



EFFECTS OF DIABETES NUTRITION EDUCATION ON GLYCEMIC CONTROL AND DIABETES-RELATED OUTCOMES AMONG INDIVIDUALS WITH TYPE 2 DIABETES MELLITUS AT SELECTED HEALTH CLINICS IN PADANG, INDONESIA

By

ICE YOLANDA PURI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

December 2022

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

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ICE YOLANDA PURI

December 2022

Chairman : Professor Barakatun Nisak binti Mohd Yusof, PhD
Faculty : Medicine and Health Sciences

While structured nutrition education is vital for patients with Type 2 Diabetes (T2DM), comprehensive studies that look into the patient and the nutritionist's needs in developing and evaluating the appropriate nutrition education tools in Indonesia are scarce. Thus, this study was conducted to determine the effects of diabetes nutrition education (DNE) on glycemic control and other-related outcomes among patients with T2DM at selected health clinics in Padang, Indonesia. The study consisted of three phases based on Generalized Model for Program Planning and during the COVID-19. Phase I involved a cross-sectional need assessment survey with nutritionists (n=48) and patients (n=179) in Padang City. Phase II focused on developing and assessing DNE modules and materials based on the Health Belief Model (HBM). Phase III was a cluster randomized controlled study involving eight Public Health Centers (PHC), with 150 participants in the Intervention Group (IG; N=75) and Control Group (CG; N=75). The IG received a structured 7 sessions of DNE delivered by nutritionists at an individual level for every month within the first 3 months and came for follow-up at 6 months. Participants in the CG continued attending the regular sessions delivered by the nutritionists for the same study period. Primary outcomes measure included glycemic control (HbA1c and fasting blood glucose (FBG)), and secondary outcomes were diabetes-related, which included the nutritional status (anthropometry, blood pressure, dietary intake), knowledge-attitude practice (KAP) regarding diabetes management, and quality of life (QoL). The Phase I study identified leaflets (93.8%) as the primary material for nutrition education. The nutritionists (52.1%) were also concerned that their patients were reluctant to attend the education sessions and about 20.8% of them reported that the current materials were insufficient to attract interest, which highlighted the need to develop the DNE. In fact, nearly half of patients

with T2DM (42.3%) did not attend the nutrition education session since their doctor did not refer them to the nutritionists.

In Phase III, Baseline characteristics between the groups were comparable except for fiber intake and knowledge component in KAP, which was better in IG. At the end of 6 months, like CG, participants in IG did not improve their HbA1c, FBG, anthropometric data, and QoL, which were no different from CG. Nonetheless, a more significant improvement was observed in IG than CG for diastolic blood pressure (BP), level of KAP regarding Diabetes Management, and the component of dietary intake (energy and dietary carbohydrate, fat, and fiber). Concurrently, participants in CG achieved a substantial systolic BP improvement compared to IG participant. In conclusion, the study highlighted the need to have structured diabetes nutrition education for T2DM patients from patients themselves and nutritionists, which led to the DNE development. The delivery of DNE had shown improvement in diastolic BP and KAP regarding Diabetes Management and dietary intake. The patients and the nutritionists well accepted the DNE.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KESAN PENDIDIKAN PEMAKANAN DIABETES TERHADAP KAWALAN
GLISEMIK, DAN HASIL YANG BERKAITAN DIABETES DALAM
KALANGAN PESAKIT DIABETES MELLITUS JENIS 2 DI KLINIK
KESIHATAN TERPILIH, DI PADANG, INDONESIA**

Oleh

ICE YOLANDA PURI

Disember 2022

Pengerusi : Profesor Barakatun Nisak binti Mohd Yusof, PhD
Fakulti : Perubatan and Sains Kesihatan

