Enhancing Diabetic Elderly Health Diet Education Through Mobile Application: An Interdisciplinary Conceptual Framework

Li Jinglong[1], Rosalam Che Me[2], Faisul Arif Ahmad[3] and Zhu Qisen[4]

Abstract

The increasing incidence of diabetes among the elderly has heightened the demand for effective healthcare solutions, with mobile applications emerging as promising options for managing healthy diet education. However, age-related declines in cognitive, physical, and sensory functions may reduce elderly's willingness to learn new technologies. This study aims to examine the dietary needs of diabetic elderly, identify factors influencing their learning habits, and explore key elements in designing and accepting mobile applications. Using a four-step approach—identifying target users, reviewing literature, pinpointing key variables, and developing a conceptual framework—the study found that exercise, BMI, and a healthy diet attitude significantly shape dietary habits. It also identified appearance, functionality, and interface design as critical factors for mobile applications. Additionally, perceived ease of use, usefulness, safety, and enjoyment were found to be important for acceptance. These elements should guide future research in designing mobile applications for diabetic elderly healthy diet education.

Keywords: *Diabetic Elderly, Healthy Diet Education, Mobile Application, Application Design, Conceptual Framework*

INTRODUCTION

The global population is ageing, and with it, the prevalence of chronic conditions such as diabetes is on the rise (Jinglong et al., 2023). Diabetes, particularly among the elderly, poses significant public health challenges due to its complex management requirements and the need for continuous medical care (Nicolaou et al., 2022). Therefore, it is important to understand the social, cultural, and psychological aspects of diabetes management among elderly people to provide a potential solution which includes exploring how social structures and individual behaviors intersect to influence health outcomes in this demographic (Libiseller et al., 2020).

For elderly people living with diabetes, possessing accurate health diet knowledge is crucial for effective disease self-management (Ojo et al., 2024). Moreover, it is reported that maintaining a healthy diet is critical to managing their condition and preventing complications (Papathanail et al., 2023). However, there is a significant gap in their knowledge about proper dietary practices. Despite the critical role of diet in diabetes management, many elderly people lack access to effective education on this healthy diet knowledge (Fu et al., 2024). This knowledge gap can lead to poor health outcomes, underscoring the need for targeted educational interventions that can reach and engage the diabetic elderly effectively (Hernandez et al., 2016).

In the digital age, mobile applications have emerged as potential interventions for health diet education, offering a promising avenue to address the educational deficit among the elderly diabetic population. These applications can provide personalized diet recommendations, monitor dietary habits, and offer real-time feedback (Carey et al., 2018). Despite their potential, current mobile applications face challenges in achieving widespread acceptance and use among the elderly. Such as there is a lack of research on the difficulties or obstacles that diabetic elderly may encounter when using mobile applications. This highlights the importance of addressing issues related to acceptance and usability to improve the overall experience for these users (Shahbazi et al., 2021).

[1] Department of Industrial Design, Faculty of Design and Architecture, Universiti Putra Malaysia, Serdang, Malaysia, E-mail: likinglong@126.com

[2] Department of Industrial Design, Faculty of Design and Architecture, Universiti Putra Malaysia, Serdang, Malaysia,. Malaysian Research Institue on Ageing (MyAgeing), Universiti Putra Malaysia, Serdang, Malaysia E-mail: rosalam@upm.edu.my, (Corresponding Author)

[3] Department of Computer and Communication Systems Engineering, Faculty of Engineering, Universiti Putra Malaysia, Selangor, Malaysia E-mail: faisul@upm.edu.my

[4] Faculty of Education, Universiti Kebangsaan Malaysia, Selangor, Malaysia; E-mail: p115780@siswa.ukm.edu.my

To address the issue of mobile application adoption among the elderly, the purpose of this paper is to identify crucial factors that contribute to the identification of variables to develop a comprehensive conceptual framework to guide mobile application design to better educate diabetic elderly on healthy diet knowledge. Furthermore, this research is significant as it addresses a crucial public health challenge by exploring the challenges and barriers faced by diabetic elderly in using mobile applications that meet their specific needs and improve their knowledge of healthy diets as well this conceptual framework can provide actionable insights for healthcare providers, app developers, and policymakers. The ultimate goal is to improve the accessibility and effectiveness of diet education for elderly diabetic individuals, thereby contributing to better health management and quality of life for this vulnerable demographic.

