DOCTORAL THESIS

UCAM
UNIVERSIDAD CATÓLICA DE MURCIA

INTERNATIONAL DOCTORAL SCHOOL

Doctoral Programme in Health Sciences

INCREASING SELF-EFFICACY FOR THE MANAGEMENT OF PATIENTS WITH TYPE 2 DIABETES THROUGH AN ADVANCED PRACTICE EDUCATION PROGRAM FOR PRIMARY CARE PROFESSIONALS

Author:

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Supervisors:

PhD. Paloma Echevarría-Pérez

PhD. Isabel Morales-Moreno

Murcia, September 2025

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AUTORIZACIÓN DEL DIRECTOR DE LA TESIS PARA SU PRESENTACIÓN/ AUTHORISATION OF THE THESIS SUPERVISOR FOR ITS PRESENTATION

El Dr. D. Paloma Echevarría Pérez y el Dr. D. Isabel Morales Moreno, como Directores(1) de la Tesis Doctoral titulada "Increasing self-efficacy for the management of patients with type 2 diabetes through an advanced practice education program for Primary Care professionals" realizada por D. Bushra Yunis en el Programa de Doctorado en Ciencias de la Salud, autoriza su presentación a trámite dado que reúne las condiciones necesarias para su defensa./ Dr. D. Paloma Echevarría Pérez and Dr. D. Isabel Morales Moreno, as Directors(1) of the Doctoral Thesis entitled "Increasing self-efficacy for the management of patients with type 2 diabetes through an advanced practice education program for Primary Care professionals" carried out by Mrs. Bushra Yunis in the Doctoral Programme of Health Sciences, authorises its submission for processing as it meets the necessary conditions for its defence.

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En Murcia a 22 de septiembre de 2025./ In Murcia on 22 of September 2025.

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ABSTRACT

Background and Objectives:

Type 2 diabetes mellitus (T2DM) represents one of the **most** prevalent and complex chronic diseases globally, exerting a substantial burden on healthcare systems and significantly impacting patients' quality of life. Effective management of type 2 diabetes mellitus (T2DM) within primary care (PC) settings is crucial, as these services are often the initial and most frequent point of contact for patients. However, existing literature consistently indicates insufficient knowledge and limited self-efficacy among PC health professionals in managing T2DM, potentially compromising clinical outcomes. This study sought to examine the impact of an advanced practice educational program tailored for PC professionals on their diabetes-related knowledge, self-efficacy, perceived quality of care, and the metabolic control of their patients with T2DM.

Methods:

A quasi-experimental longitudinal design was employed, integrating two complementary perspectives. First, an educational intervention was implemented among PC health professionals within Meuhedet Health Services, North District (Israel), between January 2022 and June 2023. Diabetes knowledge was assessed in 157 professionals at baseline, and those scoring below 3.5 out of 7 were allocated to the intervention group. A structured eight-week advanced educational program, designed to strengthen clinical competencies, was delivered to 77 professionals, with subsequent evaluation of self-efficacy and perceived quality of care. Second, a prospective cohort study was conducted among 4,099 patients with T2DM under the care of these professionals. Biochemical and clinical parameters, including

fasting glucose, glycated hemoglobin (HbA1c), and estimated glomerular filtration rate (eGFR), were measured at baseline and after 12 months. Data were analyzed using ANOVA for changes from baseline, and a mixed-effects model was applied to account for variability within PC teams and between patient groups.

Results:

The educational program yielded statistically significant improvements in knowledge ($p < 0.001$) and across all dimensions of self-efficacy ($p < 0.001$). Notably, these professional gains translated into clinically relevant patient benefits: after six months, patients managed by trained professionals demonstrated significantly lower fasting glucose ($p < 0.001$) and HbA1c ($p < 0.001$), as well as improved eGFR ($p = 0.006$), compared to patients under standard care.

Conclusions:

The advanced practice education program substantially enhanced the clinical preparedness and self-efficacy of PC health professionals, resulting in measurable improvements in metabolic control among patients with T2DM. These findings highlight the strategic importance of targeted, competency-based educational interventions in primary care for the management of complex chronic diseases. By bridging knowledge gaps and reinforcing professional confidence, such programs can generate meaningful improvements in patient outcomes and contribute to the sustainability of healthcare systems.

Keywords:

Primary Care; Advanced Practice Nursing; Health Professionals; Type 2 Diabetes; Health Education; Self-efficacy; Chronic disease; Disease Management

RESUMEN

Antecedentes y Objetivos:

La diabetes mellitus tipo 2 (DM2) constituye una de las enfermedades crónicas más prevalentes y complejas a nivel mundial, ejerciendo una carga sustancial sobre los sistemas sanitarios y afectando de manera significativa la calidad de vida de los pacientes.

La gestión eficaz de la DM2 en el ámbito de la Atención Primaria (AP) resulta crucial, dado que estos servicios suelen constituir el primer contacto con el sistema sanitario, además de ser el más frecuente para los pacientes. Sin embargo, la literatura evidencia un conocimiento insuficiente sostenido en el tiempo, y una limitada autoeficacia entre los profesionales de la AP en el manejo de la DM2, lo que potencialmente compromete los resultados clínicos. El presente estudio tuvo como propósito examinar el impacto de un programa educativo de práctica avanzada, diseñado específicamente para profesionales de la AP, sobre su conocimiento en diabetes, autoeficacia, percepción de la calidad asistencial y el control metabólico de sus pacientes con DM2.

Métodos:

Se empleó un diseño cuasi-experimental longitudinal, integrando dos perspectivas complementarias. En primer lugar, se implementó una intervención educativa entre profesionales de AP pertenecientes a los Servicios de Salud Meuhedet, Distrito Norte (Israel), entre enero de 2022 y junio de 2023. El conocimiento en diabetes fue evaluado en 157 profesionales al inicio; aquellos que obtuvieron una puntuación inferior a 3,5 sobre 7 fueron asignados al grupo de intervención. Se

impartió un programa formativo en práctica avanzada, a 77 profesionales sanitarios, estructurado en ocho semanas, orientado a fortalecer las competencias clínicas, evaluándose posteriormente su autoeficacia y percepción de la calidad asistencial. En segundo lugar, se desarrolló un estudio de cohorte prospectivo con 4.099 pacientes con DM2 bajo la atención de dichos profesionales. Se midieron parámetros bioquímicos y clínicos —incluyendo glucemia en ayunas, hemoglobina glicosilada (HbA1c) y tasa de filtrado glomerular estimada (TFGe)— al inicio y a los 12 meses. Los datos se analizaron mediante ANOVA para evaluar cambios respecto al estado inicial, y se aplicó un modelo de efectos mixtos para considerar la variabilidad intragrupo e interpacientes.

Resultados:

El programa educativo generó mejoras estadísticamente significativas a nivel del conocimiento ($p < 0,001$) y en todas las dimensiones de la autoeficacia ($p < 0,001$). De manera destacada, estas mejoras profesionales se tradujeron en beneficios clínicamente relevantes para los pacientes: a los seis meses, ya que los pacientes atendidos por profesionales capacitados presentaron glucemia en ayunas y HbA1c significativamente más bajas ($p < 0,001$), así como una mejoría en la TFGe ($p = 0,006$), en comparación con los pacientes bajo la atención estándar.

Conclusiones:

El programa de educación en práctica avanzada en diabetología fortaleció de forma sustancial la preparación clínica y la autoeficacia de los profesionales de la AP, resultando en mejoras medibles del control metabólico en pacientes con DM2. Estos hallazgos ponen de relieve la importancia estratégica de intervenciones educativas dirigidas y basadas en competencias dentro de la Atención Primaria para el manejo de enfermedades crónicas complejas. Al reducir brechas de conocimiento y reforzar

la confianza profesional, dichos programas pueden generar mejoras significativas en los resultados de salud y contribuir a la sostenibilidad de los sistemas sanitarios.

Palabras clave:

Atención Primaria de salud; Enfermería de práctica avanzada; Profesionales de la salud; Diabetes mellitus tipo 2; Educación en salud; Autoeficacia; Enfermedad crónica; Manejo de la enfermedad.

ACKNOWLEDGEMENTS

I wish to extend my deepest gratitude to my supervisors, Dr. D. Paloma Echevarría-Pérez and Dr. D. Isabel Morales-Moreno, for their invaluable guidance, continuous support, and unwavering encouragement throughout this journey. Your consistent availability, insightful feedback, and dedication—especially the boundless accessibility and commitment of Dr. D. Isabel Morales-Moreno—have been instrumental in the successful completion of this thesis.

My heartfelt appreciation goes to Meuhedet Health Services, North District, my professional home for many years, for the support, encouragement, and trust in making this program a reality. Your ongoing endorsement and willingness to enable this initiative are deeply valued and by no means taken for granted.

A special tribute is dedicated to my beloved mother, to whom this thesis is also devoted. Although she is no longer with us, I find comfort in knowing that she was aware I had begun this academic journey. Her faith in me continues to inspire every step I take.

I am profoundly grateful to my husband, Wael Yunis, for his steadfast support, for standing by my side at all times, for the warm embraces, for never allowing me to give up, and for creating the most conducive environment for me to persevere.

To my dear son, Dr. Sami Yunis, my soul and my pride—thank you for always believing in my potential and for inspiring me to reach this milestone. I still remember the day you told me, "Mother, I will not begin my academic studies until you promise to continue yours." Your words have stayed with me and have driven me forward.

An immense and heartfelt thanks goes to the one and only, my daughter, Dr. Nadia Yunis, my talented and exceptional companion. You have been there for me in every possible way, always ready with an answer to my questions, often at the expense of your own personal time. Your help, patience, and love are treasures beyond measure. You have supported me tirelessly, assisted in every aspect, and given everything needed to ensure I would complete my thesis, never sparing your effort or time. I will never forget how you told me, almost every day, that I am leading a transformation in diabetes care and driving the field toward meaningful change. Hearing this from you has fueled my motivation to grow and push forward, more and more each day.

To all of you, I owe more than I can ever express. This achievement is as much yours as it is mine.

"Education plants the seed, self-efficacy nurtures it, and patient health is the yield".

