary adherence in patients, the information provided in Iran about self-care and diet by healthcare staff to chronic kidney patients is very general due to the high number of visiting patients. In addition, no institutionalized support system exists to care for these patients, such as providing nutritional education and encouraging them to follow a diet [24].

The widespread use and popularity of new technologies, including smartphones, have made people more dependent on technology. In fact, smartphones are mobile phones with advanced features and functions beyond traditional capabilities such as making phone calls and sending text messages, which have affected all aspects of human life, including business, education, health, and social life [25]. In recent years, researchers have increasingly used smartphones to provide health interventions, and this research covers a wide range of health conditions that originate from the two sciences of health and computer [26]. Also, according to studies, almost half of smartphone users use their phones to access health-related services [27]. Smartphones self-care education, as one of the new available methods of education for patients, allows them to learn in a desired location without the need to leave their home or workplace, according to a desired schedule and based on their interest and need, and to take action in an attractive and diverse environment to improve their health [28].

Considering the increasing rate of dialysis patients in the world, especially Iran, and the various economic and social effects on the family and society, the need to increase awareness and self-care through education in these patients seems very necessary and important. Also, considering the role of mobile applications in health and the impact of various factors (age, gender, nutrition, etc.) in this field, this study was conducted with the aim of information requirements and determining the capabilities of a smartphone-based application for nutrition education of dialysis patients.

MATERIAL AND METHODS

This was a descriptive study conducted to determine the information requirements of a Smartphone based nutritional education application for dialysis patients. In this research, the information requirements and important and influential nutritional points were obtained from library studies and research articles by searching in reputable databases (Web of Science, Scopus, Science Direct, PubMed). Based on this, a researcher-made questionnaire was prepared to determine the information requirements of the application.

This questionnaire had a section for receiving demographic information of physicians including 4 questions, and another section of the questionnaire included 39 questions about information requirements, which included other subsections. The demographic information section had 8 questions, the physical parameters section had 4 questions, the clinical tests section had 15 questions, the vital nutrients section had 5 questions, and the food groups section had 7 questions. At the end of each section, an open question was included to receive the participants' opinions regarding additional items they considered. The validity of the questionnaire was checked through content review and obtaining opinions by four professors of medical informatics and four nephrology specialists, and the desired corrections were made. The reliability of the questionnaire was assessed by the test-retest method and its result was reported.

The research population included all general practitioners and nephrology specialists, and the research environment was the hemodialysis center of Hajar Hospital of Shahrekord and the hemodialysis center of Shahid Hashemi Nejad Hospital, Iran University of Medical Sciences. Sampling was done randomly and included 18 (9 specialists and 9 subspecialists of nephrology) who underwent information needs assessment and completed the questionnaire.

Inclusion criteria for this study were individuals who had a specialty and subspecialty in the field of nephrology, having at least five years of work experience and cooperation with the hemodialysis center of Hajar Hospital of Shahrekord and the hemodialysis center of Shahid HashemiNezhad Hospital of Iran University of Medical Sciences, and were able to cooperate and provide information due to having time. Exclusion criteria included the unwillingness of eligible individuals to participate in the study.

In order to comply with the research ethics regulations, complete information about the motivation and purpose of the study was provided to the participants during the distribution of the questionnaire, and ethical considerations including freedom to participate or not in the study and ensuring the confidentiality of information were also taken into account. In this stage, the needs assessment questionnaire was distributed among the physicians, and then the collected responses were analyzed using SPSS version 25 software. Data analysis was performed at the level of descriptive statistics and included the mean. In the end, the needs and educational items that at least 70% of the participants confirmed were considered necessary items.

RESULTS

There were an equal number of nephrology specialists and subspecialists participating in the study, with 9 in each group. Also, Nearly 62% of the specialists were women, and nearly 56% of the participating specialists in this study were between 40 and 50 years old. On the other hand, the work experience of more than 10 years of the participants in the survey was close to 78%, which indicates the relatively good experience of the participants in nephrology and dialysis.

Table 1: Physicians' perspectives on information requirements

Variable		Frequency	Percentage
Age	Under 40	3	16.66
	40-50	10	55.56
	Over 50	5	27.78
Gender	Male	7	38.88
	Female	11	61.12
Specialization	Nephrology Specialist	9	50
	Nephrology Subspecialist	9	50
Work Experience	< 10 years	5	22.22
	10-20 years	7	50
	> 20 years	2	27.78

Nutritional education requirements in 6 main sections including: demographic information, physical parameters, clinical tests, vital nutrients,

food groups, are shown in Table 2. The participating in the research considered 36 out of 39 information needs questions as necessary and confirmed them. Regarding the sections of clinical tests, vital nutrients, and food groups, all items were considered necessary by the experts. In the demographic information section, the items "Education Level" and "Marital Status" were "Not Necessary" by the participating, and also in the physical parameters section, the "Height" item did not meet the threshold of necessary items.