METHODOLOGY

This paper adopts a four-step method to propose a conceptual framework for designing mobile applications that educate and improve the healthy diet knowledge of diabetic elderly. The proposed four-step method is illustrated in Fig. 1. The first step involves identifying the target users, which in this case are diabetic elderly who will use mobile applications. Understanding their unique needs and limitations is critical in the app design process. The second step entails conducting a literature review process that collects relevant data and variables through the "Literature Review Synthesis Process" (Ibrahim, 2008). Topics were identified based on Ibrahim's research question's construct categorization technique for identifying four different RQ constructs— "WHO", WHAT", "HOW1" and "HOW2"—to formulate research questions and keywords. In this paper, WHO is diabetic elderly, WHAT is mobile applications, HOW1 means a healthy diet, and HOW2 refer to knowledge education. According to four RQ constructs, four topics can be defined to collect the articles: a) the need for healthy diet education among diabetic elderly; b) factors that influence diabetic elderly's learning healthy diet knowledge; c) key elements that influence the smart product design for diabetic elderly; d) factors that influence the acceptance among the elderly. The search for relevant articles was conducted under these keywords: ("type II diabet*" OR diabet*) AND (old* OR elder* OR aged OR senior*) AND ("mobile application*" OR "app*" OR "mobile app*") AND (diet* OR "healthy diet*") AND ("knowledge education") through Google Scholar, Scopus, PubMed and Web of Science databases. After those titles were searched and abstracts screened among the whole research articles from 2014 to 2024, 75 articles were initially identified. The original literature was manually screened. Inclusion criteria were: (1) research with diabetic elderly aged over 55; (2) elderly people using mobile applications; (3) Mobile applications as a major tool or intervention for education healthy diet knowledge. Exclusion criteria were: (1) young diabetic patients, but not type 2 diabetes; (2) Health diet intervention out of mobile applications. According to the criteria, 29 articles were finally selected for this review through a detailed search inquiry. The third step is to identify the key variables that influence the diabetic elderly's healthy diet knowledge education effectiveness. The fourth step involves identifying other important variables and relationships that affect the diabetic elderly's acceptance of mobile application education. Finally, a conceptual framework is developed based on the collected variables. Overall, this methodology provides a comprehensive approach to developing an ageing-oriented design framework for diabetic elderly mobile applications. The use of a literature review synthesis process and the identification of key variables and relationships provide a solid foundation for developing a conceptual framework that considers the unique needs and limitations of this population.
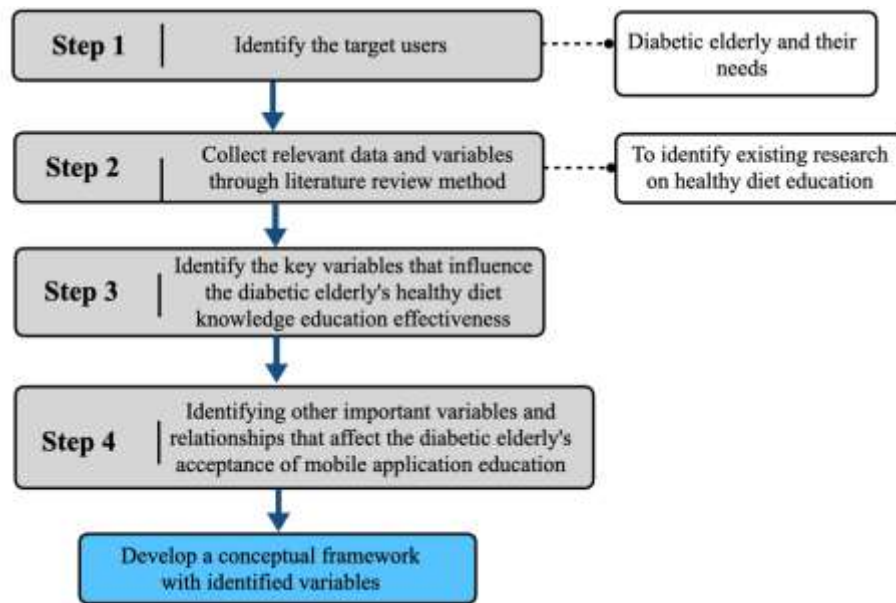
Fig. 1. A four-step method diagram, adopted from (Jinglong et al., 2024)