Bushra Yunis

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ACRONYMS AND ABBREVIATIONS

AADE, American Association of Diabetes Educators

AANP, American Association of Nurse Practitioners

ACE, Angiotensin-Converting Enzyme

ACP, Advance Care Planning

ACP, Advanced clinical practitioners

ADA, American Diabetes Association

ADDQoL, Audit of Diabetes-Dependent Quality of Life

AIC, Akaike Information Criterion

ANA, American Nurses Association

ANCOVA, Analysis of Covariance

ANOVA, Analysis of Variance

APNs, Advanced practice nurses

APRN, Advanced Practice Registered Nurse

ARBs, Angiotensin II Receptor Blockers

AWARD, Assessment of Weekly AdministRation of Dulaglutide

BIC, Bayesian Information Criterion

BMI, Body Mass Index

CAD, Coronary Artery Disease

CCM, Chronic Care Model

CDC, Centers for Disease Control and Prevention

CDEs, Certified Diabetes Educators

CGM, Continuous Glucose Monitoring

Chisq, Chi-squared Statistic (Likelihood Ratio)

CI, Confidence Interval

CINED, Chronic Illness Needs Educated Doctors

CKD, Chronic Kidney Disease

CME, Continuing Medical Education

CNS, Clinical Nurse Specialist

COPD, Chronic obstructive pulmonary disease

COVID-19, Coronavirus Disease 2019

CPGs, Clinical Practice Guidelines

CVD, Cardiovascular Disease

DBP, Diastolic Blood Pressure

DESMOND, Diabetes Education and Self-Management for Ongoing and Newly Diagnosed

Df, Degrees of Freedom

DiNP, Diabetes Nurse Practitioner

DL, Deciliter

DM, Diabetes Mellitus

DPP, Diabetes Prevention Program

DSME, Diabetes Self-Management Education

DSMES, Diabetes Self-Management Education and Support

DSMS, Diabetes Self-Management Support

DTSQ, Diabetes Treatment Satisfaction Questionnaire

EASD, European Association for the Study of Diabetes

EBM, Evidence-Based Medicine

eCCM, eHealth Chronic Care Model

eGFR, estimated glomerular filtration rate

ESRD, End-Stage Renal Disease

GDM, Gestational Diabetes Mellitus

GIP, Gastric inhibitory polypeptide

GLP-1, Glucagon-Like Peptide-1

HbA1c, Hemoglobin A1C

HDL, high-density lipoprotein

HMOs, Health Maintenance Organizations

HPE, Health Professions Education

IBM, International Business Machines

ICN, International Council of Nurses

IDF, International Diabetes Federation

IPE, Interprofessional education

IQR, Interquartile Range

iQuaD, Improving Quality of Care in Diabetes

ITE, Insulin Therapy Evaluation

KG, Kilogram

LDL, Low-Density Lipoprotein

LDL-C, Low-density lipoprotein-Cholesterol

LMICs, Low- and middle-income countries

LogLik, Log Likelihood

M, Mean

m^2, Square meter

MENA, Middle East and North Africa

mg, Milligram

min, Minute

ml, Milliliter

MLM, linear mixed model

mmHG, millimeters of mercury

MODY, Maturity-onset diabetes of the young

MOH, Ministry of Health

N, Number of participants

NAC, North America and Caribbean

NIS, New Israeli Shekels

NP, Nurse Practitioner

Npar, Number of Parameters in Model

OECD, Organization for Economic Co-operation and Development

OSCE, Objective standardized clinical exercises

P, Probability

PACK, Practical Approach to Care Kit

PAD, Peripheral Artery Disease

PC, Primary Care

PCMH, Patient-Centered Medical Home

PCP, Primary Care Provider

Pr(>Chisq), p-value for Chi-squared Test

PSM, Propensity score matching

RD, Registered dietitians

REML, Restricted (or Residual) Maximum Likelihood

RNCCs, Registered nurse care coordinators

ROI, Return on investment

SACA, South and Central America

SBP, Systolic blood pressure

SD, Standard Deviation

SE, Standard Error

SEA, South-East Asia

SES, Socioeconomic status

SGLT2, Sodium-glucose cotransporter-2 inhibitors

SPACE, Self-Management Program of Activity Coping and Education

SPSS, Statistical Package for the Social Sciences

SRCC, Steno REACH Certificate Course in Clinical Diabetes Care

STROBE, STrengthening the Reporting of OBservational studies in Epidemiology

T, test-t-value / t statistic (comparing the means of two groups)

T1DM, Type 1 Diabetes Mellitus

T2DM, Type 2 Diabetes Mellitus

TAP-ITP, The Arthritis Program - Interprofessional Training Program

TPB, Theory of Planned Behavior

UK, United Kingdom

US, United States

USD, United States Dollar

VS, Versus

WHO, World Health Organization

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I – INTRODUCTION

I- INTRODUCTION

1. INTRODUCTION TO RESEARCH PROBLEM

Type 2 Diabetes Mellitus (T2DM) has become a major global health challenge, contributing to rising healthcare costs, reduced productivity, and diminished quality of life (Parker et al., 2024). The latest International Diabetes Federation (IDF) Diabetes Atlas (2025) reports that 11.1% – or 1 in 9 – of the adult population (20-79 years) is living with diabetes, with over 4 in 10 unaware that they have the condition. By 2050, projections show that 1 in 8 adults, approximately 853 million, will be living with diabetes, an increase of 46% (International Diabetes Federation, 2025).

Type 2 diabetes mellitus (T2DM) is a significant global health burden due to its high prevalence and the serious complications it causes. These complications, both microvascular and macrovascular, lead to increased morbidity and mortality, significantly impacting patients' quality of life and placing a substantial burden on healthcare systems worldwide. The prevalence of T2DM is rising, with projections indicating a significant increase in the number of affected individuals in the coming decades. This increase is driven by factors such as obesity, sedentary lifestyles, and an aging population. The complications associated with T2DM are diverse and affect multiple organ systems, necessitating comprehensive management strategies to mitigate their impact. The growing complexity of diabetes care—driven by demographic shifts, therapeutic advancements, and evolving healthcare delivery—necessitates improved training for healthcare professionals to ensure effective disease management. (Frag et al., 2024; Rowe et al. 2023; Powers et al., 2020)

The increasing complexity of diabetes care underscores the critical role of nurses, particularly those with expertise in diabetes education, in overcoming barriers and guiding patients. As diabetes management becomes more intricate due to advancements in therapies and the prevalence of comorbidities, the role of advanced practice nurses (APNs) becomes indispensable. These nurses not only provide direct patient care but also play a pivotal role in behavior modification and the implementation of new therapies, thereby enhancing patient outcomes and quality of life.

Advanced practice nurses are instrumental in educating patients about diabetes management, which includes teaching them how to monitor blood glucose levels, adhere to medication regimens, and make lifestyle changes. This education is crucial for empowering patients to manage their condition effectively and prevent complications (Peimani et al., 2010) (Seley & Weinger, 2007).

APNs employ strategies to motivate patients to adopt healthier behaviors, such as dietary changes and increased physical activity. This is essential for managing diabetes and reducing the risk of complications (Seley & Weinger, 2007). With the rapid development of new diabetes treatments, APNs are at the forefront of integrating these therapies into patient care plans. They help patients understand and adapt to new medications and technologies, such as insulin pumps and glucose monitoring devices (Childs, 2005) (Spollett, 2003). APNs focus on delivering care that meets the physical, social, and emotional needs of patients. This integrated approach is crucial for managing the complexities of diabetes and improving patient satisfaction and outcomes (Lawal, 2015).

The involvement of APNs in diabetes care has been shown to improve clinical outcomes, such as reduced hospital stays and better management of blood glucose levels (Frag et al., 2024). By providing education and support, APNs help patients

achieve better control over their diabetes, which can lead to an improved quality of life and reduced risk of complications (Lo Monaco et al., 2018; Spollett, 2003).

NPs work effectively within multidisciplinary teams, often bridging the gap between nursing and medicine. This collaboration is crucial for providing comprehensive diabetes care and ensuring that all team members, including Primary Care physicians, are aligned in their approach (White, 2002) (Pinheiro & Dehoul, 2022). This team-based approach is vital for addressing the multifaceted needs of diabetes patients, particularly those with multiple comorbidities (Frag et al., 2024; Lo Monaco et al., 2018). Their role in teams caring for Medicare patients with diabetes has shown that outcomes can be equivalent or even superior when NPs are involved, highlighting their effectiveness in managing complex cases (Everett et al., 2013).

Advanced practice training has emerged as a key strategy for enhancing T2DM management by equipping Primary Care providers with evidence-based knowledge, decision-support tools, and patient-centered approaches (Powers et al., 2020). Multidisciplinary educational programs have demonstrated positive outcomes, including improved metabolic control, reduced hospitalizations, and increased adherence to treatment plans (Rowe et al., 2023). Integrating interprofessional education within Primary Care teams has also led to better collaboration and improved patient care quality (Fang et al., 2024).

Despite these advancements, limited research exists on how such training programs impact provider self-efficacy and perceived quality of care. Given the individualized nature of diabetes treatment, healthcare providers must feel confident in making informed decisions tailored to patients' needs and comorbidities (Vuohijoki et al., 2020). Addressing this gap, the present study evaluates the effectiveness of an advanced training program—based on the latest

clinical guidelines—in improving Primary Care providers' self-efficacy, decision-making abilities, and patient outcomes. By assessing its impact on metabolic parameters and healthcare delivery, this research aims to provide a comprehensive framework for optimizing diabetes care in primary settings.

In addition to provider training, patient education is a cornerstone of effective diabetes management. Structured patient education programs have been shown to improve glycemic control, reduce hospitalizations, and enhance self-care behaviors (Quynh et al., 2024; Fang et al., 2022). However, while patient-focused interventions have been widely studied, extending these principles to Primary Care providers remains underexplored. Training programs that equip healthcare professionals with skills in shared decision-making, behavioral counseling, and self-management support are critical in addressing this gap. Without adequately trained providers, even the best patient education programs may fail to achieve optimal outcomes.

The evolving landscape of diabetes pharmacotherapy further underscores the need for continuous provider education. Despite the availability of advanced medications such as glucagon-like peptide-1 receptor agonists (GLP-1 RAs) and sodium-glucose cotransporter-2 inhibitors (SGLT-2i), their adoption in Primary Care remains suboptimal (Ling et al., 2024). A review by Wright and Nicholas (2024) emphasized that inadequate knowledge of these therapies often leads to therapeutic inertia, where providers delay treatment intensification despite evidence of inadequate glycemic control. Bridging this knowledge gap through structured, DiNP-led education programs is essential to ensure Primary Care professionals can deliver personalized, guideline-directed diabetes care (Murumba et al., 2024).

Recognizing the growing evidence supporting advanced practice education for healthcare providers, there remains a scarcity of data on its impact on provider self-efficacy and perceived quality of care in primary settings. While Continuing Medical Education (CME) programs in diabetes management have been evaluated, existing literature does not comprehensively examine the direct relationship between structured diabetes education and improvements in provider confidence, guideline adherence, and patient outcomes. Given the critical role of Primary Care providers in diabetes management, it is imperative to investigate how targeted educational interventions influence their decision-making and ability to implement guideline-based care effectively.

Furthermore, while numerous studies have explored diabetes management from a patient-centered perspective, limited research examines how provider training translates into real-world clinical improvements. Understanding these dynamics is essential for designing sustainable education programs that address the evolving needs of healthcare professionals while ensuring continuity in diabetes care delivery.