Walaupun pendidikan pemakanan berstruktur adalah penting untuk pesakit Diabetes Jenis 2 (T2DM), kajian menyeluruh yang menyelidik keperluan pesakit dan pakar pemakanan dalam membangunkan dan menilai alat-alat pendidikan pemakanan yang sesuai di Indonesia adalah kurang. Oleh itu, kajian ini dijalankan untuk menentukan kesan pendidikan pemakanan diabetes (DNE) terhadap kawalan gula darah dan hasil berkaitan lain di kalangan pesakit T2DM di klinik kesihatan terpilih di Padang, Indonesia. Kajian ini terdiri daripada tiga fasa berdasarkan Model Am untuk Perancangan Program dan semasa COVID-19. Fasa I melibatkan tinjauan keperluan rentas seksyen dengan pakar pemakanan (n=48) dan pesakit (n=179) di Bandar Padang. Fasa II tertumpu pada pembangunan dan penilaian modul dan bahan DNE berdasarkan Model Kepercayaan Kesihatan (HBM). Fasa III adalah satu kajian terkawal rawak kelompok melibatkan lapan Pusat Kesihatan Awam (PKA), dengan 150 peserta dalam Kumpulan Intervensi (IG; N=75) dan Kumpulan Kawalan (CG; N=75). IG menerima 7 sesi berstruktur DNE yang disampaikan oleh pakar pemakanan secara individu setiap bulan dalam 3 bulan pertama dan datang untuk pemantauan pada bulan ke-6. Peserta dalam CG terus menghadiri sesi biasa yang disampaikan oleh pakar pemakanan untuk tempoh kajian yang sama. Ukuran hasil utama termasuk kawalan gula darah (HbA1c dan glukosa darah puasa (FBG)), dan hasil kedua adalah berkaitan dengan diabetes, termasuk status pemakanan (antropometri, tekanan darah, pengambilan makanan), pengetahuan-sikap-praktis (KAP) mengenai pengurusan diabetes, dan kualiti hidup (QoL). Kajian Fasa I mengenal pasti risalah (93.8%) sebagai bahan utama untuk pendidikan pemakanan. Pakar pemakanan (52.1%) juga bimbang bahawa pesakit mereka enggan menghadiri sesi pendidikan dan kira-kira 20.8% melaporkan bahawa bahan-bahan semasa tidak mencukupi untuk menarik minat, yang menekankan keperluan untuk membangunkan DNE. Sebenarnya,

hampir separuh pesakit T2DM (42.3%) tidak menghadiri sesi pendidikan pemakanan kerana doktor mereka tidak merujuk mereka kepada pakar pemakanan.

Dalam Fasa III, ciri-ciri pangkalan antara kumpulan adalah serupa kecuali untuk pengambilan serat dan komponen pengetahuan dalam KAP, yang lebih baik dalam IG. Pada akhir 6 bulan, seperti CG, peserta dalam IG tidak meningkatkan HbA1c, FBG, data antropometri, dan QoL, yang tidak berbeza dari CG. Walau bagaimanapun, peningkatan yang lebih signifikan diperhatikan dalam IG berbanding dengan CG untuk tekanan darah diastolik (BP), tahap KAP mengenai Pengurusan Diabetes, dan komponen pengambilan makanan (tenaga dan karbohidrat, lemak, dan serat). Pada masa yang sama, peserta dalam CG mencapai peningkatan tekanan darah sistolik yang ketara berbanding dengan peserta IG. Kesimpulannya, kajian ini menekankan keperluan untuk mempunyai pendidikan pemakanan diabetes yang berstruktur untuk pesakit T2DM dari pesakit dan pakar pemakanan sendiri, yang membawa kepada pembangunan DNE. Penyampaian DNE telah menunjukkan peningkatan dalam BP diastolik dan KAP mengenai Pengurusan Diabetes dan pengambilan makanan. Pesakit dan pakar pemakanan menerima DNE dengan baik.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Barakatun Nisak binti Mohd Yusof, PhD

Professor
Faculty Medicine and Health Sciences
Universiti Putra Malaysia
(Chairman)