RESULTS

This study provides important insights into the factors that impact healthy diet education for diabetic elderly individuals, including the essential design elements that enhance the acceptance of mobile applications and other influences on educational effectiveness. The analysis centres on four key themes, which are explored in detail throughout this paper. These themes address the necessity of healthy diet education for diabetic elderly, the variables affecting their dietary habits, the critical components of mobile application design for their dietary education, and the factors influencing acceptance among the elderly. The following sections will delve into these four themes in order.

The Need for Healthy Diets Among Diabetic Elderly

The health of diabetic elderly is a complex matter that greatly affects their overall well-being. Managing their condition effectively presents challenges, and this section elaborates the specific needs of the diabetic elderly in Fig. 2. These needs encompass diabetes care, the prevention and management of complications, and overall health management. Furthermore, this review highlights the critical role of adhering to a healthy diet in achieving the best health outcomes for elderly patients with diabetes.
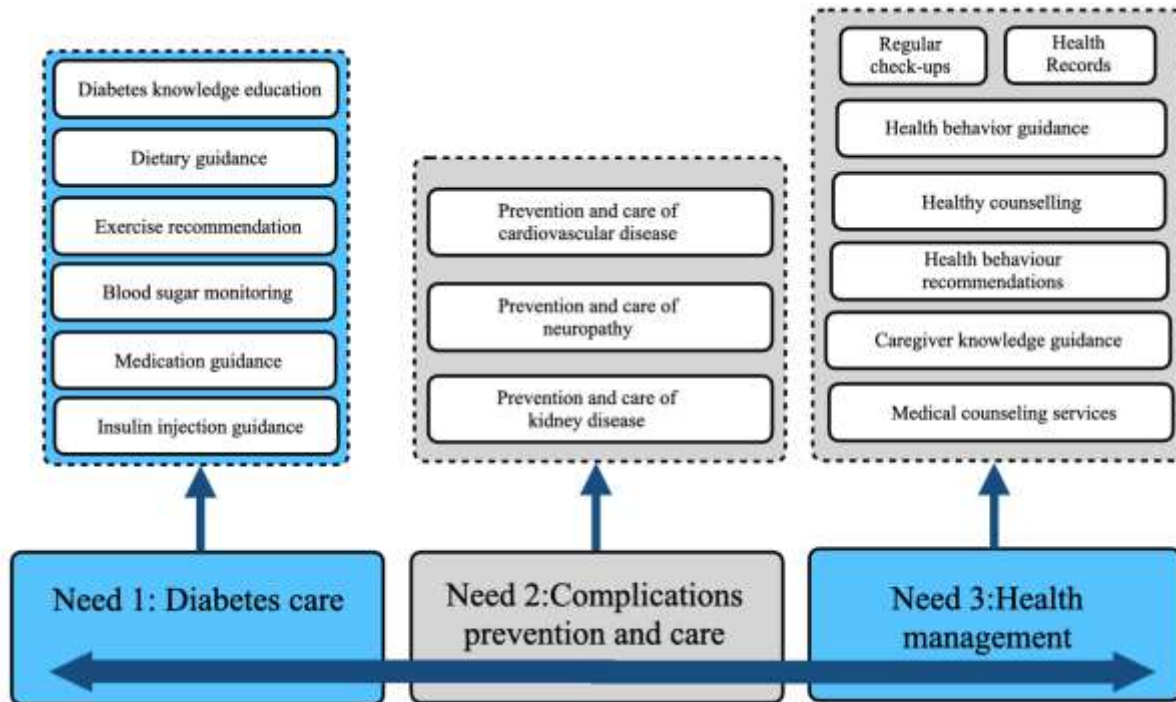
Fig. 2. Three main specific needs of diabetic elderly

