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A Study on Service Model for Preventive Diabetes Care - Based on Transtheoritical Model (TTM Model)

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Introduction

1.1. Background and Purpose:
The prevalence of diabetes emphasizes lifestyle improvements in pre-onset stages to delay or prevent disease progression. Challenges arise because individuals in the prediabetes stage lack symptoms and awareness, which hinders the understanding of optimal habits. Inadequate healthcare efforts in pre-diabetes lead to low awareness and proactive prevention, necessitating an expansion of hospital-based interventions into a self-sustaining support service. The goal is to define a basic model for a diabetes prevention service based on behavior change theory. Utilizing the Hospital-Based Lifestyle Modification Program (H-LSM) and the transtheoretical model of Prochaska et al. (1983), the study proposes a user-centered, self-preventive pre-diabetes management model that aims for proactive prevention through lifestyle modification guidelines and nutrition/exercise therapies.

1.2. Scope and Methodology:
This study endeavors to formulate a foundational model for preventive management services targeting individuals in the pre-diabetic stage. Through an extensive literature review, we systematically analyzed large-scale lifestyle intervention studies to glean theoretical insights. Employing the Transtheoretical Model (TTM) as our guiding framework, we scrutinized the Korean Diabetes Prevention Study (KDPS) Lifestyle Modification program. Employing human-centered design thinking and methodology, we discerned challenges, needs, and dropout factors. Empirical research, encompassing surveys involving healthcare professionals and pre-diabetic participants, facilitated the derivation of cognitive-behavioral factors at distinct TTM stages. In conclusion, we propound a self-service model for proficient self-management, furnishing a meticulously tailored, step-by-step guide that aligns with the nuanced needs of pre-diabetic individuals at each developmental stage.

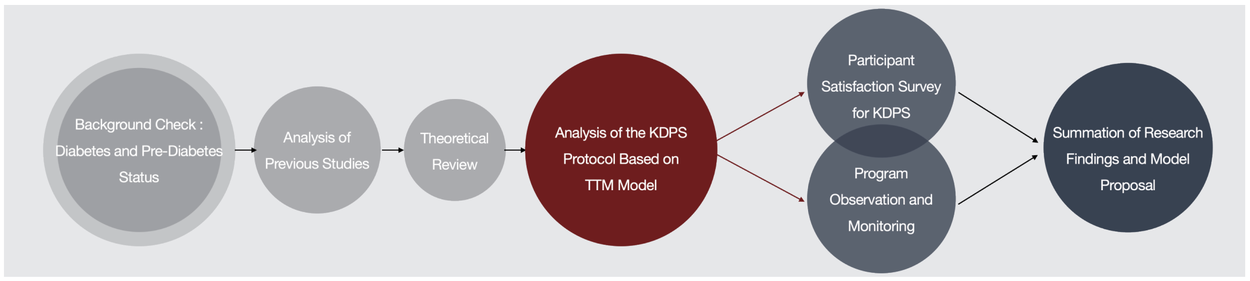

Figure 1. Research Progress

2. Analysis of Previous Studies

Lifestyle intervention refers to the provision and application of principles for maintaining and improving health through physical activity, stress management, nutrition, and non-pharmacological activities. Current management strategies for diabetes and prediabetes are divided into medical treatment and testing by hospitals and lifestyle interventions. Lifestyle intervention programs include lifestyle modification, nutritional therapy, and exercise therapy. An analysis of previous domestic and international studies implementing interventions for diabetes research was conducted [Table 1]. The results of the analysis showed that long-term, large-scale prospective studies conducted abroad reported numerous cases of diabetes reduction by lifestyle modification and drug therapy. Considering that the detailed protocols of each study were tailored to the lifestyle habits of different countries, a review of studies conducted in accordance with the domestic situation was also conducted to verify the effectiveness of lifestyle intervention therapies.