Zalina binti Abu Zaid, PhD

Senior Lecturer
Faculty Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

Amin bin Ismail, PhD

Professor
Faculty Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

Hasnah binti Haron, PhD

Associate Professor
Faculty of Health Sciences,
Universiti Kebangsaan Malaysia
(Member)

Nur Indrawaty Lipoeto, PhD

Professor
Faculty of Medicine
Andalas University
(Member)

ZALILAH MOHD SHARIFF, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 14 December 2023

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LIST OF ABBREVIATIONS

ADA	American Diabetes Association
ANOVA	Analysis of Variate
BMI	Body Mass Index
BP	Blood Pressure
CG	Control Group
CHO	Carbohydrate
CONSORT	Consolidated Standards of Reporting Trials
DBP	Diastolic Blood Pressure
DM	Diabetes Mellitus
DNE	Diabetes Nutrition Education
FBG	Fasting Blood Glucose
HbA1c	Glycated Hemoglobin
HBM	Health Belief Model
IDF	International Diabetes Federation
IG	Intervention Group
ITT	Intention-To-Treat
KAP	Knowledge-Attitude-Practice
PHC	Public Health Care
QoL	Quality of Life
SCT	Social Cognitive Theory
T2DM	Type 2 Diabetes Mellitus
TTM	Trans-Theoretical Model
WC	Waist Circumference
RCT	Randomized Controlled Trial

CHAPTER 1

INTRODUCTION

1.1 Background

Diabetes Mellitus (DM) is a type of Non-communicable Disease (NCD) that results from insufficient or resistance leading to hyperglycemia (IDF., 2019). In turn, uncontrolled hyperglycemia has been associated with the development of various diabetes-related complications such as cardiovascular diseases, neuropathy, nephropathy, and retinopathy (IDF., 2019). DM has reached a global epidemic level at an estimated prevalence of around 9% (IDF., 2019). Type 2 Diabetes Mellitus (T2DM) contributes to the most frequently diagnosed cases of up to 90-95% (IDF., 2019). Moreover, T2DM has rapidly increased in developing countries, including those in the Southeast Asia (SEA) region. In particular, Indonesia was ranked sixth in terms of diabetes prevalence among the 11 SEA countries with 7.0% of its population (WHO., 2016).

One of Indonesia's most populous cities is Padang, the capital city of West Sumatra. Over the decades, the vibrant city has experienced rapid economic growth and urbanization, which has seen a nutritional transition among its population. Based on the data from the Padang City Health Centre, the prevalence of diabetes in Padang City recorded a relatively higher range of 6.4–10.6% (Mardyah *et al.*, 2019), in contrast to the lower overall prevalence of diabetes of 1.8% across the West Sumatra province (Research, 2013, 2017, 2018, 2019). Besides, the average level of glycated hemoglobin (HbA1c) among T2DM patients who attended Public Health Centre (PHC) in other Indonesian states, including in North Sumatra and Manado, was around 8.6–8.7%, indicating poor glycemic control (Rusdiana *et al.*, 2018). Thus, the above-average prevalence of diabetes and non-optimal glucose control among the population in Indonesia necessitates urgent attention to developing appropriate approaches to managing diabetes at PHCs.

Apart from other medical treatments, medical management in diabetes highlights the essential roles of diabetes self-management education and support (ADA., 2022). The integral component of diabetes self-management education is Medical Nutrition Therapy (MNT) (ADA., 2020), which aims to promote healthy eating patterns of T2DM patients to achieve optimal glycemic control, body weight, and cardiovascular risk by addressing their nutritional needs based on personal and cultural preferences (ADA., 2022). Previously, a study in Malaysia showed that a 12-week MNT intervention led to a significant reduction in HbA1c ($7.6 \pm 1.2\%$ to $7.2 \pm 1.1\%$; $p < 0.001$), waist circumference (90.7 ± 10.2 cm to 89.1 ± 9.8 cm; $p < 0.05$), HDL-cholesterol (1.1 ± 0.3 mmol/L to 1.2 ± 0.3 mmol/L; $p < 0.05$), dietary intake, and nutrition knowledge score ($42 \pm 19\%$ vs $75 \pm 17\%$; $p < 0.001$) (Barakatun Nisak *et al.*, 2013). A study in America also reported that MNT improved HbA1c by about 0.5–2% in T2DM patients (Chester *et al.*, 2018).