Firstly, providing effective diabetes care is crucial for managing the health of elderly diabetic elderly. This care involves several key aspects, including educating diabetes knowledge education, offering dietary guidance, providing exercise recommendations, blood sugar monitoring, and offering guidance on medication and insulin injections (Ashrafzadeh & Hamdy, 2019). Among these components, Dietary guidance is especially important among these components due to its ability to regulate blood sugar levels and lower the risk of diabetes-related complications, ultimately supporting better health outcomes in elderly individuals with diabetes (American Diabetes Association, 2020). Studies have shown that elderly individuals with diabetes who follow a healthy diet tend to achieve better glycemic control and have a lower risk of diabetes-related complications. As a result, incorporating healthy eating and regular exercise into diabetes care is an effective first step in preventing type 2 diabetes mellitus among the elderly with diabetes (Ellahham, 2020). It's essential to recognize that diabetic care is focused on preventing the onset of complications related to diabetes in the elderly population.

As time goes on, if diabetes in the elderly is not properly managed, it can result in various complications, such as cardiovascular disease, neuropathy, retinopathy, and kidney disease (Harding et al., 2019). As a result, their quality of life can be greatly diminished. Thus, managing diabetes-related complications has become a top priority in the care of elderly individuals with diabetes. Implementing a healthy diet is widely recognized as an effective approach to preventing these complications (Ma, 2018). Research indicates that healthy diet interventions can enhance cardiovascular risk factors and substantially lower the likelihood of developing related complications (Cole & Florez, 2020). Therefore, offering healthy diet recommendations to elderly individuals with diabetes can enhance their quality of life and help prevent diabetes-related complications. Achieving this requires proper health management throughout the diabetes treatment process.

Effective diabetes management in the elderly requires a thorough approach to health management (Adu et al., 2019), which involves a variety of healthcare services, including regular health check-ups, guidance on healthy behaviors, and health counseling (Shan et al., 2019). The specific needs outlined in Fig. 3 highlight the critical role of health records, medical consultation advice, caregiver knowledge, and health behaviour recommendations in addressing the requirements of elderly individuals with diabetes. These areas are essential and should be explored further in future research. (*Individualized and Precision Health Management for Diabetes:*

Evidence from the Latest Guidelines and Development Prospects in China   .Pdf, n.d.). In summary, the primary needs of elderly individuals with diabetes include managing diabetes care, preventing and handling complications, and overall health management. Among these, maintaining a healthy diet is especially important for them.

As previously noted, proper and healthy diet knowledge is crucial for managing diabetes, particularly for elderly individuals with the condition (Geetha et al., 2022). To examine the dietary habits of elderly patients with type 2 diabetes, a review of relevant literature was conducted, leading to the identification and presentation of significant variables and relationships in Figure 3. The analysis uncovered three major deficiencies in the diets of elderly diabetic patients: 1) imbalanced intake of thermogenic nutrients; 2) insufficient dietary fiber intake; and 3) inadequate calcium intake. Based on these findings, specific design needs were identified: 1) balanced diet planning under the guidance of a registered dietitian; 2) increasing the intake of fiber-rich foods; and 3) providing timely feedback and guidance, nutrition education, and encouraging patients to keep dietary records and monitor their intake according to food exchange portions.
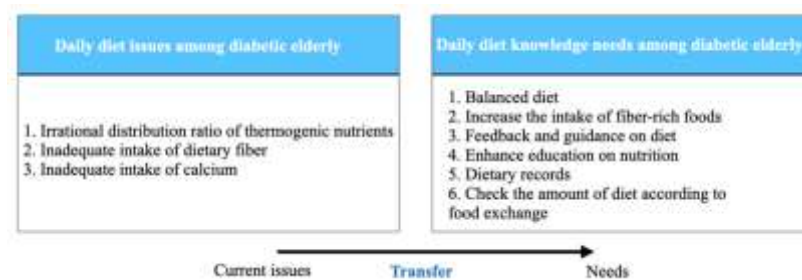

Fig. 3. Needs of diabetic elderly's healthy diet

Factors That Influence Diabetic Elderly's Healthy Diet

Although a healthy diet is essential for managing diabetes in elderly people, various factors can influence their dietary behaviours. This section explores these factors by reviewing the current literature and identifying key influences on the dietary habits of elderly individuals with diabetes. Among these, four variables—exercise, education, dietary interventions and attitude towards a healthy diet—were frequently highlighted. Consequently, this section will delve into these four factors that have a direct impact on the dietary practices of diabetic elderly, as illustrated in Figure 4 below.

