



The Effectiveness of Digitalization in Family Caregiver Empowerment Model (FCEM) for Reducing Diabetes Incidence in Rural Areas: An App-Based Literature Review Study

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A B S T R A C T

Diabetes mellitus (DM) is a condition characterised by anomalies in insulin production, action, or both, which result in hyperglycemia and insufficient management of blood glucose levels. Patients, their families, and the healthcare system must bear a heavy burden when it comes to the long-term management of diabetes mellitus (DM) via medication and lifestyle changes. To lower the prevalence of diabetes, especially in rural regions, this project aims to explore the possibility of incorporating the Family-Centered Empowerment Model (FCEM) into a digital application. Using a literature review technique, this study gathered information from books, articles from relevant organizations, and journal publications. The search was conducted using keywords like Empowerment, Family, Diabetes, Telehealth, and FCEM to find sites that fit the inclusion requirements. According to the findings, the FCEM intervention significantly improves quality of life, psychological management, physical activity, and health education in addition to encouraging lifestyle changes. Additionally, it raises health literacy, which boosts psychological support, increases adherence to blood sugar management, and lessens disease-related anxiety.

INTRODUCTION

Diabetes mellitus (DM) is characterized by inadequate blood glucose control (Sapra & Bhandari, 2022). It manifests as elevated blood glucose levels or hyperglycemia, resulting from abnormalities in insulin secretion, insulin action, or a combination of both (Banday et al., 2020). Managing DM requires long-term treatment and lifestyle modifications, which place considerable burdens on both patients and healthcare systems (Al-Matrouk & Al-Sharbati, 2022).

DM significantly impacts various aspects of life, including physical, psychological, and social well-being. It is associated with numerous short- and long-term complications that may impair the ability to work or engage in daily activities (Puspasari & Farera, 2021). Therefore, healthcare support and continuous monitoring are crucial to ensure effective blood sugar control and successful patient rehabilitation. Furthermore, such support enhances patient satisfaction, improves healthcare quality, and reduces overall healthcare costs (Tekir et al., 2021). This aligns with the Sustainable Development Goals (SDGs), particularly Goal 3, which focuses on ensuring healthy lives and promoting well-being.

Globally, DM cases have been increasing. As of 2021, 536.6 million people were living with diabetes, with this figure expected to rise to 783.2 million by 2025 (International et al., 2021). In Indonesia, diagnosed DM cases rose from 1.5% to 2% between 2013 and 2018, according to the Ministry of Health

(2018). Indonesia now ranks fifth globally, with 19.5 million diabetes patients, and the number is projected to reach 28.6 million by 2045 (International Diabetes Federation, 2021).

The current era, marked by the Fourth Industrial Revolution and the transition towards Society 5.0, is characterized by rapid technological advancements and globalization. These changes present opportunities to positively impact health outcomes through economic, social, and political development (Jani, Joshi, & Mehta, 2019). Addressing the rising incidence of DM requires empowering patients using digital tools that align with contemporary needs.

Digital health empowerment goes beyond process modifications, serving as a tool to help healthcare providers maintain engagement with patients (Foadi & Varghese, 2022). Empowering DM patients through digital platforms simplifies disease management and reduces healthcare costs while addressing primary healthcare needs. However, many existing technologies remain limited to measuring specific physiological parameters and lack comprehensive healthcare integration (Andreoni, Caiani, & Castaldini, 2022).

Empowerment, a central concept in social work, involves equipping individuals to exert influence over their lives (Joseph, 2020). Empowering caregivers in the context of DM management considers factors such as cultural beliefs, caregiving responsibilities, and available resources to improve outcomes (Rondhianto, 2021). Family-centered care plays a critical role in DM management by supporting caregivers in planning care strategies (Luthfa & Ardian, 2019). Empowered caregivers can enhance diet regulation, physical activity, medication adherence, glucose monitoring, and foot care (Rondhianto et al., 2022).