Although the benefits of MNT have been well-established, the delivery method is considered the most challenging part of diabetes-self-education management (ADA., 2022). Hence, MNT must be delivered with appropriate nutrition education to ensure that T2DM patients can adapt to the MNT components. Nutrition education refers to teaching and sharing knowledge and facts with an individual or group in the clinic or community and facilitating sustainable behavioral change (ADA., 2022). Nevertheless, nutrition education components must consider the population's individual and cultural needs by breaking down the various topics in MNT into minor culturally-specific topics (2022). Therefore, effective nutrition education materials must be developed based on the specific needs of the target T2DM population.

The provision of nutrition education has been reported to improve glycemic control, body weight, and cardiovascular risk factor in T2DM patients (Evert *et al.*, 2019). Interestingly, significant weight reduction has been observed when nutrition education is delivered by a nutrition expert, a dietitian, or a nutritionist, compared to other healthcare personnel (Sun *et al.*, 2017). Besides, nutrition education can alter eating habits (Siopis *et al.*, 2020), cultivate nutrition knowledge (Dube *et al.*, 2015), and enhance food preparation skills among T2DM patients (Nkomani *et al.*, 2021). Improving their knowledge of food choices and dietary practices after education sessions are necessary to achieve positive diabetes-related outcomes through sustainable lifestyle modification (Ouyang *et al.*, 2017).

Diabetes education also improves Knowledge, Attitude, and Practice (KAP) regarding diabetes management, leading to enhanced diabetes control (Ouyang *et al.*, 2017). Factors influencing knowledge levels of T2DM include a family history of diabetes, socio-demographic, urban residence, disease duration of 1–5 years, type of work, and economic conditions (El-Khawaga *et al.*, 2015). Cultural factors also played a role in knowledge levels of T2DM (El-Khawaga *et al.*, 2015), while food control, diet, lifestyle changes, and medication adherence had positive attitudes responses. Based on past results, culturally specific nutrition education is expected to improve the Indonesian population's KAP level.

A systematic review and meta-analysis study identified that T2DM patients exhibit a generally lower Quality of Life (QoL) than healthy people (Wang *et al.*, 2019). Factors affecting the QoL in T2DM patients include the lack of physical activity, depression, over-concern regarding their DM, and prolonged DM (Wang *et al.*, 2019). Furthermore, several studies conducted in Oman (Alghafri *et al.*, 2018), China (Wang *et al.*, 2019), and the UK (O'Neil *et al.*, 2016) employed the cluster randomized controlled design to assess the effect of nutrition education programs on T2DM patients. Accordingly, substantial improvements were observed in glycemic control and body weight (O'Neil *et al.*, 2016), systolic blood pressure, Body Mass Index (BMI) (Alghafri *et al.*, 2018), and dietary intake, especially carbohydrates (Bowen *et al.*, 2017).

1.2 Problem Statement

There is a growing interest in nutrition practices and education provided by Indonesian nutritionists. However, nutrition education programs for T2DM patients involving nutritionists in the Indonesia have various drawbacks and limitations. At the national level, the Ministry of Health of Indonesia has launched the Indonesia Public Health Care guidelines and the Balanced Nutrition Guide as standard clinical practice guidelines for treating and managing T2DM patients. The Balanced Nutrition Guide comprises ten messages that facilitate nutrition recommendations, such as consuming vegetables and fruits, minimizing the consumption of food high in sugar and fat, routine breakfast consumption, regular exercises, frequent water intake, washing hands, and reading the food labelling (Mboi *et al.*, 2014). Nevertheless, information about nutrition education remains minimal (Dube *et al.*, 2015). The impact of these guidelines on diabetes control of T2DM patients has also not been investigated (Pedoman Gizi Puskesmas., 2014) (Ariane *et al.*, 2019).