Firstly, exercise plays a crucial role in helping elderly individuals with diabetes maintain a healthy weight and enhance their mental well-being (S Oliveira et al., 2020). Secondly, education is an important indicator to pose a positive influence on exercise and healthy diet attitude (B. Liu et al., 2021). Lastly, a positive attitude towards a healthy diet—marked by motivation and willingness to adopt healthier eating habits—is essential for improving dietary adherence and glycemic control in elderly diabetic patients. For instance, dietary interventions that educate elderly diabetic individuals on making healthy food choices and managing nutrition intake have been shown to foster better eating habits and glycemic control (Kollannoor-Samuel et al., 2016). Additionally, community-based intervention programs have been effective in improving diet quality and glycemic control among elderly diabetic patients (Gilson et al., 2016). These key factors are critical in enhancing dietary adherence and glycemic management in diabetic elderly populations (Li et al., 2021).
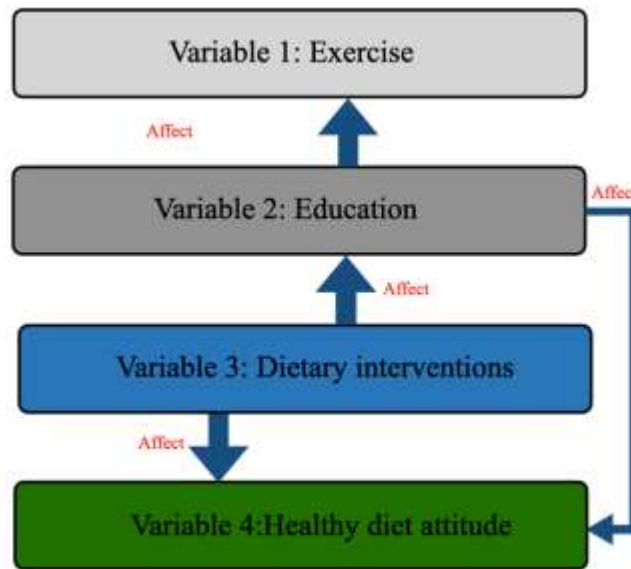
Fig. 4. Key variables that influence diabetic elderly's healthy diet

Key Factors That Influence Mobile Application Design for Diabetic Elderly

The design of mobile applications for diabetic elderly users should be guided by the principles of universalization design, usability design, and personalization design (Afra et al., 2018). These factors are crucial in ensuring that the app is accessible, user-friendly, and tailored to meet the specific needs of elderly individuals managing diabetes. The intersection of these principles helps to create a comprehensive tool that not only supports effective diabetes management but also accommodates the physical, cognitive, and emotional challenges faced by older adults (Jimenez et al., 2019).

Universal design is a foundational principle in creating mobile applications for elderly users, as it emphasizes inclusivity and accessibility for people of all abilities and ages (Fuentes et al., 2022). This approach involves designing interfaces that are easy to use and understand, regardless of the user's physical or cognitive abilities. For example, the use of large, high-contrast text and simplified navigation can greatly enhance accessibility for elderly users who may have vision impairments or limited dexterity (Remillard et al., 2024). A study by the International Journal of Human-Computer Studies highlights that universal design principles, such as using clear and simple layouts, can significantly improve the usability of mobile applications for older adults (Y.-C. Liu et al., 2020).

Usability design focuses on making the application intuitive and easy to use, which is particularly important for elderly users who may not be as familiar with technology (Oesch et al., 2017). This involves creating user interfaces that are straightforward and minimizing the complexity of interactions. For instance, features like large, well-labelled buttons, voice commands, and straightforward navigation paths can help users with limited technological experience (Ittarat et al., 2023). Research conducted by the Journal of Usability Studies (2020) indicates that applications designed with user-friendly interfaces and clear instructions lead to higher satisfaction and lower frustration among elderly users (Boele et al., 2023).