Rural areas, defined as regions where agriculture is the primary livelihood, require interventions tailored to local cultural and environmental contexts (Susanto, 2022). Farmers in these areas face health risks linked to their work environment and activity patterns. Health interventions must consider the sociodemographic, occupational, and environmental factors that influence diagnoses in rural populations (Susanto, 2022).

In response to these challenges, various diabetes management applications, such as Track-3 Diabetes Planner, Diabetes Checker, and DM Assistant, have been introduced. However, these applications face limitations, including the absence of theoretical frameworks and insufficient integration with healthcare services. Addressing these gaps requires a sustainable healthcare model that integrates digital solutions with broader healthcare infrastructure.

METHOD

The writing method employed in this scientific work is through a narrative literature review, which is one of the methods without a systematic approach. The narrative method aims to summarize previous research findings, reduce duplicate publications, and identify new studies. Articles were obtained through Google Scholar, NCBI, ProQuest, Science Direct, and Scopus. Several steps in the narrative review include literature searches in databases that meet the criteria. Keywords will be identified to find sufficiently relevant articles and synthesize findings from selected articles for integration into the manuscript.

Inclusion Criteria	Exclusion Criteria
a. The research design of the analyzed articles includes randomized controlled and quasi-experimental designs.	a. Studies deviating from the intended topic;
b. The study participants in the research articles are families with diabetes mellitus patients.	b. Articles lacking in full paper content;
c. The Family Caregiver Empowerment Model (FCEM) involves primary healthcare providers, particularly nurses.	c. Articles containing only abstracts;
d. The articles are written in either Indonesian or English.	d. Articles derived from conferences or proceedings;
e. The articles were published between the years 2019 and 2023.	e. Articles published in more than one journal, in which case one of them is retracted;
f. The articles elaborate on the relationship between family empowerment and the incidence of diabetes mellitus.	f. Articles retracted due to violations of publication ethics;
	g. National journals that do not include a type-setting examination.

Table 1. PICO

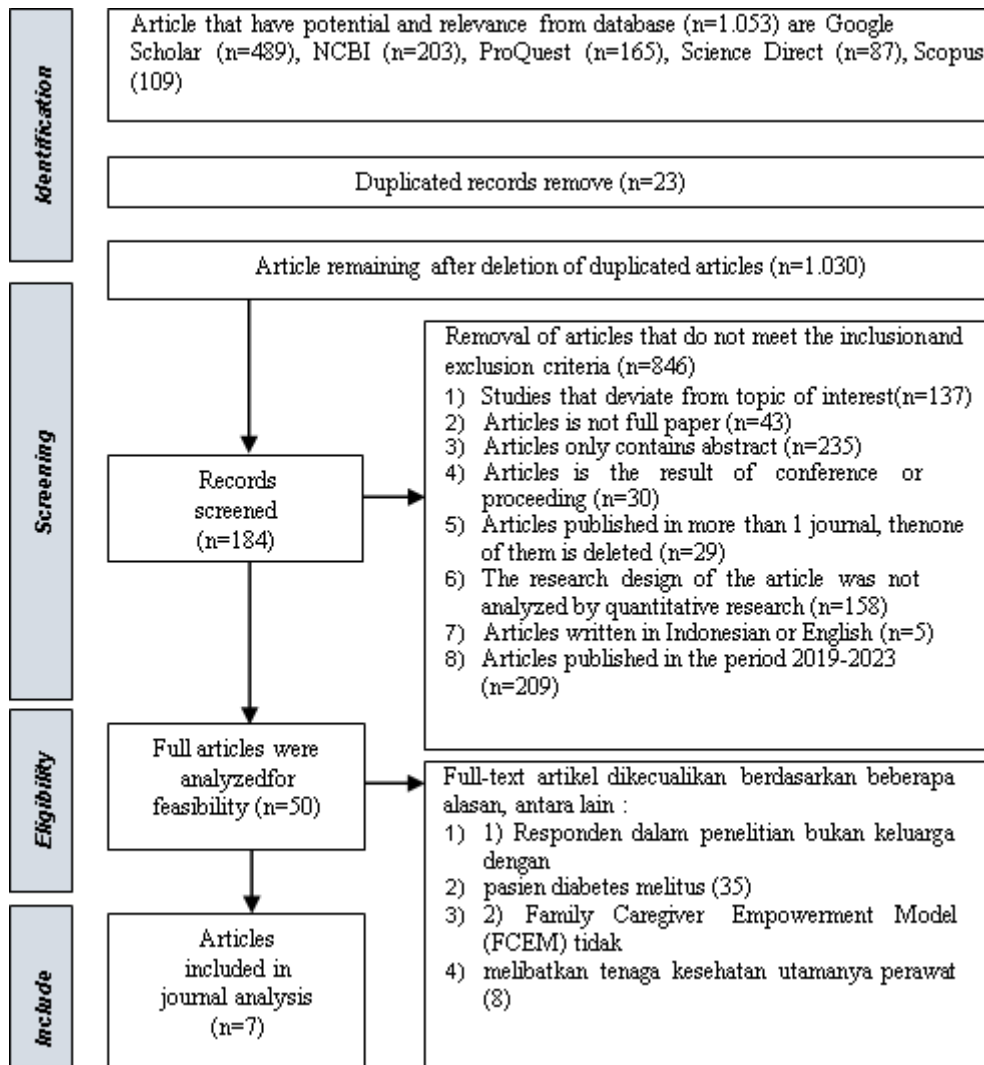
Analysis	Contents
Problem/Population	Sufferers of diabetes in rural areas.
Intervention	Digitization of the Family Caregiver Empowerment Model (FCEM) based on an application.
Comparison	Existing programs are not operating optimally due to time and cost constraints.
Outcome	Reduction in the incidence of diabetes and improvement in disease management.