A review of Indonesia's health system development by Soewondo *et al.*, (2013) also acknowledged the roles of the Indonesian Endocrinology Society (PERKENI), the Indonesian Diabetes Association (PERSADIA), and the Ministry of Health in implementing various diabetes management programmes with close partnership with the World Diabetes Fund (WDF). One of the projects focused on the training capacity of 1237 health care professionals consisting of specialists, general practitioners, and community nurses to deliver diabetes education in eight cities, including Padang (WDF., 2008). Despite improved diabetes education provisions from 46% to 68% in PHC (WDF., 2008), the study excluded essential information related to specific nutrition education. The study has only involved doctors and nurses, with limited data about nutritionists, who should be part of the team in educating patients with T2DM.

In recent years, the Ministry of Health of Indonesia has set up the PHC as a prima healthcare institution that delivers the policy and guidelines for Health Centre (HC) providers to impart knowledge to patients. Most T2DM patients are referred to PHCs to receive primary healthcare services from the healthcare team, which includes doctors, nutritionists, nurses, midwives, lab analysts, and pharmacists. Regarding nutrition education, nutritionists are the primary providers responsible for imparting nutrition knowledge. Nutritionists handle the nutrition education component to manage chronic diseases, including T2DM. Besides preventing and controlling NCDs, nutritionists in PHCs are accountable for promoting other nutrition-related issues, such as maternal and infant feeding and school-based community projects.

Each PHC is provided with 1–3 nutritionists who cover 23 programs with approximately 100 patients' workloads daily. Besides, nutritionists with high qualifications, such as bachelor's degree holders, need to fulfil other administrative and financial commitments in the department, limiting their time to provide diabetes nutrition education to T2DM patients. Conversely, dietitians

in Indonesia provide clinical services in the hospital setting. Although nutritionists and healthcare professionals at PHC work together, they must also oblige to their respective responsibilities. For example, nurses at PHC are responsible for nursing practices, nursing education, and nursing research, besides handling emergencies such as earthquake, floods, and volcanos. Thus, the frequent under-staffing and workload highlights the need for a structured nutrition education package.

Furthermore, the current NCD guidelines have only emphasized the clinical component of DM management with non-diet-related topics (Ariane *et al.*, 2019). The available educational materials used by healthcare professionals at PHC are mainly in the form of leaflets. Consequently, nutritionists have no specific nutrition education guide and module for T2DM patients, except those from the Balanced Nutrition Guide (Ariane *et al.*, 2019), initially developed for the general population. In fact, over 70% of nutritionists used *Pedoman Gizi Seimbang* as their primary guideline, although this guideline was also developed for non-T2DM patients (Mboi, N., 2014). Thus, these nutrition guidelines may not effectively educate patients with T2DM and improve their glycemic outcomes. Therefore, the study highlighted the need to provide nutrition education to maintain healthy eating patterns (Wiradarma *et al.*, 2018).

1.3 Study Objectives

1.3.1 General Objective

To determine the effects of diabetes nutrition education on glycemic control and diabetes-related outcomes among individuals with Type 2 Diabetes Mellitus at selected health clinics in Padang, Indonesia.

1.3.2 Specific Objective

To achieve the above objective, this study consists of three phases that used the Generalized Model for Program Planning (McKenzie, Nigier, and Thackeray *et al.*, 2009) as a guide. The study uses the health belief model (HBM). The proposed model emphasizes developing health promotion programs from planning and implementing to evaluating the program.

Each phases is connected, and the objective for each is presented below.

- In brief, Phase 1 was the Need Assessment study among the nutritionist and patients with T2DM.
- The results informed the nutrition education development in Phase 2.
- The development of nutrition education named Diabetes Nutrition Education or DNE was implemented and evaluated in Phase 3.