Personalization design takes into account the unique needs and preferences of individual users, allowing the app to be tailored to each person's specific requirements (Yates et al., 2023). For elderly users with diabetes, this might include customizing the app's functionality to accommodate various levels of health literacy and integrating features that address their personal health goals. For example, an app could offer customizable alerts for medication reminders and blood sugar monitoring, as well as the ability to adjust font sizes and color schemes based on individual preferences (Zhou et al., 2020). A study by Rezaee demonstrates that

personalized features, such as individualized feedback and adjustable settings, can enhance user engagement and improve health outcomes for elderly users (Rezaee et al., 2023).
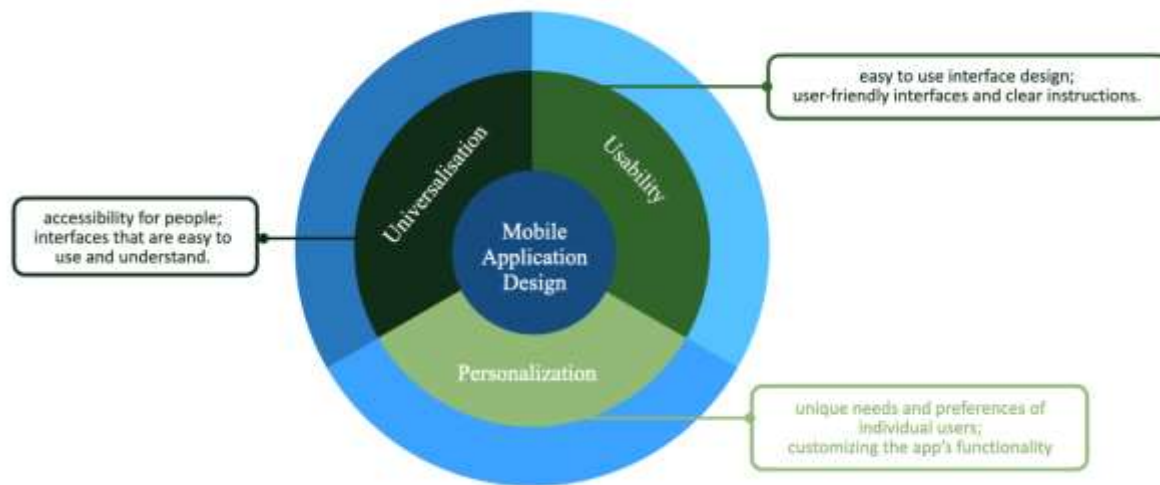

Fig. 5. Key variables that influence mobile application design

By incorporating these design principles—universal design, usability design, and personalization design—mobile applications can effectively meet the needs of elderly users with diabetes. Ensuring accessibility, ease of use, and personal relevance not only improves the functionality of the app but also supports better management of diabetes and enhances the overall user experience.

Factors That Influence Healthy Diet Knowledge Education Acceptance Among Diabetic Elderly

The design of mobile applications for elderly users should consider both their needs and specific design factors to ensure high acceptability (Street et al., 2022). Although elderly users' needs can indirectly affect their acceptance of mobile applications, direct acceptance determinants include perceived ease of use, usefulness, safety, and enjoyment (Street et al., 2022). Among these factors, perceived ease of use and usefulness are particularly significant in driving elderly users' acceptance of mobile applications. Designers should also consider self-effency and enjoyment as important factors that can influence elderly users' willingness to adopt such applications (Choi et al., 2020). By prioritizing these factors, designers can develop mobile applications that meet the needs of elderly users and increase their acceptance and adoption of these applications, ultimately enhancing their independence and educating their healthy diet knowledge (Chang & Nam, 2021).

The perceived enjoyment of mobile applications for elderly users is influenced by both usability and personalization design, while the perceived usefulness is mainly affected by the personalization design of mobile applications (Maswadi et al., 2022). The perceived ease of use of smart appliances, which is crucial for elderly users, is determined by all design elements, including appearance, function, and interaction design. Furthermore, the self-efficiency of mobile applications is mainly related to personalization and interactive usability design. It is worth noting that the interaction interface, as the carrier of the function, is closely related to all design factors and is an important consideration in mobile application design (Rafique et al., 2020).