This study seeks to bridge these gaps by evaluating the impact of structured diabetes education programs on Primary Care providers' self-efficacy, adherence to evidence-based guidelines, and patient outcomes. By identifying key barriers to effective diabetes management and assessing how targeted training can mitigate these challenges, this research aims to develop educational frameworks that empower healthcare professionals with the knowledge, skills, and confidence needed to deliver high-quality, patient-centered diabetes care.

1.1. General Context of Type 2 Diabetes

1.1.1 Basic definition and clinical relevance

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia due to defects in insulin secretion, insulin action, or both. It manifests as a heterogeneous condition affecting carbohydrate, fat, and protein metabolism and follows a progressive course with diverse clinical presentations (Banday et al., 2020). DM is classified into four main types: type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), gestational diabetes mellitus (GDM), and diabetes associated with specific conditions, pathologies, or disorders (Banday et al., 2020; CDC, 2022). T2DM, the most prevalent form, accounts for 90-95% of all diabetes cases and arises from insulin resistance in peripheral tissues, primarily muscle, liver, and adipose tissue, combined with progressive beta-cell dysfunction. Initially, beta cells compensate for insulin resistance through increased insulin secretion, maintaining normoglycemia, but over time, their function deteriorates, leading to insulin deficiency and persistent hyperglycemia (Muoio & Newgard, 2008). Thus, the shift from compensated hyperinsulinemia to progressive beta-cell failure underlies the chronic hyperglycaemia that characterises most diabetes cases.

The progression of T2DM is often asymptomatic, with diagnosis frequently occurring only when classic symptoms of severe hyperglycemia, such as polyuria, polydipsia, weight loss, growth impairment, and blurred vision, emerge in the advanced stages. At the time of diagnosis, most patients already exhibit classic hyperglycaemic symptoms, with 89 % reporting at least one such sign—usually of less than three months duration—reflecting the rapid onset of symptomatic disease. (Drivsholm et al., 2005)

The etiology of T2DM is multifactorial, with both genetic and environmental factors playing critical roles. A strong genetic predisposition is evident, particularly among Native Americans, Asian Americans, African Americans, and Hispanic/Latino populations, while modifiable risk factors such as obesity, physical inactivity, poor dietary habits, and comorbid conditions like hypertension and dyslipidemia significantly contribute to disease onset and progression (Banday et al., 2020). T1DM, in contrast, is an autoimmune disorder resulting from T-cell-mediated destruction of pancreatic beta cells, leading to absolute insulin deficiency. Its pathogenesis is influenced by genetic and environmental factors but remains incompletely understood (Kahaly & Hansen, 2016; Banday et al., 2020). GDM, a condition of glucose intolerance diagnosed during pregnancy, typically resolves post-delivery but is associated with an increased lifetime risk of developing T2DM. Its incidence varies widely, ranging from 1% to 14% of pregnancies, with risk factors including maternal age, obesity, history of GDM, and previous pregnancies with macrosomic infants (Banday et al., 2020; CDC, 2024). Beyond these primary classifications, diabetes can also result from monogenic defects in beta-cell function, insulin action abnormalities, endocrinopathies, exocrine pancreatic diseases, and other rare conditions. Monogenic diabetes, including maturity-onset diabetes of the young (MODY) and neonatal diabetes, constitutes 0.6–2% of all diabetes cases (Banday et al., 2020).

Type 2 diabetes mellitus (T2DM) is a significant global health burden due to its high prevalence and the serious complications it causes. These complications, both microvascular and macrovascular, lead to increased morbidity and mortality, significantly impacting patients' quality of life and placing a substantial burden on healthcare systems worldwide. Among microvascular complications, diabetic neuropathy affects a large subset of T2DM patients, often resulting in pain, sensory

loss, and foot ulcers, with amputation risk (Demisse et al., 2024; Mohan et al., 2013). Diabetic nephropathy remains a leading cause of ESRD, marked by albuminuria and progressive renal decline (Demisse et al., 2024; Bolen et al., 2016). Diabetic retinopathy, prevalent among T2DM patients, is a leading cause of adult blindness and demands routine ophthalmologic monitoring (Patil et al., 2023; Ikem et al., 2022). In terms of macrovascular complications, T2DM markedly elevates cardiovascular risk—including CAD, stroke, and PAD—contributing substantially to morbidity and mortality (Guan et al., 2024; Shah et al., 2025). Stroke incidence is significantly higher in this population, often with long-term disability (Demisse et al., 2024; Dórea et al., 2024). PAD is frequently observed and linked to poor limb outcomes (Bolen et al., 2016; Ikem et al., 2022). Collectively, the broad spectrum of T2DM complications highlights the critical importance of early detection, multidisciplinary management, and sustained preventive efforts to reduce both the clinical and socioeconomic burden of the disease.

Understanding the pathophysiology, risk factors, and complications associated with diabetes, particularly T2DM, is crucial for improving prevention, early diagnosis, and management strategies to mitigate its global burden. Chronic hyperglycemia in diabetes leads to an increased risk of both microvascular and macrovascular complications, significantly impacting morbidity and mortality (Lu et al., 2023). Obesity, particularly visceral fat accumulation, contributes to systemic low-grade inflammation, which is implicated in both diabetes and cardiovascular pathogenesis. Dyslipidemia, characterized by elevated levels of low-density lipoprotein (LDL) cholesterol, further increases the risk of atherosclerosis and cardiovascular events (Matheus et al., 2013). Additionally, diabetes-related metabolic dysfunctions, oxidative stress, and chronic inflammation contribute to endothelial dysfunction and cardiovascular autonomic neuropathy, which is

recognized as a major contributor to sudden cardiac death in individuals with diabetes (Matheus et al., 2013).

1.1.2. Magnitude of the problem (global prevalence, economic and social consequences)

Type 2 diabetes mellitus (T2DM) is a rapidly escalating global public health concern. The International Diabetes Federation (2025) estimates that 589 million adults aged 20–79 years (1 in 9) are currently living with diabetes worldwide, a figure projected to rise to 853 million (1 in 8) by 2050. Four out of five adults with diabetes live in low- and middle-income countries, and 43% remain undiagnosed. In 2024, diabetes caused 3.4 million deaths—one every nine seconds—and accounted for more than USD 1 trillion in global health expenditure. Furthermore, 635 million adults have impaired glucose tolerance, and nearly one in five live births are affected by hyperglycaemia in pregnancy.(International Diabetes Federation, 2025) These statistics underscore the urgent global need for effective strategies in prevention, early detection, and long-term management .

The prevalence of type 2 diabetes mellitus (T2DM) differs markedly between regions due to variations in population structure, socioeconomic status, healthcare infrastructure, and lifestyle. The burden of type 2 diabetes mellitus (T2DM) varies significantly across regions, with each facing distinct epidemiological and health system challenges (Table 1). In the Western Pacific region, approximately 215 million adults were living with diabetes in 2024, representing 12.4% of the adult population. This region accounts for over one-third of the global diabetes population, with China alone comprising one in four global cases. It also recorded the highest number of diabetes-related deaths (1.2 million in 2024) and has the highest proportion of undiagnosed cases (50%). In the Middle East and North

Africa (MENA), the prevalence is the highest globally at 17.6%, with 85 million adults affected in 2024 and an expected increase to 163 million by 2050. This region also reports the highest diabetes prevalence among older adults (32.3%) and the second-highest projected increase in case numbers (92%), with more than one-third of individuals undiagnosed. In South-East Asia (SEA), 107 million adults were living with diabetes in 2024, with India alone accounting for one in seven cases worldwide. The regional prevalence is 9.7%, with a 73% projected increase by 2050. Nearly 43% of cases are undiagnosed, and the region has the second-lowest diabetes-related expenditure globally**. In the North America and Caribbean (NAC) region,** 56 million adults had diabetes in 2024, with a prevalence of 15.1%, the second-highest among all regions. This region incurs the highest per-person expenditure on diabetes (USD 7,811), represents 43% of global healthcare spending on diabetes, and has the highest diabetes-related mortality rate, accounting for 21.4% of global deaths. **In Europe,** 66 million adults were affected in 2024 (9.8% prevalence), with one-third undiagnosed. Europe also has the highest number of individuals with type 1 diabetes (2.7 million) and the second-highest average cost of care per person, with total expenditure reaching USD 193 billion. In South and Central America (SACA), 35 million adults had diabetes in 2024, corresponding to a regional prevalence of 10.0%. One in three cases are undiagnosed, and the number of affected individuals is expected to increase by 46% by 2050. The region reported 224,000 diabetes-related deaths in 2024. In Africa, 25 million adults were living with diabetes in 2024 (4.2% prevalence), with a projected increase of 142% to 60 million by 2050—the highest relative increase among all regions. More than 72% of individuals with diabetes in Africa are undiagnosed, and the region accounts for just 1% of global healthcare spending on diabetes, underscoring major gaps in access to care. These differences highlight the need for context-specific strategies to

improve prevention, diagnosis, and treatment across regions. (International Diabetes Federation, 2025)

Region	Adults with Diabetes (2024)	Prevalence (%)	Projected 2050	% Undiagnosed
Western Pacific	215 million	12.4%	254 million	50%
Middle East & North Africa (MENA)	85 million	17.6%	163 million	37.2%
South-East Asia (SEA)	107 million	9.7%	185 million	42.7%
North America & Caribbean (NAC)	56 million	15.1%	68 million	29.1%
Europe	66 million	9.8%	72 million	33.6%
South & Central America (SACA)	35 million	10.0%	52 million	30.4%
Africa	25 million	4.2%	60 million	72.6%

Table 1. Regional Prevalence of Type 2 Diabetes Mellitus: Estimates for 2024 and Projections for 2050 (International Diabetes Federation, 2025)

Globally speaking, approximately 75% of People with diabetes are in low- and middle-income nations, and the burden of diabetes on healthcare systems continues to rise (Lin et al., 2022; Li, 2025). Diabetes prevalence was similar in men and women and was highest in those aged 75–79 years. Prevalence (in 2021) was estimated to be higher in urban (12.1%) than rural (8.3%) areas, and in high-income (11.1%) compared to low-income countries (5.5%) (Sun et al., 2022).

In Israel, diabetes is the third most common cause of death (The Knesset – Research and Information Center, 2023). As of 2023, according to reports of the Ministry of Health in Israel the estimated percentage of diagnosed diabetics over the age of 18 are 10.5% (Israel National Program for Quality Indicators in Community Healthcare,2023). The prevalence of diabetes in Israel is higher than the average prevalence of 7.0% in the Organization for Economic Co-operation and Development (OECD) countries (OECD, 2025).

In addition to its high morbidity and mortality, diabetes has severe economic and social consequences, including increased healthcare costs, lost productivity, and diminished quality of life for millions of individuals. Although advancements in diabetes treatment and management strategies have improved patient outcomes, the gap between evidence-based guidelines and real-world clinical practice remains a persistent challenge (Green et al., 2024).