Phase I: Need Assessment

At this phase, two surveys were conducted among nutritionists and patients with T2DM

1. To determine the socio-demographic characteristic, current practices, and perception about the adequacy of the current nutrition service among nutritionists at PHC, in Padang, Indonesia
2. To determine the socio-demographic characteristics and the needs for nutrition education among patients with T2DM who are attending PHC, in Padang, Indonesia.

Phase II: Module Development

1. To develop and assess the diabetes nutrition education module.

Phase III: Implementation and Evaluation

1. To determine and compare the socio-demographic characteristics, glycemic control (HbA1c and Fasting Blood Glucose (FBG)), nutritional status, knowledge-attitude-practice on diabetes management, and quality of life of patients with T2DM in the Interventions Group (IG) and Control Group (CG) before the study (baseline).
2. To determine and compare changes in glycemic control (HbA1c and Fasting Blood Glucose), nutritional status, knowledge-attitude-practice on diabetes management, and quality of life of patients with T2DM in IG) and CG, at 3 months and 6 months of the study.
3. To explore the acceptability of the Diabetes Nutrition Education (DNE) modules among nutritionists and T2DM patients.

1.4 Study Hypothesis

There is a significant difference in glycemic control (HbA1c and FBG) nutritional status, knowledge-attitude-practice (KAP) on Diabetes Management, quality of life (QoL), and acceptability between the IG and CG patients after 3 and 6 months of the study.

1.5 Conceptual Framework

This study was conducted in 3 phases and utilized the Generalized Model for Program Planning (McKenzie *et al.*, 2009) and the Health Belief Model (HBM). The health promotion program was applied to educate health professionals and patients (Allenworth *et al.*, 2010). Understanding the need assessment among the

target population was essential to ensure the developed program could help change behavior (McKenzie, J. F., Neiger, B. L., & Thackeray., 2009). Thus, in Phase 1, two need assessment surveys were carried out to determine the current T2DM management practices among nutritionists and T2DM patients.

The proposed DNE module was then designed in Phase II based on the results in Phase I and the guidelines set by the Indonesian Ministry of Health (Ariane *et al.*, 2019). HBM guided the development of the module to promote behavioral changes. HBM was selected in this study as it is the most influential health education model in T2DM that connect health belief and behavior to improve diabetes outcomes (Shabibi *et al.*, 2017). Using HBM has been proven beneficial to improve glycemic control, knowledge, and QoL among Iranian patients with T2DM (Mohammadi *et al.*, 2018). Also, HBM identifies potential predictors of adherence to medical regimens (Marathe *et al.*, 2016) and helps T2DM patients avoid complications by educating them to monitor their blood glucose levels and have a healthy diet. HBM consists of six critical constructs model that includes perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy, and cue of action (Vazini *et al.*, 2014) that matched the topics in DNE. The health promotion program can be conducted in the classroom and the group setting (McKenzie *et al.*, 2009). Health promotion programs structured following intervention shall contained potential theories to address intrapersonal factors, such as knowledge, attitudes, belief, motivation, and skills (Figure. 1).

Lastly, the effects of the proposed DNE on outcomes measures, i.e. primary outcome glycemic control (HbA1c and FBG) and secondary outcomes (nutritional status, dietary intake KAP on Diabetes Management, and QoL) between IG and CG were evaluated in Phase III. Knowledge of diabetes provides information about eating attitude, weight monitoring, blood glucose levels, self-dietary management, and knowledge. Besides, the QoL was assessed to evaluate various elements, such as modality, self-care, usual activities, pain/discomfort, and anxiety/depression. Other dimensions were Physical Health (PH), Physical Function (PF), Role limitations due to physical health problems (RP), General Health perceptions (GH), and Emotional State (ES) (Nouri *et al.*, 2021).

A systematic review and meta-analysis determined the factors associated QoL T2DM patients. The study found that duration of diabetes, diet with red meat, and depression were the factors related to QoL (Jing *et al.*, 2018).