Previous Study	Target (n)	Duration	Content
DaQing Study. 1997	530	6Y	Providing either dietary modification, exercise, or a combination of both can indicate effective improvement in dietary habits for Asians.
DPS (Finnish Diabetes prevention study). 2001	522	3.2Y	Focusing on individualized dietary correction sessions and personalized physical activity correction sessions, we emphasize a one-on-one curriculum tailored to each participant.
DPP (Diabetes Prevention Program). 2002	3,234	2.8Y	The 16 individual sessions for lifestyle correction through diet and exercise are structured with an initial emphasis on information delivery for the first 8 sessions and a later focus on psychological and social motivation for the remaining 8 sessions.
Japanese Trial in IGT males. 2005	458	4Y	A study conducted on Japanese male patients with erectile dysfunction. The intervention group (lifestyle modification group) set an appropriate BMI criterion at 22 kg/m2, taking into account the physical characteristics of the Japanese population.
IDPP-1 (Indian Diabetes Prevention Program). 2006	531	3Y	Providing monthly phone sessions for physical activity and exercise advice, along with individual sessions at six-month intervals for motivation and support.
Saito T, et al. 2011	641	3Y	Offering a minimum of 9 individual lifestyle correction instructions with post-support. Providing suggestions for physical activities that can be incorporated into daily routines instead of sports or gym workouts, catering to busy individuals.
Sakane N, et al. 2011	304	304	Conducting individual consultations, group studies, food frequency surveys, and exercise journal sessions. Analyzing the reasons for dropout, identifying a tendency among middle-aged Japanese men to prioritize work over health.

Table 1. Analysis of Previous Studies on Lifestyle Intervention

3. Theoretical Review : Transtheoretical Model, TTM

This study underscores the importance of consistent diabetes management and self-care practices. It contrasts hospital-based lifestyle interventions, typically implemented on a national scale, with individual self-management services. Lifestyle interventions, which are effective over several years, require the establishment of habits for ongoing individual self-management in daily life for use as self-preventive services, such as mobile apps. While hospital-based interventions involve professional support, self-management services are challenging because they require individuals to maintain processes independently. To address this and explore effective self-service directions, the study utilizes the Transtheoretical Model (TTM) to identify methodological factors that induce lifestyle changes in the pre-diabetes stage.The stages and processes of behavior change in the Transtheoretical Model are depicted in [Figure 2].