Table 2: Physicians' perspectives on information requirements

Category	Item	Necessary		Not Necessary		Final Result
		N	%	N	%	
Demographic Information	Age	16	88.88	2	11.12	Confirmed
	Education Level	10	55.55	8	44.45	Rejected
	Marital Status	12	66.66	6	33.34	Rejected
	History of Kidney Failure	18	100	0	0	Confirmed
	Cause of Chronic Kidney Disease	16	88.88	2	11.12	Confirmed
	Duration of Dialysis	18	100	0	0	Confirmed
	History of Transplantation	18	100	0	0	Confirmed
	History of Peritoneal Dialysis	18	100	0	0	Confirmed
Physical parameters	Height	9	50	9	50	Rejected
	Dry Weight	16	88.88	2	11.12	Confirmed
	Pre-dialysis Weight	17	94.44	1	5.56	Confirmed
	BMI	18	100	0	0	Confirmed
Clinical Tests	Albumin	17	94.44	1	5.56	Confirmed
	Phosphorus	16	88.88	2	11.12	Confirmed
	Potassium	16	88.88	2	11.12	Confirmed
	Cholesterol	17	94.44	1	5.56	Confirmed
	LDL	17	94.44	1	5.56	Confirmed
	HDL	18	100	0	0	Confirmed
	Calcium	18	100	0	0	Confirmed
	Hemoglobin	18	100	0	0	Confirmed
	IPTH	18	100	0	0	Confirmed
	Triglyceride	18	100	0	0	Confirmed
	Blood Urea	18	100	0	0	Confirmed
	Sodium	18	100	0	0	Confirmed
	Ferritin	18	100	0	0	Confirmed
	Hematocrit	17	94.44	1	5.56	Confirmed
	Creatinine	17	94.44	1	5.56	Confirmed
Vital nutrients	Protein	18	100	0	0	Confirmed
	Sodium	18	100	0	0	Confirmed

Category	Item	Necessary		Not Necessary		Final Result
		N	%	N	%	
	Phosphorus	18	100	0	0	Confirmed
	Potassium	18	100	0	0	Confirmed
	Milk and Dairy Products	18	100	0	0	Confirmed
Food Groups	Meat and its Substitutes	18	100	0	0	Confirmed
	Bread and Grains	18	100	0	0	confirmed
	Vegetables	18	100	0	0	confirmed
	Fruits	18	100%	0	0%	confirmed

Participating in the study provided suggestions, which were then compiled, the questionnaire revised, and the revised version submitted to the experts for re-approval . As can be seen in Table 3, among the experts' suggestions, introducing different types of diets and cooking methods achieved the necessary threshold as a necessary item (70%), and the rest of the items were not considered necessary.

Table 3: Expert responses regarding suggestions

Row	Suggestions	Necessary		Not Necessary		Final Result
		N	%	N	%	
1	Number of Meals	11	61.12	7	38.88	Rejected
2	Introducing different types of diets and cooking methods	14	77.77	4	22.23	Confirmed
3	Introducing hemodialysis centers in the country	8	44.44	10	55.56	Rejected
4	User suggestions and comments section	11	61.12	7	38.88	Rejected

DISCUSSION

According to the research team's review, most studies in Iran have focused on the Financial, social, and political burden of end-stage renal disease patients, the importance of nutrition in hemodialysis patients, the need to pay attention to proper education about nutrition for hemodialysis patients, etc., and nutritional education studies such as the present study have not been conducted. Studies show that patients tend to be educated about their disease, its complications, and how to manage their nutrition during the illness because education, in addition to raising awareness and increasing knowledge, leads to self-management actions to improve health and well-being. The study by Heydarzadeh et al., aimed at determining the effect of peer education on the self-efficacy of dialysis patients referred to the Urmia Educational-Therapeutic Hospital.The results showed after one month that there was a significant difference in the self-efficacy score of the two test and control groups [29].

Since dialysis is with patients for the rest of their lives, various educations must be given to patients. And since education and awareness (such as lifestyle changes and diet) is a long-term process and cannot be solved with one or a few sessions, it requires continuous and frequent visits with the doctor and nurse to receive various educations, which in itself imposes more costs in addition to treatment on patients and has caused patients not to fully complete the educations and treatment, or even abandon these educations. Various studies have shown that the use of information and communication technology and telemedicine in recent years has become a viable solution to the problems of health service delivery, and this provides an opportunity for doctors and patients to provide remote care through digital technologies [18].