DISCUSSION

This article explored the essential variables and factors related to the acceptance of mobile applications by elderly users. The findings of this review underscore the multifaceted challenges in managing diabetes among elderly people, highlighting significant gaps in healthy diet knowledge, the need for personalized dietary

suggestions, and barriers to effective glucose monitoring and physical activity. Addressing these issues requires targeted educational interventions that dispel misconceptions, practical and individualized nutrition plans, user-friendly glucose monitoring technologies, and accessible, enjoyable physical activities. Incorporating these strategies into clinical practice and public health policies can enhance diabetes management and improve health outcomes for elderly people with diabetes.

Based on these findings, the present study proposes a conceptual framework Figure. 6 that outlines the relationships between key variables influencing the acceptance of smart products by the elderly. The framework identifies three design variables during the mobile application design, including personalization, usability, and universal design, and their varying degrees of positive influence on factors related to acceptance. Among these variables, personalization design is the most critical, directly impacting all aspects of elderly users' perceptions of the mobile application, which means the personalization design has a significant influence on perceived ease of use, perceived usefulness, self-efficiency and perceived enjoyment. The usability design influences the perceived ease of use, self-efficiency and perceived enjoyment, while the universal design affects the perceived ease of use. Additionally, the four critical acceptance factors can guide and inspire improvements in the factors of mobile application design. By considering these design factors and their impact on acceptance factors, designers can develop mobile applications that cater to the needs and preferences of diabetic elderly and ultimately enhance their acceptance and adoption of these applications.
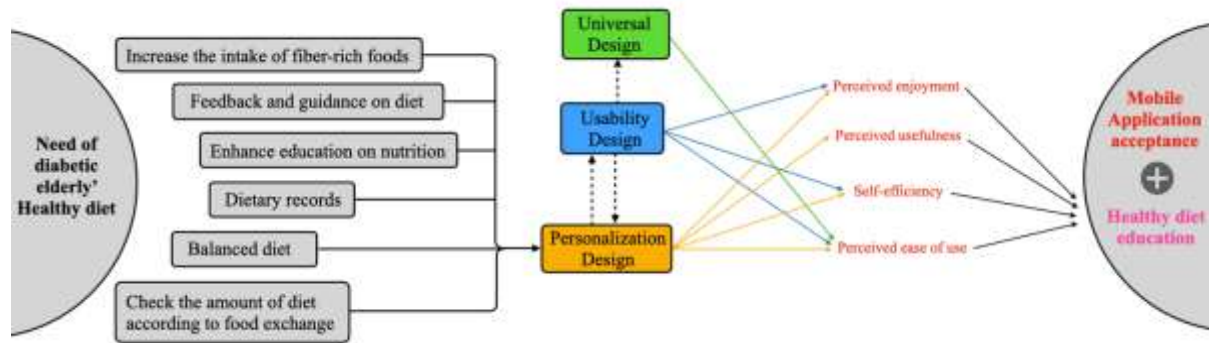

Fig. 6. An interdisciplinary concept framework for mobile applications to educate healthy diets for diabetic elderly

CONCLUSION

In conclusion, the proposed conceptual framework highlights the relationship between healthy diet needs, design factors, and acceptance factors. Results indicate that mobile applications with useful, easy-to-use, enjoyable, and self-efficiency variables are most appealing to the diabetic elderly. It is essential to promote the perceived usefulness and ease of use of mobile applications among the elderly by improving the personalization and usability variables of mobile application design. These findings have important implications for researchers, designers, healthcare providers, and policymakers working towards improving the health and well-being of diabetic elderly individuals. Despite the insights provided by this conceptual framework, several limitations and future challenges must be acknowledged. Many studies relied on self-reported and literature review data, which can be subject to biases and inaccuracies. Future research should use qualitative methodology such as interviews to enhance data reliability. Another challenge is the integration of these interventions into real-world settings, considering the development of user-friendly, cost-effective products that can be widely adopted by elderly populations with varying degrees of technological literacy.

Acknowledgement

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