In another systematic review and meta-analysis study conducted in China, the focus was on an empowerment-based self-management program, with a mean different -0.66, 95% CI [-1.19, -0.13]. This study included 121 subjects, each participating in a 5-month duration program (Cheng *et al.*, 2018). The findings of this study indicated that the program intervention did not result in a significant reduction in HbA1c levels. Nonetheless, a different study in China (Dong *et al.*, 2018) utilized the WeChat platform plus. This study reported that the WeChat

platform plus approach led to improved glycemic control (HbA1c), with a -1.72 95% CI [-1.99, -0.91]. Additionally, in Japan, a Structured individual-based lifestyle education (SILE) program, conducted over 6 months, demonstrated potential benefits in improving HbA1c when compared to a conventional program, with a mean different - 0.30 95% CI [-0.65, 0.05] (Adachi *et al.*, 2018).

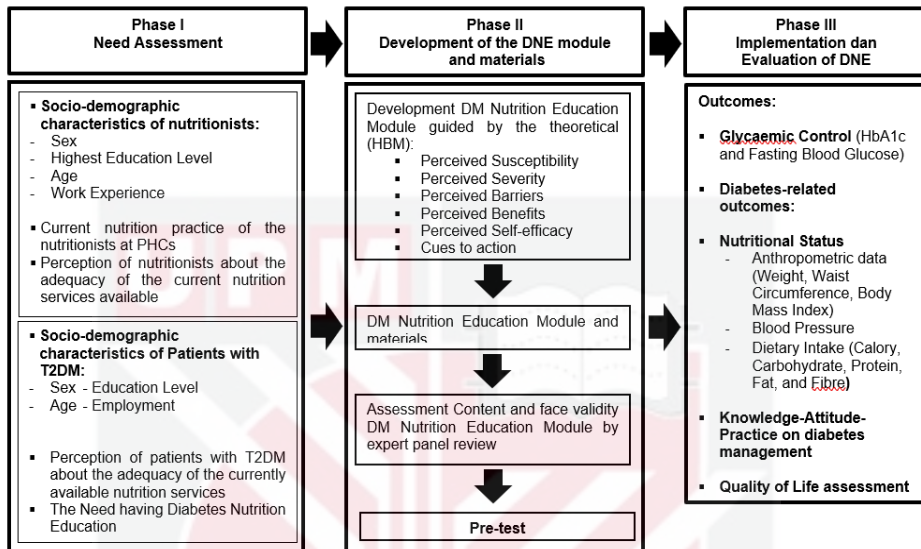


Figure 1.1 : Conceptual framework of the whole study based on the Generalized Model for program planning

(Source: General Model for Planning Program, McKenzie *et al.*, 2009)

1.6 Study Significance

Although nutritionists have an essential role in nutrition education in Indonesia, structured education for T2DM is absent to support them. Thus, this study proposed a structured DNE module and materials to assist nutritionists in providing appropriate nutrition education for T2DM patients and addressing their nutrition needs. As part of the package, the module includes a booklet for patients to read at home, further enhancing their behavioral change. The booklet also includes the patients' data, which can be used to monitor and evaluate their behavioral progress.

The DNE would serve as an extension of the available NCD guideline under the Indonesia Ministry of Health. Implementing the developed DNE module would facilitate healthcare professionals, particularly nutritionists, at PHCs to conduct individual nutrition education. Besides, the developed DNE module allows nutritionists to update the glycemic control assessment, unlike the National Research Basic Data (Riskesmas), which does not yet provide HbA1c data.

Therefore, this study can be used to develop new policies related to the HbA1c data in the National Research Basic Data.

The DNE module was also developed to allow other health professionals at PHCs to utilize the module, including medical doctors, nurses, nutritionists, midwives, pharmacists, and analysis laboratories. Hence, all health professionals and diabetes educators may help their patients to achieve considerable improvement in diabetes outcomes. Last but not least, the outcome of this study would be a reliable source of data to assist the government and policymakers in formulating new policies and guidelines related to nutrition at PHC ensuring effective DM management (Ligita *et al.*, 2018).



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