DM impacts the lives and well-being of individuals, families, and societies around the world (Sun et al., 2022). The increased numbers of patients with diabetes leads to a corresponding increase in the economic burden of the disease on health services, the patients and those around them. Global diabetes-related health expenditures were estimated at 966 billion USD in 2021 and are projected to reach 1,054 billion USD by 2045. Most of these costs were related to direct medical

care, including hospitalization, medication, and physician services. (Sun et al., 2022)

Diabetes also contributes to significant productivity losses due to morbidity and mortality. Individuals with diabetes are more likely to suffer from comorbidities such as heart disease and stroke, leading to increased disability and premature death, which can significantly impact workforce productivity. Furthermore, expenses arising from governmental welfare systems, including disability benefits and social support programs, and productivity loss add to the overall societal cost of diabetes .(American Diabetes Association, 2021; Balicer et al., 2018)

These facts clearly show that diabetes is a significant burden on society, highlighting the urgent need for effective prevention and management strategies to reduce the economic and social impact of the disease.

1.2. Importance of Primary Care in chronic disease management

1.2.1 Role of physicians and nurses in chronic patient care

The primary objective of type 2 diabetes mellitus (T2DM) management is to prevent or delay the onset of microvascular and macrovascular complications by achieving optimal glycaemic control, promoting weight reduction where necessary, and addressing cardiovascular risk factors (Davies et al., 2018). Given the progressive nature of T2DM, many patients require combination therapy with multiple glucose-lowering agents to attain and sustain glycaemic targets (Davies et al., 2018; Garber et al., 2020). Healthcare professionals, including physicians and nurse practitioners, must possess an in-depth understanding of available

therapeutic options to tailor treatment regimens that align with patient-specific needs while optimizing clinical outcomes.

Early screening, timely diagnosis, and prompt initiation of evidence-based interventions are essential to mitigate the risk of diabetes-related complications. Nurses and clinical nurse specialists play a critical role in patient education, providing guidance on insulin administration, medication adherence, and self-management strategies to empower individuals in achieving treatment goals. As diabetes care continues to shift toward Primary Care settings, patients increasingly receive treatment from multidisciplinary teams composed of family physicians, nurses, and dietitians, ensuring accessibility to care within their communities. The ever-evolving landscape of diabetes management necessitates continuous professional development for Primary Care providers, equipping them with the latest clinical insights to deliver high-quality, personalized care. Experienced diabetes specialists serve as invaluable resources, offering guidance and support to both patients and healthcare teams in implementing effective treatment strategies. A collaborative, patient-centered approach—incorporating self-care planning, continuous assessment, and tailored interventions—remains the cornerstone of successful diabetes management, reinforcing the need for ongoing education and professional training among clinical staff (Toljamo & Hentinen, 2001).

A well-coordinated, multidisciplinary model is imperative to ensure holistic management of T2DM, particularly in patients with coexisting comorbidities and diabetes-related complications (Rangaswami et al., 2020). Optimally managing diabetes requires seamless collaboration among nephrologists, cardiologists, endocrinologists, diabetes educators, social workers, and community support services to provide comprehensive outpatient care. Effective communication between Primary Care physicians (PCPs) and specialists is paramount in

maintaining continuity of care, with clearly defined treatment modifications and timely specialist referrals playing a crucial role in preventing disease progression and complications (Kushner et al., 2022; Rangaswami et al., 2020).

Despite the existence of well-established clinical guidelines for diabetes management, high-quality care is not consistently achieved, and risk factor control remains suboptimal across healthcare systems worldwide (Riordan et al., 2020). Variability in clinical practice and inadequate adherence to evidence-based interventions contribute to inconsistencies in patient outcomes, underscoring the critical need to bridge the gap between research findings and routine clinical practice. The challenge of integrating guideline-directed care into Primary Care settings persists, highlighting the necessity for innovative strategies that enhance implementation fidelity, improve treatment adherence, and foster a more structured approach to delivering effective, evidence-based diabetes care.

Primary Care providers play a crucial role in the management of type 2 diabetes, serving as the first point of contact for many patients. They are responsible for screening, diagnosing, and initiating treatment, as well as developing a comprehensive care plan that includes lifestyle modifications, medication management, and regular monitoring of key health metrics. Primary Care physicians also coordinate care, referring patients to specialists as needed and ensuring that all aspects of diabetes management are addressed. They play a vital role in patient education, helping individuals with type 2 diabetes understand the importance of self-care, medication adherence, and managing comorbidities. By providing personalized, evidence-based care and fostering strong patient-provider relationships, Primary Care physicians can improve glycemic control, prevent or delay the onset of complications, and enhance the overall quality of life for individuals with type 2 diabetes.

According to Riordan et al. (2020), physicians must balance competing goals and time constraints, tenets that are exacerbated by workforce shortages, specifically when managing complicated patients with comorbidities and chronic conditions such as diabetes. Other researchers support this notion by asserting that identifying the characteristics that influence diabetes management quality in Primary Care may help to identify strategies for improving adherence to evidence-based care and tailoring quality improvement interventions to the real-world setting. Further studies have indicated that PCPs provide better care to diabetics than other caregivers, particularly in the Primary Care setting, because they have a higher likelihood of influencing prescriptions and offering lifestyle advice (Davidson, 2010).

Nurses are central to the effective management of type 2 diabetes, particularly in Primary Care settings where they contribute directly to clinical outcomes, patient education, and disease prevention. Within modern healthcare systems, nursing roles range from generalists to advanced practice nurses (APNs), including nurse practitioners (NPs) and clinical nurse specialists (CNSs), who often hold master's level education and are authorized to perform tasks historically reserved for physicians. NPs are uniquely positioned to initiate, modify, and adjust medications, provide structured patient education, and manage complex technologies such as insulin pumps and continuous glucose monitoring (CGM). Evidence consistently shows that nurse-led care improves glycaemic control, reduces hospitalizations, lowers cholesterol, and enhances patient self-care confidence, with outcomes comparable or superior to physician-led models (Dickman et al., 2018; Hicks et al., 2012; Sangster-Gormley et al., 2011).

Globally, the NP role has expanded substantially since its introduction in the United States in the 1960s, improving healthcare access, cost-effectiveness, and

quality of care in diverse settings, including underserved populations (Calnan & Fahey-Walsh, 2005; Foster, 2010). Today, NPs are integrated into health systems across more than 70 countries, though scope of practice, prescriptive authority, and educational standards vary widely (ICN, 2020). In Israel, Advanced Practice Registered Nurses (APRNs) are formally recognized in multiple clinical areas, including diabetes, geriatrics, palliative care, and surgery (Nursing Administration Circular, 2015; MOH, 2023). Within diabetes care, APRNs are authorized to perform a broad range of advanced clinical tasks, such as adjusting insulin doses, initiating laboratory investigations, referring patients for sensor-based glucose monitoring, and administering medications from pre-approved lists. These responsibilities are outlined in official Ministry of Health circulars and underscore the APRN's role in managing treatment targets, wound care, early complication detection, and patient education. The training pathway includes postgraduate education, completion of a mandatory residency, and a government-administered expertise examination, ensuring that APRNs are well-prepared to integrate medical treatment with counseling, patient empowerment, and coordination of multidisciplinary care. (Nursing Administration Circular, 2015; MOH, 2023)

Beyond clinical tasks, nurses play a critical role in addressing psychosocial and cultural dimensions of diabetes care. Structured nurse-led education programs have been shown to reduce unnecessary specialist visits, improve treatment adherence, and lower readmission rates, especially in resource-limited contexts (Vas et al., 2017; Sussman et al., 2020). Clinical nurse specialists, in particular, provide behavioral coaching and culturally tailored education, addressing social determinants of health that influence diabetes outcomes in multicultural contexts such as Israel (Liu et al., 2019; Khan et al., 2024). This combination of clinical expertise and cultural competence allows nurses to bridge gaps in equity and

access, empower patients toward sustained self-management, and reduce the global burden of diabetes. Strengthening the role of nurses—through expanded authority, advanced training, and integration into multidisciplinary teams—remains a cornerstone strategy for improving the quality, efficiency, and inclusiveness of diabetes care worldwide.

1.2.2.Challenges and gaps in the management of type 2 diabetes at the Primary Care level

Type 2 Diabetes Mellitus (T2DM) management at the Primary Care level is fraught with challenges and gaps that significantly impact patient outcomes and healthcare efficiency. Despite advancements in treatment and guidelines, many patients remain inadequately controlled, underscoring the need for improved strategies and a deeper understanding of barriers in Primary Care settings.

One of the primary challenges in T2DM management is clinical inertia, or the failure to intensify treatment appropriately. This issue is exacerbated by a noted gap in the awareness and uptake of evidence-based care approaches among Primary Care providers, leading to suboptimal patient outcomes (Wright & Nicholas, 2024). Additionally, resource and workload issues pose significant challenges, particularly when initiating insulin therapy in patients with poorly controlled T2DM on oral medications. This process is resource-intensive and increases workload, further complicated by the lack of resources in both primary and secondary care settings (Jeavons, 2006).

Furthermore, gaps in knowledge and training among Primary Care providers hinder effective T2DM management. A survey revealed significant gaps in clinical knowledge related to T2DM treatment intensification, indicating a need for

improved training and education to address these deficiencies and enhance patient care (Larkin, 2024). The survey also highlighted that many patients are not meeting glycemic and weight management goals, suggesting that current knowledge and practices may be insufficient (Larkin, 2024). Patient and clinician beliefs also play a crucial role in T2DM management. Patients often view diabetes as a mild disease and resist insulin therapy, while clinicians recognize the need for active management but face resistance from patients (Jeavons, 2006). These beliefs are not always addressed in current management strategies, indicating a gap in understanding and communication between patients and healthcare providers (Jeavons, 2006).

In terms of non-pharmacological strategies, despite the availability of various treatments, there is a lack of direct comparisons to determine the most effective strategies for managing T2DM in Primary Care settings (Nogueira et al., 2024). A systematic review identified 23 non-pharmacological strategies, with Diabetes Self-Management Education and Support (DSMES) associated with social support showing the highest probability of reducing HbA1c levels (Nogueira et al., 2024).

Addressing these challenges and gaps in T2DM management at the Primary Care level requires a multifaceted approach, including enhancing clinical knowledge, addressing resource constraints, and improving patient-clinician communication. Future research should focus on developing and implementing effective training programs and exploring innovative non-pharmacological interventions to optimize T2DM management in Primary Care settings.