Data Selection

The potential and relevant articles identified from electronic databases (n=1,053) include Google Scholar (n=489), Science Direct (n=87), Scopus (n=109), NCBI (n=203), and ProQuest (n=165). Duplicate records were removed (n=650). Elimination of articles not matching keywords and abstracts was conducted (n=219). Articles deemed not highly relevant based on inclusion and exclusion criteria were excluded (n=134). Full-text articles were assessed for eligibility and analyzed (n=50). Full-text articles were excluded for several reasons, including 1) Lack of relevance to the issue of stunting (n=36), and 2) The Family Centered Care theory does not involve healthcare professionals, particularly nurses (n=8). Research articles included in the main journal analysis amounted to six (n=6). Article selection, as

depicted in the PRISMA diagram, resulted in obtaining and analyzing six articles, as presented in Table 2 of the article analysis.

Figure 1. PRISMA Diagram



RESULT

Table 2. Analisis Jurnal

Author & Tahun	Judul	Negara	Jumlah Responden	Metode	Hasil
Yazdanmanesh et al (2023)	Relieving care burden and promoting health-related quality of life for family caregivers of elderly people with Alzheimer's disease via an empowerment program	Iran	70 responden	Experimental study	The decrease in care burden and improvement in health-related quality of life among Alzheimer's patients based on the Family Caregiver Empowerment Program show significance with the value of $p < 0.001$
Shoghi et al (2019)	The Effect of the Family-Centered Empowerment Model (FCEM) on the Care	Iran	78 responden	Quasy Experimental	The influence of FCEM on caregiving burden in children with cancer is evidenced by a p-value of < 0.001 .