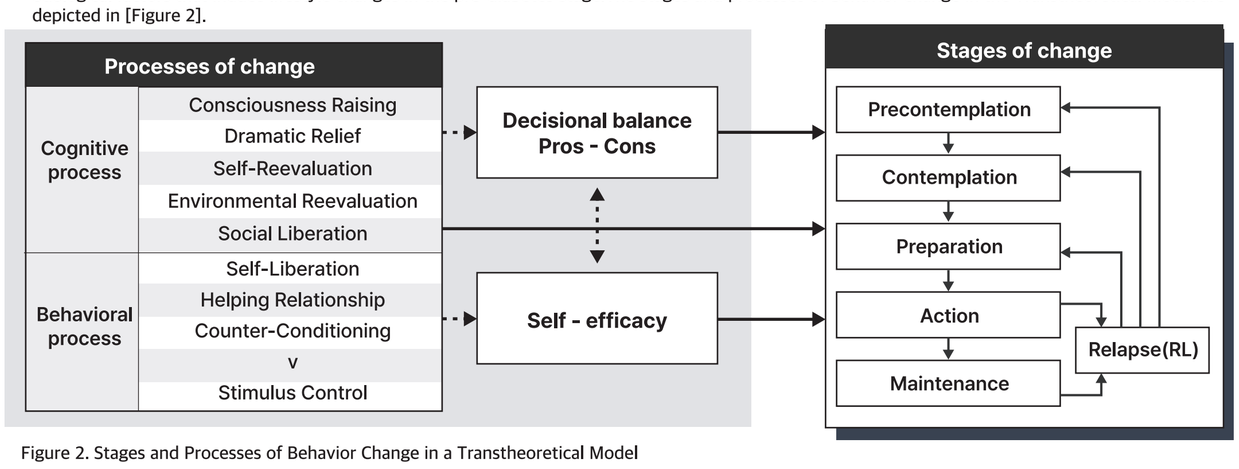

Figure 2. Stages and Processes of Behavior Change in a Transtheoretical Model

4. Analysis of the KDPS Protocol Based on TTM Model

The KDPS, in collaboration with Kyung Hee Medical Center, is conducting a clinical trial comparing hospital-based diabetes prevention methods. It evaluates standard care, medication, and lifestyle interventions for adults at high risk for type 2 diabetes. The goal is to validate the benefits of lifestyle interventions, tailor a diabetes prevention program to Korean characteristics, and establish a self-management strategy based on the Transtheoretical Model (TTM). The structure of the program is outlined in a primary framework, as shown in Figure 3.
The KDPS Lifestyle Intervention Program (LSM) offered personalized interventions such as tailored weight goals, dietary advice, and physical activity suggestions based on individual conditions. It used multiple methods, including phone calls and texts, and provided ongoing education to motivate participants. Using the Transtheoretical Model (TTM), the program focused on collecting health data in the pre-contemplation and contemplation phases to trigger cognitive changes. In the preparation stage, pre-intervention education induced significant cognitive shifts regarding the impact of current habits on health. The action and maintenance phases emphasized education about healthy habits, practical behavior change, and feedback, with phases 4 and 5 emphasizing behavioral processes such as counter-conditioning and self-liberation. Expert nutrition counseling, facility visits, and regular text/-phone interventions emphasized collaborative relationships.

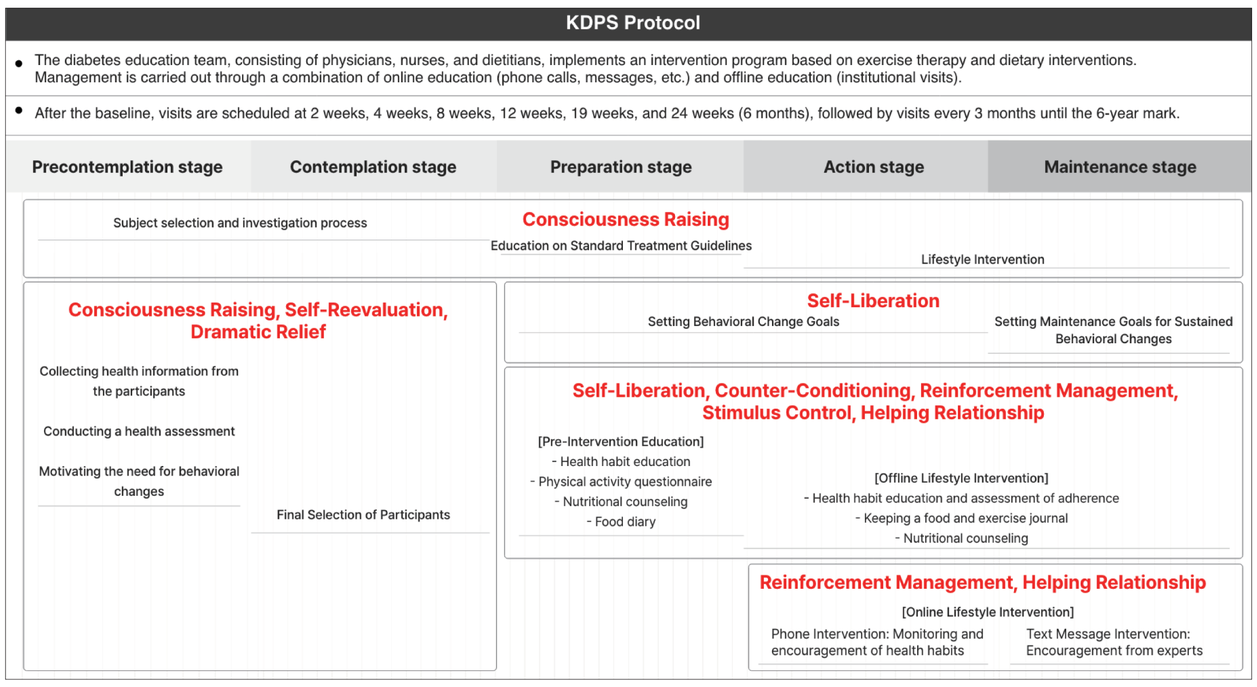

Figure 3. Analysis of the KDPS Protocol Based on the Transtheoretical Model

5. The Lifestyle Intervention Program Validation Study within the KDPS Protocol

5.1. KDPS Participant Satisfaction Survey
The KDPS Participant Satisfaction Survey, conducted in collaboration with Kyung Hee Medical Center, was designed to understand the impact of the program on the behavioral stages and changes of actual participants and to identify key behavioral drivers. The survey collected responses from 56 participants at 13 institutions. This survey used mixed methods to comprehensively examine the impact of the program on behavioral drivers and stages. The results, presented in Section 1, show increased awareness and recognition of lifestyle changes, which positively correlates with increased engagement in effective health support. Low participation is associated with cognitive challenges such as lack of time and difficulty implementing changes in real life. Positive changes in attitudes and health behaviors were observed in section 2, while potential factors for relapse were identified. Section 3 highlighted the effectiveness of face-to-face counseling and collaborative relationships, along with key elements for relapse prevention, including ongoing education, reminders, and alternative actions. Stimulus control, reinforcement management, and counterconditioning played an important role.