2.CONCEPTUAL AND THEORETICAL BASES

2.1. Self-efficacy theory

2.1.1. Definition of self-efficacy and its relationship to clinical practice

Self-efficacy, a core concept within the social cognitive theory developed by Albert Bandura, is a fundamental aspect of human behavior and motivation that has significant implications for clinical practice. Self-efficacy refers to an individual's beliefs about their own capabilities to perform a specific task or behavior effectively, and it is a crucial determinant of the choices, effort, persistence, and emotional responses individuals exhibit in various domains. (Vaughan-Johnston & Jacobson, 2020) (Zhang & Li, 2021)

The definition of self-efficacy, as outlined by Bandura, emphasizes the importance of an individual's perceptions and judgments about their own abilities, rather than their actual skills or competencies. This distinction is crucial, as individuals may possess the necessary knowledge and skills to perform a task, but ultimately fail to do so due to low self-efficacy beliefs. In the context of clinical practice, self-efficacy beliefs can shape the way healthcare professionals approach their work, as well as their interactions with patients and the overall quality of care they provide.

Self-efficacy has been recognized as a key construct in the study of health behavior, as individuals with high self-efficacy are more likely to engage in and persist with behaviors that are necessary for the effective management of their health conditions. (Adefolalu, 2018) For healthcare professionals, self-efficacy beliefs can influence their ability to effectively implement evidence-based practices,

adopt new technologies or treatment modalities, and navigate the challenges inherent in the dynamic and complex healthcare environment.

Research has demonstrated the beneficial effects of interventions targeting self-efficacy beliefs in a wide range of clinical settings, including the management of chronic diseases, such as diabetes, and the promotion of healthy behaviors, such as physical activity and smoking cessation. (Farley, 2019) (Dehghan et al., 2017) By fostering a strong sense of self-efficacy among healthcare professionals, clinical practice can be enhanced, leading to improved patient outcomes and increased job satisfaction and well-being among the healthcare workforces.

2.1.2. Evidence relating professional self-efficacy to quality of care and health outcomes

Professional self-efficacy among healthcare providers is a critical determinant of the quality of care and patient outcomes. Self-efficacy, defined as an individual's belief in their ability to execute behaviors necessary to achieve specific performance attainments, influences clinical decision-making, adherence to treatment protocols, and engagement in continuous professional development. In healthcare settings, higher self-efficacy has been linked to greater job satisfaction, stronger professional commitment, and improved patient care outcomes (Wu et al., 2012).

The self-efficacy model posits that individuals who recognize a challenge and believe they can effectively address it are more likely to persist in their efforts and achieve positive outcomes (Adefolalu, 2018). This principle has been demonstrated in various healthcare contexts, where interventions designed to enhance self-efficacy have led to improvements in patient-centered behaviors such as smoking cessation, physical activity, and adherence to healthy dietary practices (Łuszczyńska & Schwarzer, 2020).

In the nursing profession, self-efficacy has been explored as a factor influencing clinical performance. A study by Alavi (2014) found that nursing students with higher levels of self-efficacy demonstrated superior performance in clinical settings, reporting greater confidence in decision-making and patient interactions. Similarly, Farley (2019) examined the relationship between self-efficacy and patient education, suggesting that nurses with higher self-efficacy were more likely to provide effective chronic disease management support.

Self-efficacy influences healthcare providers' engagement in evidence-based practice, interdisciplinary collaboration, and resilience in challenging clinical environments (Caruso et al., 2016). In Primary Care, where practitioners play a pivotal role in chronic disease management, higher self-efficacy is associated with improved communication, patient advocacy, and the ability to coordinate care effectively across different healthcare settings.

Healthcare providers with higher self-efficacy are more likely to take a proactive approach to disease prevention and health promotion, leading to better patient adherence and disease control outcomes (Farley, 2019). A systematic review found that educational interventions aimed at increasing the self-efficacy of both nursing students and registered nurses significantly enhanced patient outcomes, including increased breastfeeding rates and improved self-care behaviors among chronically ill patients (Abusubhiah et al., 2023).

Furthermore, in a study conducted among general practitioners in the United Kingdom, higher levels of job satisfaction—often correlated with self-efficacy—were linked to lower rates of hospital admissions and emergency department visits among their patients (Riisgaard et al., 2017). These findings underscore the importance of fostering self-efficacy among Primary Care providers to enhance healthcare system efficiency and patient well-being.

However, it is equally important to recognize the challenges that threaten the development and maintenance of self-efficacy in clinical practice. Professional stress and workload significantly impact nurses' self-efficacy, with direct consequences on the quality of care delivered. Elevated stress levels and excessive workloads are major contributors to burnout—a syndrome characterized by emotional exhaustion, depersonalization, and a diminished sense of personal accomplishment—which in turn reduces self-efficacy, or the belief in one's capacity to perform clinical tasks effectively. This erosion of confidence adversely affects patient safety and overall care quality. Empirical studies have identified workload and stress as strong predictors of burnout, with emotional exhaustion being a critical factor that undermines nurses' confidence and performance (Gil-Monte et al., 2008; Gil-Monte & García-Juesas, 2008). While self-efficacy can act as a protective factor, buffering the impact of stress and sustaining performance levels under pressure, its decline due to persistent burnout correlates with poorer care outcomes (Molero et al., 2018; Gil-Monte et al., 2008). Emotional exhaustion and depersonalization escalate due to chronic workload, leading to decreased self-efficacy and reduced quality of care (Alnaiem et al., 2022; Hussien et al., 2024). Burnout has also been linked to increased clinical errors, adverse events, nosocomial infections, medication mistakes, and patient falls, as well as a general decline in patient satisfaction (Cobos et al., 2024; Li et al., 2024). Although nurses may perceive a reduction in care quality, this does not always align with patients' satisfaction (Alnaiem et al., 2022).

The prevalence of burnout among nurses further illustrates the scale of the challenge facing the development and maintenance of professional self-efficacy. A meta-analysis by Cañadas-De la Fuente et al. (2018), encompassing nearly 10,000 nurses across 17 studies, found that 30% experienced high emotional exhaustion,

15% reported high levels of depersonalization, and 35% reported low personal accomplishment—core components of burnout. These figures reflect the significant psychological burden carried by nursing professionals and the extent to which burnout can erode their belief in their clinical capabilities, ultimately compromising quality of care and patient outcomes (Cañadas-De la Fuente et al. 2018).

To mitigate these risks, targeted organizational interventions—such as workload redistribution, team-based care, and resilience programs—are essential for preserving nurses' self-efficacy and ensuring consistent, high-quality care (Molero et al., 2018; Lopes et al., 2022). Mindfulness-based programs and mental health support have also demonstrated positive effects in counteracting burnout and restoring clinical confidence (Júnior et al., 2024; Hussien et al., 2024). Ultimately, fostering self-efficacy in healthcare providers requires not only skill development and education but also a supportive work environment that recognizes and addresses systemic stressors.

2.2. Advanced Education and Training for Health Professionals

2.2.1 Concept of Advanced Practice

Advanced practice in healthcare refers to a level of professional competence that extends beyond standard clinical training, incorporating specialized expertise, leadership, and a commitment to evidence-based care. It is a response to the growing complexity of chronic disease management and the need for healthcare professionals to operate at higher levels of autonomy, decision-making, and interdisciplinary collaboration. The increasing prevalence of chronic conditions such as diabetes, COPD, and cardiovascular diseases has made it essential to develop healthcare professionals who can address diverse patient needs through

advanced knowledge, patient-centered strategies, and continuous self-development.

Advanced education and training for health professionals, particularly those in advanced practice roles, are essential to meeting the increasingly complex demands of modern healthcare systems. Advanced practice is characterized by a set of core competencies that include advanced clinical knowledge, autonomy in decision-making, research engagement, evidence-based practice, and leadership and pedagogical abilities. These competencies collectively enable practitioners to deliver high-quality, patient-centered, and evidence-informed care. Advanced clinical knowledge, grounded in pathophysiology, pharmacology, and comprehensive assessment skills, equips practitioners to manage complex and chronic health conditions effectively (Maclaine, 2017; McGee, 2009). This expertise is typically acquired through graduate-level education, such as master's or doctoral programs, which ensure specialization and depth of knowledge in clinical domains (Canga-Armayor, 2024). Autonomy in clinical decision-making is another hallmark of advanced practice, allowing professionals to independently prescribe treatments and manage care pathways—an autonomy that is increasingly supported by evolving healthcare policy frameworks (McGee, 2009; Aparicio, 2024). Concurrently, engagement in research and the consistent application of evidence-based practice are vital to ensuring the continual refinement of care standards. Programs such as the Integrated Clinical and Practitioner Academic programme by Health Education England and the National Institute for Health and Care Research exemplify institutional efforts to enhance the research capabilities of advanced practitioners (Dean, 2023). Beyond clinical expertise, advanced practitioners are expected to assume leadership roles within healthcare organizations, influencing clinical practice, guiding interdisciplinary teams, and contributing to health policy

and service improvement (Cox et al., 2012; Perron & Holmes, 2006). Pedagogical competencies, such as mentoring and education, further reinforce their role in cultivating a culture of continuous learning and professional development across care settings (Brown et al., 2003; Canga-Armayor, 2024). However, the recognition and implementation of advanced practice roles vary significantly across healthcare systems, shaped by socio-political dynamics, institutional policies, and organizational structures (Brown et al., 2003; Perron & Holmes, 2006). Moreover, while the pursuit of advanced practice roles is often driven by the aim to improve patient care, it may also be influenced by motivations related to professional status and recognition, underscoring the need for ongoing evaluation of role development and its alignment with health system priorities (Perron & Holmes, 2006).

Competency-based education frameworks are fundamental in ensuring that healthcare professionals develop practical, measurable skills that translate into improved patient outcomes. The Chronic Illness Needs Educated Doctors (CINED) program implemented objective standardized clinical exercises (OSCEs) to assess trainees' clinical competencies, demonstrating significant improvements in their ability to manage chronic illnesses (Nieman & Cheng, 2011). Similarly, the development of competencies for health professions education (HPE) has been a systematic process involving literature reviews, Delphi surveys, and nominal group techniques. This effort has resulted in the establishment of 25 competencies across six domains: teaching methods, educational assessment, research, diversity, and inclusion, interprofessional practice, and leadership (Caloudas et al., 2024). These competencies provide a structured framework for advanced training programs, ensuring that healthcare professionals are well-prepared for the challenges of modern healthcare.

Interprofessional education (IPE) is a cornerstone of advanced practice, fostering collaboration among physicians, nurses, pharmacists, and allied health professionals to enhance chronic disease management. Programs that incorporate IPE have demonstrated improvements in teamwork, communication, and patient care outcomes (Bain et al., 2014; Bogetz et al., 2015). A notable example is **T**he Arthritis Program – Interprofessional Training Program (TAP-ITP), which emphasized collaborative learning, reported increased participant satisfaction, and improved competencies (Bain et al., 2014). By promoting shared decision-making and coordinated care, interprofessional training strengthens healthcare delivery and enhances chronic disease outcomes.

A critical pillar of advanced practice is the ability to contribute to research and evidence-based medicine. However, challenges such as lack of time, limited research training, and insufficient institutional support hinder engagement in research activities (Dean, 2023). Encouraging research capabilities through doctoral-level study and integrated academic programs can address these challenges and foster the development of future research leaders. Advanced clinical practitioners (ACPs) are increasingly expected to participate in research initiatives that inform policy and clinical guidelines, thereby improving the quality of patient care and healthcare system efficiency.