Burden of the Parents of Children Diagnosed with Cancer					
Jafari et al (2020)	Family-centred empowerment program for health literacy and self-efficacy in family caregivers of patients with multiple sclerosis	Iran	70 responden	Quasy Eksperimental	Health intervention with FCEM can enhance health literacy and self-efficacy among caregivers of sclerosis patients, with a significant value of $p < 0.001$.
Hsu et al (2023)	Applying the theory of planned behavior to investigate type 2 diabetes patients' intention to receive injection therapy	China	254 Responden	Randomized Controlled	FCEM has an impact on care burden and can enhance the role of caregivers in elderly individuals with Parkinson's, as demonstrated by a significant value of $p < 0.001$
Mahdi et al (2020)	The Effect of Family Empowerment in Nursing Implementation Toward Self-Efficacy among Patients with Diabetes Mellitus	Indonesia	40 responden	Quasy Eksperimental	The influence of FCEM on increasing motivation and self-efficacy in patients with diabetes mellitus is observed with a value of $p < 0.05$
Shahabi et al (2022)	The effect of telenursing training based on family-centered empowerment pattern on compliance with diet regimen in patients with diabetes mellitus type 2: a randomized clinical trial	Iran	60 responden	Randomized Controlled Trial	FCEM through telenursing affects the improvement of dietary compliance in diabetic patients, with a significant value of $p < 0.001$.
Deyhoul et al (2019)	The effect of family-centered empowerment program on the family caregiver burden and the activities of daily living of Iranian patients with stroke: a randomized controlled trial study	Iran	90 responden	Randomized Controlled Trial	There is an increase in the quality of life of stroke patients and a decrease in caregiving burden for stroke patients through FCEM, with a significant value of $p < 0.001$.

1. Development Trends of Diabetes and Technology

Diabetes stands as one of the largest global public health challenges, imposing a substantial burden on public health and socio-economic development. While its prevalence is decreasing in some countries, diabetes has surged over the past decades in most developed and developing nations. In 2021, a staggering 536.6 million individuals worldwide were diagnosed with diabetes, and this figure is projected to rise to 783.2 million by 2025 (IDF, 2021). Paradoxically, Indonesia currently ranks fifth globally, with 19.5 million individuals afflicted by diabetes, which is expected to escalate to 28.6 million by 2045 (International Diabetes Federation, 2021). Diabetes has become a leading global cause of death, contributing to over 80% of premature deaths from non-communicable diseases (NCDs). Individuals with diabetes face a 2-3 times higher risk of all-cause mortality. The presence of diabetes is associated with increased mortality from infections, cardiovascular diseases, stroke, chronic kidney disease, chronic liver

disease, and cancer. Despite progress in promoting population health and extending life expectancy, diabetes remains the second-largest negative contributor to global health-adjusted life expectancy (Chen et al., 2019).

In the current era of globalization and the rapid growth of technology, entering the 5.0 era of society provides an opportunity to develop internet connectivity and applications tailored to public health needs. This is supported by the increasing number of internet users in Indonesia, reaching 171.17 million, accounting for 64.8% of the total population (Mudawamah, 2020). Internet usage percentages based on age indicate 74.23% for those aged 19-34 and 44.06% for those aged 35-54. Regarding economic class, 58.55% of lower-class individuals and 82.95% of middle-class individuals use the Internet. Regarding health applications, 51.06% of individuals search for health information online, and 14.05% use the Internet to consult with healthcare professionals. Given the sophistication of the current digital era, these figures are expected to rise over time.

2. Utilization of Applications in Family Empowerment

The current use of applications extends to health interventions, as applications can serve as promotive, preventive, and rehabilitative tools (Novianto et al., 2019). Current health applications focus on increasing knowledge and promoting healthy lifestyles to empower individuals or groups. Mobile technology has successfully integrated into people's lives from all walks of life due to its low cost, mobility, and time efficiency (Suciati, 2022).

This increase should be maximized, and one way to do that is through digitizing empowerment. This is supported by the fact that the number of healthcare workers in Indonesia is far below the standard, considering the country's population. Additionally, the chronic and lifelong nature of diabetes suggests the need for comprehensive interventions (Sulastri et al., 2023). Consistency in treatment is the solution to diabetes-related problems, contrasting with challenges such as quantity, mobilization, time, and costs. Empowering clients and their environment through digital empowerment are the way to initiate and improve diabetes treatment consistency. The empowerment application will address issues related to the quantity of healthcare workers, mobilization, time, and costs (Suciati, 2022).