5.2 Program Observation and Monitoring
The study used program observations and in-depth interviews to analyze Transtheoretical Model (TTM) behavioral factors in the service contact process among participants, clinical dietitians, and counselors. The qualitative methodology was designed to complement the quantitative survey results and identify TTM behavioral factors in actual provider-patient interactions to support effective service designs.
In the LSM group, after six months of participation, participants received offline education every three months that included health habit education and physical activity assessments. If the target weight was not maintained for more than six months, the researchers provided additional nutritional counseling at their discretion, even at 18 months. This nonlinear process of behavior change, combined with tailored interventions in the KDPS, is consistent with the goals of the service model study.
Nutrition counseling focused on providing practical dietary recommendations for daily living. Counseling used food diary details to identify alternative behavioral substitutions and used visual aids such as food models to increase awareness. Lifestyle counseling combined practice assessment and physical activity results to provide personalized guidance for changing participants' lifestyle patterns and achieving self-liberation. Counselors established a strong supportive relationship by setting and reviewing achievements and goals together.

6. Summation of Research Findings and Model Proposal

In this study, we propose a self-diabetes prevention management service model to slow down or prevent the onset of diabetes, a representative chronic disease, by synthesizing previous studies and empirical research. Unlike existing management services for diabetics, this service model is a mid- to long-term perspective-based service that considers cognitive and behavioral change factors of prediabetes, and presents the process structure and functions of preventive services for users' life modification according to the five stages of behavior change. The final model was constructed as Figure 4.

6.1. Precontemplation Stage Service:
Essential for initial diagnosis and change, it includes a self-health analysis feature, intuitive information visualization, and mandatory profile entry. My Diabetes Prevention Log tracks glycated hemoglobin, fasting blood glucose, and postprandial blood glucose for baseline detection.

6.2. Contemplation Stage Services:
Includes self-assessment, awareness, and motivation for behavior change. My Lifestyle Collection" tracks eating and exercise habits, emphasizing the impact on health. Features such as "Expert Lifestyle Guide Articles" and success stories reinforce the need for management. Hospital integration enables appointment scheduling and reminders to prevent dropouts. Personalized data collection facilitates behavior change monitoring.

6.3. Preparation Stage Services:
This stage entails cognitive and behavioral modifications with a focus on implementing personalized diabetes management solutions. Users are provided with expert guidance and individualized plans, including "Your Nutrition Coach," "Your Trainer," and "Your Mindfulness Coach." These features entail personalized diet and exercise plans, statistical analysis for identifying health improvement barriers, and motivational support. The Trainer offers exercise guides tailored to user preferences, designed to facilitate behavior change.

6.4. Action Stage Service :
This active phase includes nine cognitive and behavioral change factors, excluding dramatic relief. Users learn about a 60% risk reduction for diabetes through diet control, exercise, and weight management. Today's Goal Reminder" increases self-efficacy, while the "Nutrition Coach" suggests alternative meals. The Community feature encourages discussion and goal setting. Active communication among users builds trust and motivation, and emphasizes collaborative problem solving. Practical features such as coaching-based programs support habit formation. Ongoing health information, visualized goal achievement through My Health Report and Daily Quest Progress, and the Heart Care Coach increase self-efficacy and prevent dropout.

6.5. Maintenance Phase Service:
This phase involves active stimulus control and reverse conditioning. Reward systems, such as points or badges for completing daily quests, contribute to a personalized lifestyle management system that fosters user satisfaction and confidence. Suggestions for alternative behaviors, periodic health assessments, and proactive problem-solving through reminders maintain user pride, confidence, and self-efficacy. The "Health Report" is critical to maintaining health awareness, including glycated hemoglobin, fasting blood glucose, and subcutaneous glucose levels. Analysis of maintenance failures helps to tailor individualized countermeasures. Given the high risk of relapse, identifying and addressing factors that prevent continued use is critical. Community support groups and encouragement from mindfulness coaches are valuable during relapse and address users' self-esteem and confidence issues.