Mentorship plays a vital role in advanced clinical training by providing guidance, support, and professional development opportunities. A UK-based support project for advanced clinical practitioners highlighted the importance of ACP leads, who could offer tailored support and educational events based on their own experiences with advanced practice training (Jenkinson & Fisher, 2024). Such mentorship programs not only enhance learning experiences but also contribute to

workforce retention by ensuring that emerging healthcare leaders feel supported in their roles.

2.2.2. Models of Continuing Education and Their Importance in Chronic Disease Management

Continuing education models provide healthcare professionals with ongoing opportunities to refine their skills, stay current with medical advancements, and improve their ability to manage chronic diseases effectively. These models vary in their structure, delivery, and scope but share the common goal of fostering lifelong learning and professional development.

Designing effective continuing education programs requires a thorough needs assessment to identify skill gaps and training priorities. Research has highlighted deficiencies in public health professionals' competencies, particularly in areas such as health economics and policy analysis, underscoring the need for targeted training interventions (Wilcox et al., 2014). Similarly, an assessment of remote health staff training needs emphasized the importance of prevention and early detection strategies in chronic disease management (Smith et al., 2006). These insights inform the development of training curricula that address real-world healthcare challenges.

Modern continuing education programs employ diverse instructional methods to enhance knowledge retention and clinical application. Innovative approaches such as hands-on learning, practice-based coaching, and storytelling have been successfully used to improve healthcare education. A program designed for Aboriginal Health Workers incorporated storytelling to facilitate knowledge transfer and cultural relevance (Pearson et al., 2024). These

dynamic learning methods ensure that healthcare professionals can effectively apply theoretical knowledge to clinical practice.

The evolution of continuing education has been significantly influenced by technological advancements. In Russia, continuing medical education (CME) has shifted toward short cycles of advanced training, incorporating distance learning and professional development modules tailored to specific areas of practice (Buslaeva et al., 2024). Digital learning platforms, e-learning modules, and virtual simulations have expanded access to high-quality training, particularly for healthcare providers in remote or underserved areas. However, challenges such as provider discomfort with technology and limited infrastructure must be addressed to maximize the potential of these tools (Muramoto et al., 2003).

To sustain the benefits of continuing education, training programs must incorporate follow-up support, mentorship, and outcome evaluations. Studies on chronic heart failure training programs have demonstrated that continuous reinforcement enhances self-efficacy and leads to sustained improvements in clinical practice (Higgins et al., 2013). Ongoing mentorship and peer learning can help maintain long-term competency and confidence among healthcare providers.

Despite these efforts, barriers such as limited funding, workforce turnover, and lack of organizational support continue to hinder the effectiveness of continuing education programs. Strategies to overcome these challenges include providing flexible learning opportunities, integrating training into clinical workflows, and leveraging institutional resources (Muramoto et al., 2003; Newton et al., 2011). Addressing these structural barriers is essential to ensuring that continuing education remains accessible and impactful.

The benefits of well-structured continuing education programs extend beyond professional development, directly influencing patient care. Training

initiatives such as the CASALUD Model, established in Mexico, have been linked to improved vaccination rates, better blood pressure control, and increased patient engagement in chronic disease management (Gallardo-Rincón et al., 2017). Similarly, the SPACE for COPD self-management program, developed in the UK, has been associated with increased healthcare provider confidence in delivering patient-centered care and improved patient outcomes (Blackmore et al., 2017).

However, evaluating the long-term impact of these programs remains a challenge. Variability in program design, differences in outcome measures, and methodological limitations complicate efforts to assess effectiveness. Few studies have examined the sustained integration of training into clinical practice, highlighting the need for further research to optimize continuing education frameworks (McCabe et al., 2021; Cross et al., 2022).

Advanced education and training for healthcare professionals play a fundamental role in equipping providers with the skills and knowledge necessary to manage chronic diseases effectively. The concept of advanced practice encompasses interprofessional collaboration, research engagement, and leadership development, ensuring that healthcare professionals operate at the highest levels of competency. Meanwhile, models of continuing education facilitate lifelong learning and the ongoing refinement of clinical skills, addressing emerging healthcare challenges through innovative, flexible, and culturally relevant training approaches.

To maximize the impact of these training programs, healthcare systems must prioritize competency-based education, integrate digital learning strategies, and develop robust mentorship models. Despite the challenges associated with funding, workforce sustainability, and program evaluation, continued investment

in advanced education will enhance healthcare quality, improve patient outcomes, and contribute to more efficient chronic disease management.

This global perspective is reinforced by the World Health Organization's Global Strategy on Human Resources for Health: Workforce 2030 (2016), which underscores the critical role of transformative education strategies in addressing workforce shortages and improving care quality, particularly in Primary Care settings. The strategy advocates for linking education investments to population needs, prioritizing competency-based curricula that emphasize person-centered care, health promotion, and interdisciplinary collaboration to ensure health workers are equipped to address local demands. It specifically calls for continuing education reforms, including interprofessional training and technology-enhanced learning (e.g., e-learning platforms), to build resilient Primary Care teams capable of delivering integrated, community-based services. By promoting accreditation mechanisms, gender-balanced recruitment, and rural-focused training pipelines, the strategy aims to reduce geographic and skill disparities while fostering a workforce adept at managing evolving public health challenges. These measures are foundational to achieving universal health coverage and mitigating workforce burnout, as highlighted by the WHO's emphasis on lifelong learning and adaptive skill development to sustain high-quality care in under-resourced settings (World Health Organization [WHO], 2016).

Future research should focus on identifying the most effective educational strategies to ensure long-term sustainability and clinical relevance.

2.3. Perceived quality of health care

2.3.1 Definitions and factors influencing the perception of quality (patients, healthcare professionals, and healthcare system)

Quality of healthcare refers to patients' assessment of the care they receive, encompassing both individual experiences and expectations. Several factors influence this perception, including provider competence, communication effectiveness, and the degree of patient involvement in treatment decisions (Tofik et al., 2023). Notably, the alignment between perceived and actual quality is crucial: effective communication and a supportive environment can positively modify patients' perceptions, impacting their satisfaction and adherence to treatment (Lee et al., 2018).

Perceived quality of healthcare is a multifaceted construct that reflects patients' assessments of the care they receive, shaped by both subjective experiences and set expectations. According to Tofik et al. (2023), several critical factors influence this perception, including provider competence, the effectiveness of communication, and the extent of patient involvement in treatment decisions. Effective communication between healthcare providers and patients stands out as a vital contributor to perceived quality. Research indicates that successful communication enhances the exchange of vital information and constructs a supportive environment that fosters trust, thereby positively influencing patients' overall perceptions of quality and satisfaction regarding the care they receive (Kwame & Petrucka, 2021; Bahari et al., 2024). Moreover, the provider's competence is essential. Patients tend to evaluate their experiences based on their perceptions of how knowledgeable and skilled their healthcare providers are. When healthcare professionals exhibit confidence, demonstrate thorough

expertise, and convey empathy, patients are more likely to have a favourable perception of the quality of care provided (Rivera-Hernandez, 2015). This alignment between perceived and actual quality further emphasizes the importance of creating a conducive healthcare environment where effective rapport and communication are pivotal (Larkin et al., 2015). Studies indicate that if the need for patient involvement in decision-making is prioritized, patients are likely to feel more engaged and valued, thus improving their perception and satisfaction, which can lead to an increased commitment to treatment protocols (Majeed et al., 2021). Another significant aspect influencing perceived quality is the healthcare system itself, which includes organizational factors such as resource availability and the institutional culture surrounding care delivery. When systemic challenges limit healthcare providers' capacity to offer high-quality services, patients often notice these shortcomings, leading to a diminished perception of the overall quality of care received (Fayyaz & Yusuf, 2023). Thus, both provider-level factors and systemic characteristics of healthcare organizations significantly shape how patients evaluate their care experiences.

2.3.2 Relationship between quality-of-care perception, therapeutic adherence, and clinical outcomes

Research consistently demonstrates that perceived quality of care correlates strongly with therapeutic adherence and clinical outcomes. Patients who perceive a high quality of care are more likely to adhere to recommended treatments, which translates to better clinical outcomes, including improved metabolic control in diabetes patients (Bilondi et al., 2021). For instance, studies have indicated that when patients feel their healthcare providers understand and address their concerns, they report higher satisfaction levels, leading to better health

management and adherence to treatment (Shim et al., 2012). Therefore, understanding and improving perceived quality in healthcare services must be a priority, particularly in chronic disease management. By enhancing patient satisfaction through robust training and support frameworks for healthcare providers, the goal of better patient outcomes can be achieved.

The interplay between perceived quality and therapeutic adherence, along with clinical outcomes, has been extensively researched, revealing a consistent positive correlation. Patients who perceive a higher quality of care are notably more willing to adhere to prescribed treatment regimens, which has far-reaching implications for diabetes management, particularly in optimizing glycemic control and minimizing the risk of complications (Morris et al., 2009). Studies show that when patients feel that their healthcare providers are attentive to their concerns and deliver supportive care, they report higher satisfaction levels, which translates into improved health management practices and better adherence to treatment protocols (Abubakari et al., 2011). Research consistently indicates that satisfaction with care is inherently linked to several clinical outcomes. For instance, when diabetic patients perceive their healthcare to be of high quality, specifically in terms of communication and involvement in decision-making, they report enhanced emotional well-being, which directly influences their medical outcomes (Hickmann,Richter,& Schlieter 2022; Alyami et al., 2019). Improved satisfaction with care has been found to significantly correlate with better glycemic control—an essential metric for success in diabetes management. Healthcare providers who create a tailored, patient-centered approach yield higher levels of satisfaction and adherence to treatment plans, reinforcing the notion that improved perceived quality contributes to enhanced clinical outcomes (Tofik et al., 2023). Therefore, understanding the dimensions of perceived quality in healthcare delivery emerges

as an urgent priority, especially in the realm of chronic disease management. Strategies that enhance patient satisfaction through effective training and support for healthcare providers are critical. Employing frameworks that prioritize effective communication, provider professionalism, and patient engagement can create an environment conducive to improving health outcomes. Consequently, investing in these areas helps bridge the gap between patient experience and clinical efficacy, fulfilling the objective of improving patient health outcomes across diverse populations and settings.