3. The FCEM Theory in Application and Family Empowerment

The Family Caregiver Empowerment Model (FCEM) broadly focuses on promotive, preventive, and rehabilitative efforts in integrated management. As analyzed earlier, the inclusion of a supportive environment in consistent treatment is essential. Shahabi et al. (2022) asserts that the interpretation of FCEM in applications significantly influences the improvement of dietary compliance in DM patients, with a p -value < 0.001 . This statement reinforces the fact that there is an increase in motivation and self-efficacy in DM patients through application-based empowerment using the FCEM theory (Mahdi et al.,

2020). Moreover, based on previous research, there is a general improvement in the quality of life for both patients and their families after a series of application-based empowerment interventions, not only for diabetes patients but also for several other chronic long-term diseases.

DISCUSSION

1. Effectiveness of FCEM Digitalization

Digitalization of FCEM represents an advancement in family empowerment tailored to the society 5.0 era. The program directly integrates digitalization into the concept of family empowerment through the interpretation of the FCEM theory. The implementation process collaborates with various fields of health and sciences. The program encompasses five interventions aligned with FCEM components, such as knowledge, motivation, coping, spirituality, and perception (Liang, 2023). With the integration of the FCEM theory into each feature, the application's interventions are expected to be effective, as indicated by previous research. This application will assist patients with diabetes and their families in improving their quality of life.

2. Concept of Developing FCEM Digitalization based on Applications

The concept of telehealth will be incorporated into the application's development by adapting the FCEM theory's components. Five components will be developed in the effort to digitize family caregiver empowerment: knowledge, motivation, coping, spirituality, and perception. This digitalization of FCEM will help diabetes patients and their families enhance their quality of life. The interventions within the application, assessed or implemented over one month, will be submitted to relevant health centers for evaluation and comparison with the previous month as an assessment of the program's success and sustainability. The components in the digitalization of FCEM are as follows:

1) Screening

Screening is something that must be passed to determine the next intervention that will be recommended by the application based on level of education, health, economy, etc.

2) Education

Education in health is not only an instrument of prevention, but also the foundation for creating a healthier, more informed and empowered society. The research results of Mahdi et al (2020) explain that education in FCEM increases motivation and self-efficacy in DM patients with a p value < 0.05. These results will have implications for prevention of diabetes through empowered families or individuals.

3) Consultation

The exchange of messages via chat channels is interpreted as a form of two-way communication in which the sender and recipient are involved, supported by technology, such as communicating via messages on

applications (Greenwood et al., 2017). Short message services and multimedia messages are a practical and economical way to support self-management and provide benefits in the management of chronic diseases, such as diabetes (Huo et al., 2017). The use of chat services in the form of groups by individuals with type 2 diabetes mellitus aims to share daily experiences to improve glucose control (Wang et al., 2019; Yu et al., 2019)