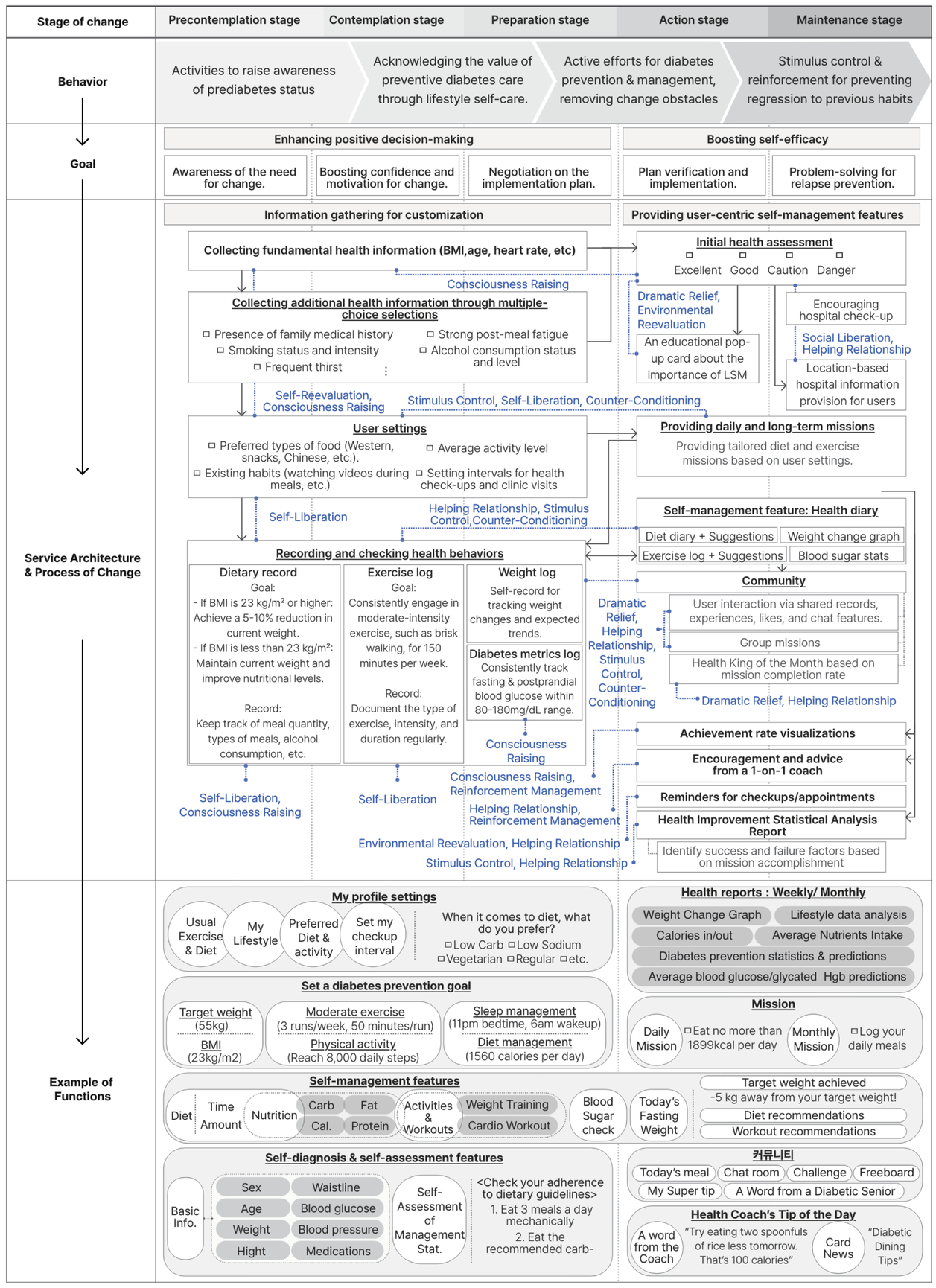

Figure 4. TTM Service Model for Preventive Diabetes Management