An often underrecognized yet essential determinant of perceived quality and adherence is the nurse-patient therapeutic relationship, particularly in the context of chronic disease management. This relationship—grounded in empathy, trust, and effective communication—has been shown to significantly enhance patients' satisfaction with care and their willingness to adhere to treatment plans. For example, in haemodialysis therapy, over 80% of patients identified empathy as a key component of quality care, while 70% emphasized the importance of mutual trust (Hreńczuk, 2021). Similarly, in mental health and oncology settings, patients report greater satisfaction and better outcomes when they are actively involved in shared goal-setting and decision-making processes with nurses (El-Abidi et al., 2023; Gergova et al., 2024). These findings are reinforced by evidence showing that nurses who engage in active listening and open communication are more successful in identifying psychosocial needs and promoting self-management (Frank-Bader et al., 2016). As such, the quality of interpersonal interactions becomes a critical lever in improving not only perceived care quality but also clinical outcomes, including medication adherence and quality of life (Johanson, 2023; Camedda & Longobucco, 2023). Nevertheless, challenges such as time constraints, administrative burden, and cultural differences can hinder the

development of these therapeutic relationships. Organizational support and ongoing training are therefore vital to sustaining meaningful nurse-patient connections that contribute to improved adherence and health outcomes.

A critical dimension of perceived quality in diabetes management is treatment satisfaction, which plays a significant role in shaping both patient adherence and clinical outcomes. Instruments such as the Diabetes Treatment Satisfaction Questionnaire (DTSQ) have proven valuable for assessing patient experiences with diabetes care, offering insights into how individuals evaluate the effectiveness and acceptability of their treatment plans. Research using the DTSQ highlights several determinants of satisfaction, including socioeconomic status, treatment modality, and continuity of care. For example, higher satisfaction levels are often associated with greater income, employment, and education levels, while lower satisfaction is reported among individuals with diabetes-related complications or on more intensive insulin regimens (Biderman et al., 2009; Bener et al., 2014; Nicolucci et al., 2009). Additionally, access to healthcare services, continuity with a primary provider, and participation in self-management education have been linked to increased satisfaction and perceived quality of care (Narayan et al., 2003). This satisfaction, in turn, is positively correlated with improved adherence to therapy, better glycemic control, and enhanced emotional well-being—factors that are essential for successful diabetes management (Sendekie et al., 2023; Bromba et al., 2015). While the DTSQ effectively captures satisfaction with treatment, it does not fully encompass the broader impacts of diabetes on quality of life. Studies employing complementary tools, such as the Audit of Diabetes-Dependent Quality of Life (ADDQoL), reveal that even patients who report high treatment satisfaction may experience significant impairments across key life domains (Bradley & Speight, 2002). These findings

underscore the need for a multidimensional assessment approach that integrates both patient-reported satisfaction and quality of life metrics into care planning and evaluation. Doing so would strengthen the alignment between perceived quality, therapeutic adherence, and clinical outcomes, providing a more holistic understanding of the patient experience in chronic disease care.

3. REVIEW OF THE LITERATURE ON EDUCATIONAL INTERVENTIONS AND DIABETES MANAGEMENT

3.1. State of the art of diabetes patient education

To combat the challenges of diabetes management, a multidisciplinary care approach that focuses on self-management is supported. This approach involves educating patients, addressing behavioural and emotional aspects of care, and ensuring effective communication between healthcare providers and patients (Powers et al., 2020). Educating patients on self-management of diabetes is a critical aspect of treatment. Improving patient adherence to lifestyle changes and medication regimens is essential for successful diabetes management. Patients must understand the disease, have a chance to adapt to the disease, and adjust the dimensions of their life with this disease (Nikpour et al., 2022). Embracing the process of decision-making based on an individual's lifestyle, along with other related metabolic, social, and psychologic factors, contribute to effective diabetes management, denoting that self-care and self-management education provide an unprecedented role in accomplishing the patients' empowerment objective (Vas et al., 2017).

Addressing the emotional burden of diabetes is another essential component of effective patient education and care. Depression, anxiety, and diabetes-specific

distress are common among T2DM patients and can negatively impact self-care behaviors and glycemic control. Addressing these emotional issues is essential for improving treatment adherence and reducing complications (Kohut et al., 2019) (August et al., 2015) (Ogunsemi, 2012). Family support, patient-provider relationships, and social networks play a critical role in diabetes management. Positive social interactions can enhance self-efficacy and coping mechanisms, leading to better self-management practices (Rondhianto et al., 2022) (August et al., 2015) (P & P., 2024). Effective coping strategies and resilience are associated with reduced diabetes distress and improved self-management behaviors. Enhancing these skills can help patients better manage the emotional and practical challenges of living with T2DM (Rondhianto et al., 2022) (Wang et al., 2017).

Psychosocial support embedded in education programs—whether led by nurses, physicians, or psychologists—shows consistently greater effect on adherence than purely biomedical teaching. The literature indicates that addressing distress and self-efficacy mediates the impact of education on glycaemic outcomes. Thus, the effectiveness of interventions lies not in professional discipline but in the integration of psychosocial and clinical elements.

Structured diabetes education programs, such as DESMOND in the UK and the X-PERT Programme, have demonstrated substantial benefits in improving clinical outcomes for patients with diabetes, particularly in glycemic control as measured by HbA1c levels. These initiatives aim to empower patients through targeted education, fostering effective self-management practices. Evidence shows that structured education leads to a significant reduction in HbA1c, with the X-PERT Programme reporting a 0.6% decrease compared to a 0.1% increase in control groups (Deakin et al., 2006). Consistent findings also associate these programs with improvements in total cholesterol, body weight, BMI, waist circumference, and the

frequency of hypoglycemia (Chowdhury, 2024; Estay, 2022; Weitgasser et al., 2023). Additionally, these programs enhance self-management behaviors, diabetes-related knowledge, and lifestyle habits such as physical activity and dietary choices, contributing to better psychosocial outcomes including increased self-empowerment and quality of life (Chowdhury, 2024; Deakin et al., 2006). Structured education is also considered cost-effective, especially for patients with HbA1c levels above 7%, with telecommunication-based delivery models further improving accessibility and affordability (Ye et al., 2024). Overall, structured diabetes education is a cornerstone of effective diabetes care, but its implementation should be tailored to patient needs and supported by modern technologies and adequate resources to maximize its clinical and psychosocial benefits.

Despite strong evidence for structured education, real-world uptake remains limited. Barriers include resource constraints, patient literacy, and health system fragmentation. Thus, the gap between trial efficacy and implementation outcomes remains a critical research and policy challenge.

Building on the importance of structured and individualized education, the AADE7 Self-Care Behaviors model offers a comprehensive and practical framework for guiding both healthcare providers and patients in effective diabetes self-management. The AADE7 Self-Care Behaviors model, developed by the American Association of Diabetes Educators. This model outlines seven key behaviors—healthy eating, being active, monitoring, taking medication, problem-solving, healthy coping, and reducing risks—that are critical for effective diabetes self-management. The AADE7 framework promotes a structured and patient-centered approach to education, emphasizing the importance of tailoring interventions to individual needs and preferences (Tomky et al., 2008). Its

implementation has been associated with improved glycemic control, better lipid profiles, and reduced complication risks in patients with type 2 diabetes (Liu & Liu, 2024). Furthermore, the model supports integration with health information technologies, including mobile applications and electronic health records, enhancing the accessibility and continuity of Diabetes Self-Management Education and Support (DSMES) (Kim et al., 2021). Although originally developed for diabetes, the model's principles are adaptable to other chronic conditions, such as prediabetes and cardiometabolic diseases, reinforcing its versatility and value in broader health education efforts (Kolb, 2020; Zulkibli et al., 2023). By providing a clear framework for assessment, intervention, and follow-up, the AADE7 model empowers patients to take an active role in their care, fostering improved outcomes and greater engagement in long-term self-management.

3.1.1. Patient education programmes: their effectiveness in glycaemic contro

The DSME and DSMS algorithms are essential components of diabetes care that aim to empower individuals with diabetes through education, support, and ongoing self-management strategies. These algorithms focus on personalized care tailored to individual needs while promoting informed decision-making and active collaboration between patients and healthcare providers.

DSME is an ongoing process that aims to facilitate the knowledge, skills, and abilities necessary for diabetes self-care. It focuses on individual needs, goals, and life experiences, guided by evidence-based standards. DSME supports informed decision-making, self-care behaviors, problem-solving, and active collaboration with healthcare providers (Bardsley et al., 2017; Powers et al., 2016).

DSMS involves activities that help individuals with diabetes implement and sustain behaviors necessary for ongoing self-management. This support can be behavioral, educational, psychosocial, or clinical in nature. Strategies for providing DSMS include nurse case management, reminders for follow-up care, medication management, education, goal-setting, and psychosocial support (Funnell et al., 2010).

Communicating the information and skills needed for optimal coping and self-management in diabetes, regardless of the context, requires a personalized and comprehensive strategy. Effective delivery requires diabetes care experts with expertise in education, clinical practice, psychosocial aspects, and behavioral interventions. Effective communication and collaboration among the healthcare team consisting of a provider, an educator, and a person with diabetes are crucial to ensure clear goals, monitor progress, and implement appropriate interventions such as educational, psychosocial, medical, or behavioral strategies. Implementing a patient-centered approach to DSME/S at the time of diagnosis establishes the basis for addressing both present and future need. Continuous Diabetes Self-Management Education and Support can assist individuals in overcoming obstacles and managing the persistent challenges to enable adjustments throughout their treatment and life changes (Powers et al., 2020).

The algorithm of diabetes care is based on five guiding principles: using patient engagement, behavioral and psychosocial support, information sharing, coordinated care, and integration with other different therapies. Linked with each guiding principle are fundamental tenets that provide specific suggestions concerning associations with the patients alongside topics to address at diabetes-related educational and clinical encounters (Powers et al., 2020). Collaboration and effective communication within a patient-centered approach are the main conduits

towards patient engagement. Patient-centered approaches always include evoking emotions, perceptions, and even knowledge via active and reflective listening, exploration of the desire to acquire new knowledge or change, asking open-ended questions, and supporting efficacy (AlHaqwi et al., 2023).

The effectiveness of patient education programmes in achieving glycaemic control in individuals with diabetes has been extensively documented in the literature. Research findings indicate that structured educational interventions significantly improve HbA1c levels and general glycaemic control (Larkin et al., 2015). Programs that enhance diabetes knowledge and empower patients to engage in self-management contribute positively to metabolic outcomes, particularly when they involve practical components such as dietary management, blood glucose monitoring, and exercise (Majeed et al., 2021; Fayyaz & Yusuf, 2023).

Evidence from systematic reviews has shown that comprehensive diabetes education programmes, which include group sessions led by healthcare professionals, are more effective than traditional approaches in terms of glycaemic control (Abubakari et al., 2011). Moreover, individualized education plans tailored to meet each patient's specific needs and understanding have yielded better results compared to generic educational offerings (Eltheni et al.,2021). Programs employing the use of technology, such as mobile apps and telehealth consultations, further support sustained engagement and adherence to self-management practices, leading to improved metabolic control and enhanced patient satisfaction (Tofik et al., 2023).