Telemedicine, and especially the use of smartphones as mobile health, and the design and implementation of various applications in the field of various diseases, has emerged as a promising way to improve access to health care, especially for vulnerable populations such as dialysis patients, which offers multiple benefits that increase access, quality, and efficiency of medical services for this vulnerable population. In the study by Farhadi et al. [30], they examined the monitoring of the quality of life of dialysis patients

using information technology and based on mobile health with modeling and designing a web-based system. This system was used on the one hand to monitor the quality of life of dialysis patients individually, and on the other hand, it could be used to monitor dialysis patients collectively in a city, province, and country.

The analysis performed on the questionnaire for the needs assessment of information elements indicates that almost all elements have been correctly selected. 100% (all sub-branches) of the sections of clinical test, vital nutrients, and food groups were confirmed, 75% (3 out of 4 sub-branches) of the sections of physical parameters, and also 75% (6 out of 8 sub-branches) of the sections of demographic information were approved by nephrology specialists and subspecialists. These information requirements can be a good source for inclusion in a health application for the nutrition of patients undergoing dialysis. The results of the study by Nargesi Khoramabad et al. [31] also showed that appropriate educational programs should be developed considering the factors affecting the promotion of self-care in dialysis patients, and for greater effectiveness, capacities such as information and communication technology, social networks, and the families of patients should also be used, which is in line with the present study.

The study by Kowal MD et al. [22] showed that dialysis patients who use Smartphone to support a proper diet have different needs and usage patterns depending on age, gender, and time of application use. The need for personalization of the content of health applications, especially during hemodialysis, is quite evident. The results of the study by Lim et al. [20] showed that limited nutritional literacy is evident in about 46.3% of hemodialysis patients and adherence to a proper diet was 34.9%, and the need for nutritional literacy strengthening strategies that target self-efficacy and self-management skills is essential. Which is in line with the aim of the present research and nutrition education in particular was considered.

In the study by Fakih El Khoury et al. [16], which examined the potential effectiveness of dietary intervention using a smartphone application, the results showed that the mean daily intake of energy, protein, and serum iron increased significantly after the dietary intervention with the smartphone. In another study by the same researcher, aimed at evaluating the effectiveness of a mobile application on phosphorus management in hemodialysis patients, an increase in patients' dietary knowledge about phosphorus management and a decrease in serum phosphorus levels were observed. The results of the study by Schrauben et al. [32] showed that a short, intensive, and remote dietary intervention through a health application for adults with type 2 diabetes and early chronic kidney disease at high risk of disease progression and cardiovascular complications led to improved blood pressure and sodium intake and self-reported diet quality, but there was no improvement in albuminuria.

Patients, due to the challenges they face during their illness, should be educated from various aspects such as awareness about the disease, complications, how to use medications, type of nutrition, etc. Chronic kidney patients who are on dialysis face many challenges, including the type of nutrition, which requires education about the consumption of various food groups, minerals, etc., so that they can play a significant role in better disease management with self-management. This is more effective by including educational content in the application.

Among the limitations of the present study was the lack of cooperation of some participating, while explaining the objectives of the research, attempts were made to gain their participation, and finally, the method of sample replacement was used. On the other hand, considering that only physicians from hospitals of Iran University of Medical Sciences in Tehran and Shahrekord were used, it is suggested that in addition to physicians, patients and treatment staff from other cities should also participate, which in addition to increasing the number of samples, will result in greater generalizability.

CONCLUSION

One of the most important initial steps in designing an educational software is to determine the educational requirements related to that area. The result of this research was to determine the content of nutrition education to create a Smartphone -based application for end-stage renal disease patients undergoing dialysis. These needs included 5 main sections including demographic information, physical parameters, clinical tests, vital nutrients, food groups, which were confirmed by nephrology specialists and subspecialists of the hemodialysis center of Iran and Shahrekord Universities of medical sciences. It is hoped that health care institutions and providers will pay attention to the educational content determined in this study and use it to create a practical application to improve the level of education and quality of life of patients.

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AUTHOR'S CONTRIBUTION

MZ: Visualization, conceptualization, validation, formal analysis, writing original draft, writing, review

& editing; SAFA: Visualization, conceptualization, formal analysis, investigation, supervision, project administration, writing original draft, review & editing; PJ: Visualization, formal analysis, investigation; SH: Data curation, formal analysis, resources, software, writing original draft.

All authors contributed to the literature review, design, data collection, drafting the manuscript, read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this study.

ETHICAL APPROVAL

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No financial interests related to the material of this manuscript have been declared.

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