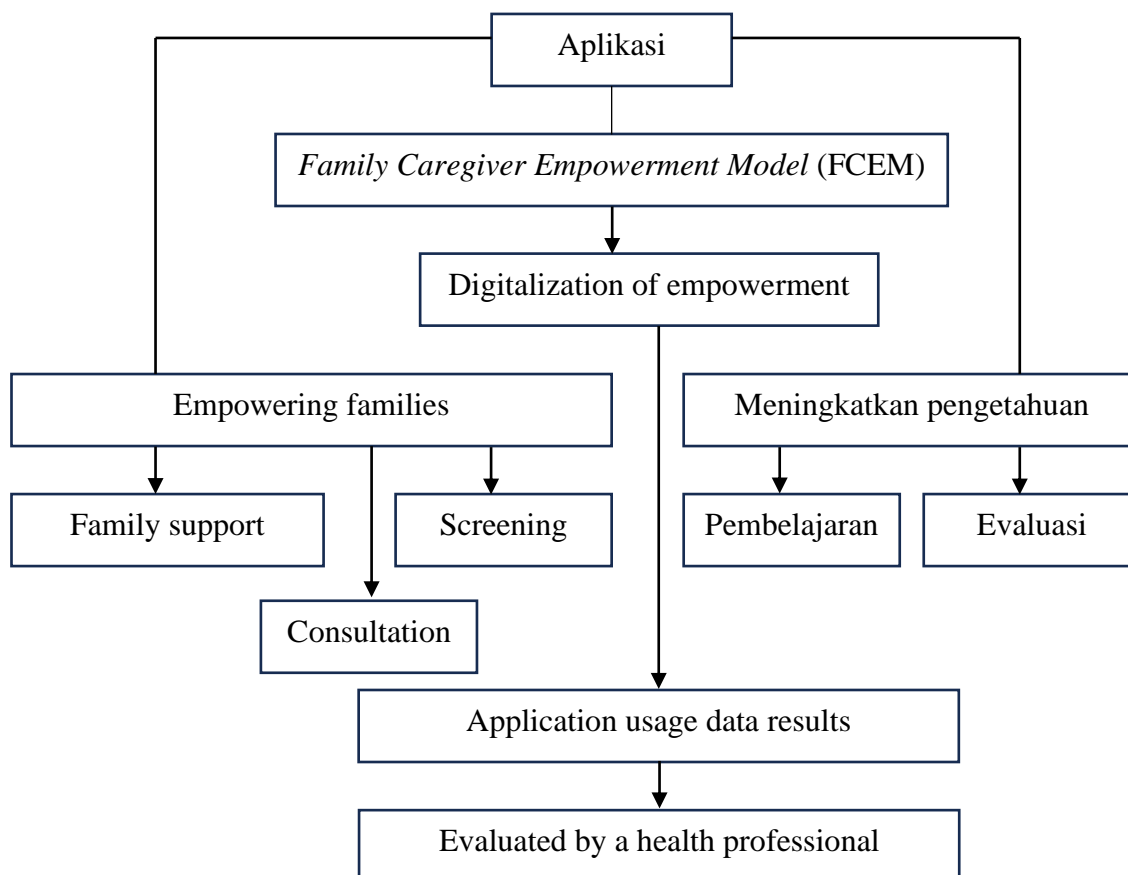
4) Support

It is an interpretation of the motivational, coping and spiritual components that will encourage the family to become a support system for patients undergoing treatment so that the family can be strengthened as caregivers and can also minimize the burden on the family. Family support can provide informative support by providing information related to diabetes problems, as well as providing emotional support such as providing motivation, calm, and accompanying when carrying out treatment. Apart from that, the family can also provide material support (Amilia, 2018).

5) evaluasi

Functioning as a post-intervention assessment, the components contained in the evaluation are the activeness and effectiveness of health workers, the level of family empowerment, and the quality of life of sufferers so that later it will become a benchmark for the success of the program and become a reference for program sustainability

3. Road Map Aplikasi



4. Implementation of Application Program as an Effort for the Digitalization of FCEM

The implementation of this application program is carried out using the Multimedia Development Life Cycle (MDLC) method, which begins with the concept stage, involving formulating the foundation of the project, its objectives, and the type of application to be developed. Subsequently, the design phase encompasses specifying the program's architecture, style, display, and material requirements. The third stage involves obtaining content material, where the collection of necessary materials or content for the application is conducted. The fourth stage, assembly, represents the production phase and requires IT expertise. After the production phase, the testing stage is conducted by applying the application on a minor scale to assess its feasibility before mass implementation. The final stage, distribution, involves disseminating the results to the target audience after confirming the application's suitability for mass implementation.

CONCLUSION

The high prevalence of diabetes in Indonesia is a critical issue that demands immediate attention. The integration of technology in the healthcare sector, particularly in the Society 5.0 era, enhances the potential to achieve the Sustainable Development Goals (SDGs) by 2030, especially Goal 3, which emphasizes the importance of addressing diabetes. One promising intervention strategy involves utilizing applications based on the Family-Centered Empowerment Model (FCEM) to empower families affected by or at risk of diabetes. This approach considers the physical, psychological, and social dimensions of care to restore patients to their highest possible level of independent function. The program within the application is designed around key components of diabetes management, including screening, education, nutrition management, and psychological support. Leveraging the Internet of Things (IoT) and featuring a user-friendly interface, the application aligns with the goals of technological advancement in the Society 5.0 era. Expected outcomes of the application's implementation include a reduction in diabetes risk, improved family health, adoption of healthier lifestyles, and an enhanced quality of life for individuals and their families.

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