3.1.2. Role of the interdisciplinary team: benefits of collaboration between doctors, nurses and nutritionists

The interdisciplinary team approach in diabetes management has emerged as a vital component in optimizing patient outcomes. Collaboration between healthcare professionals, including doctors, nurses, dietitians, and pharmacists, plays a crucial role in the quality of patient education and care. Research emphasizes that interdisciplinary care models lead to improved satisfaction among patients with diabetes and significantly enhance health outcomes, including glycaemic control and reduced hospital admissions (Lee et al., 2018).

The integration of diverse perspectives and expertise allows for a more comprehensive understanding of patient needs, enabling personalized care plans that promote adherence. Moreover, patients report a greater sense of security and trust in their treatment plans when they perceive coordinated care among multiple health professionals (Bilondi et al., 2021). The synergistic effects of teamwork improve the overall efficiency of diabetes management and empower patients in their self-care.

While initial education at diagnosis is essential, evidence suggests that fragmented delivery by a single professional is less effective than coordinated team-based approaches. Interdisciplinary programs achieve greater long-term adherence because they integrate dietary, psychosocial, and pharmacological expertise at once rather than sequentially.

Although the health care team and others can aid in acquiring and implementing new diabetes management tasks, maintaining these habits is sometimes difficult. Annual assessments of knowledge, abilities, and behaviours are thus required for both individuals who meet and those who do not meet the goals. Annual diabetes education visits are recommended to examine all aspects of

self-management, review behaviour modification and coping methods as well as problem-solving skills, identify strengths and problems of type 2 diabetes, and make therapeutic adjustments. This review can be done by a Primary Care practitioner or a clinical team, and if necessary, the patient can be referred to a DSME/S program. When a patient starts a new diabetes medication or if the patient has unexplained hypoglycemia or hyperglycemia, does not objectives and targets, has worsening clinical signs, more frequent DSME/S visits may be required. Importantly, the educator is responsible for informing the referring provider about the updated plan (Powers et al., 2016).

Identifying diabetes complications or patient characteristics that may affect self-management is a crucial indicator for diabetes education and should be addressed promptly with sufficient resources. The healthcare professional may discover issues that impact the therapy and self-care plan during regular medical appointments. The elements may encompass the patient's capacity to handle and deal with diabetic problems, other health issues, medications, physical constraints, emotional requirements, and fundamental life necessities. These indicators can be recognized during the first diabetic contact or can occur at any point. Various patient characteristics impact the clinical, psychological, and behavioural aspects of diabetes care (Powers et al., 2016). Identifying more health issues and the possible requirement for more drugs can make it harder for the patient to control their own health. Multimorbidity complicates education effectiveness. Team-based interventions, particularly those integrating dietitians and mental health professionals, show greater capacity to adapt to these complexities than physician-only models.

Diabetes education can help manage various medical diseases by focusing on changing medication, diet, and physical activity to improve results and quality of

life. Along with learning new self-care skills, effective coping in diabetes self-management education and support programs can involve having a good attitude towards diabetes, maintaining strong relationships, and improving quality of life. Specialized emotional care may be necessary for individuals experiencing worry, stress, and emotional discomfort connected to diabetes or depression (Powers et al., 2016).

Changes in age, health status, housing circumstances, or health insurance coverage may necessitate a reassessment of diabetes treatment objectives and self-care requirements over time. Key transition phases include entering adulthood, hospitalization, and relocating to assisted living, skilled nursing, correctional, or rehabilitation facilities.

DSME/S provides significant advantages to patients while they go through a life transition. Contributing to the creation of reasonable and realistic self-management and treatment plans can be a valuable asset for successfully navigating evolving circumstances. The healthcare practitioner can send a patient to a diabetes educator to assist in developing and implementing a transition plan, offering education, and supporting a successful transfer. The objective is to reduce interruptions in therapy while managing clinical, psychological, and behavioral requirements during the transition (Powers et al., 2016).

3.2. State of the art in advanced professional training

3.2.1. Interventions for doctors and nurses in Primary Care

Quantitative and qualitative studies highlight widespread deficiencies in diabetes knowledge, guideline awareness, and practical management among primary care clinicians, particularly where continuing medical education (CME) opportunities are limited. In a multicenter study from Central China, primary care

providers averaged only 7.25 out of 14 points (~52% correct) on a standardized diabetes knowledge test, with just 26.3% reporting participation in diabetes CME during the prior year (Pi, He, Fei, Shi, & Zhou, 2024). Similar gaps were evident in Southeast Nigeria, where most physicians were unfamiliar with diabetes clinical practice guidelines (79.9%), and 78.1% had not attended any diabetes training since graduation (Ugwu, Young, & Nkpozi, 2020). The same study revealed particularly poor recognition of diagnostic thresholds, with only 26.6% correctly identifying fasting plasma glucose cut-offs, 45.3% identifying random plasma glucose thresholds, and just 10.9% accurately reporting the HbA1c criterion (Ugwu et al., 2020). Beyond diagnostic competencies, systematic review evidence has highlighted persistent knowledge and behavioural-regulation gaps in dietary management of type 2 diabetes; despite clinicians' reported confidence in giving dietary advice, they frequently lacked the skills, resources, and institutional support to implement evidence-based dietary interventions, with time constraints and limited access to ongoing staff training emerging as recurrent barriers (Boocock et al., 2021).

Improving chronic disease outcomes in primary care requires interventions that address both clinician behavior and system design. Evidence consistently shows that team-based training, guideline-linked educational programs, and the empowerment of nonphysician clinicians such as nurses, pharmacists, and certified diabetes educators (CDEs) are central strategies for enhancing adherence to evidence-based guidelines and improving outcomes, particularly for type 2 diabetes mellitus (T2DM) and cardiovascular risk management (Al-Qahtani, 2024; Powell et al., 2021). Training models that prove most effective combine local adaptation, structured decision support embedded within workflows, task-shifting authority, and regular audit and feedback, thereby directly counteracting the

problem of therapeutic inertia, where treatment intensification is delayed despite suboptimal control (Chew et al., 2023).

Educational interventions for PCPs differ widely in format, duration, and delivery, yet even relatively brief exposures can shift provider behavior when well designed. Evidence from controlled studies shows that short, intensive courses and structured CME modules not only raise knowledge scores but also translate into measurable improvements in the delivery of guideline-based diabetes care. Short intensive workshops (e.g., three-day continuing-education courses) produced statistically significant increases in physician knowledge scores and measurable improvements in documentation and delivery of diabetes care processes. Within three months, trained physicians were more likely to conduct HbA1c testing, foot examinations, and diet/exercise counseling, highlighting the impact of even brief interventions on adherence to guideline-recommended care (Almetahr et al., 2020).

Structured online CME and case-based modules also demonstrate efficacy at scale. In one large sample of PCPs, a four-week online curriculum produced significant improvements in diagnostic accuracy (+10.3% in correct diagnosis confirmation) and management knowledge, including enhanced confidence in diet and activity counseling, oral glucose-lowering drug initiation, and insulin management (Emami, Kouhkan, Khajavi, & Khamseh, 2020). These findings suggest that technology-enabled CME can achieve broad reach and measurable gains in clinical preparedness.

Focused e-monographs and topic-specific curricula have proven valuable in rapidly updating PCPs on new therapies and technologies. Educational interventions on incretin-based therapies and continuous glucose monitoring (CGM), for example, yielded substantial relative knowledge gains and large post-education increases in practitioner confidence and preparedness to implement

these modalities in routine practice (Robinson, Frederick, Esgro, & Collier, 2024; Larkin, Schrand, & Le, 2022). Importantly, these topic-focused interventions not only improve knowledge but also reduce therapeutic inertia by equipping PCPs to adopt innovations earlier in the care continuum.

While each modality—short courses, online CME, targeted curricula, and advanced practice training—demonstrates measurable benefits, the literature consistently shows that sustained, system-integrated education produces the most durable improvements in both provider competence and patient outcomes. Brief interventions can raise knowledge scores, but without reinforcement, practice change and patient benefit often attenuate over time. By contrast, programs that embed education within clinical systems, such as tele-mentoring or integrated DSME/nurse-led models, not only enhance PCP self-efficacy but also reduce HbA1c and improve quality-of-care indicators in real-world settings.

Training interventions anchored in system redesign and team-based roles, such as the Chronic Care Model (CCM) and the Patient-Centered Medical Home (PCMH), have demonstrated measurable impact in multiple domains. Both frameworks integrate organizational change, coordinated team roles, clinical information systems, decision support, and patient self-management support. These interventions are associated with improved diabetes outcomes, cardiovascular risk factor control, and greater adherence to preventive measures (Al-Qahtani, 2024; John et al., 2020). Similarly, facility-based educational outreach models such as the Practical Approach to Care Kit (PACK) employ a cascade method of short, on-site sessions alternating between learning and practice to embed guidelines into routine workflows. PACK has been scaled nationally with reports of quality improvement and better outcomes across diverse primary care contexts (Simelane et al., 2018). More behaviorally oriented approaches, such as the

BETTER program, focus on equipping providers with behavioral counseling skills and structured patient goal-setting. Randomized and implementation studies show substantial increases in preventive and screening actions, alongside gains in hypertension and weight control (Aubrey-Bassler et al., 2019). Importantly, interventions that invest in role-specific upskilling of nonphysician clinicians—when combined with explicit protocols and authority to act—produce some of the most consistent results. Meta-analyses report HbA1c reductions up to −1.62% in nurse- or CDE-led programs, significantly outperforming physician-only interventions (Powell et al., 2021). Collectively, these strategies highlight that training is most successful when it is tightly coupled with system design, explicit authority, and workflow integration rather than education in isolation.

Central to the reduction of therapeutic inertia is the empowerment of nonphysician clinicians and the restructuring of care delivery to allow timely treatment intensification. Clinical inertia is widely documented in the management of diabetes, hypertension, and dyslipidemia, and interventions that explicitly shorten follow-up intervals and authorize nonphysicians to adjust therapy are repeatedly identified as more effective than traditional education-only efforts (Chew et al., 2023; Ali et al., 2021). Pharmacist-led programs illustrate this dynamic clearly, with studies in safety-net settings demonstrating higher treatment intensification rates in pharmacist-managed cohorts compared with usual provider care (Lingow & Guyton, 2020). Likewise, nurse- and CDE-led intensification interventions consistently outperform physician-only strategies, especially when structured decision support is embedded into protocols (Powell et al., 2021). Multicomponent approaches that combine team-based care, decision support, and audit/feedback prove superior to single-component or adherence-only interventions, which often fail to alter prescribing behavior (Barton et al., 2018;

Faruqi et al., 2019). Telemedicine programs, while beneficial for patient adherence, highlight the implementation caveat that technological adherence support does not reduce inertia unless prescriber decision pathways and treatment authorization are explicitly addressed (Barton et al., 2018). These findings emphasize that training interventions targeting therapeutic inertia must extend beyond knowledge transfer to include mechanisms of accountability, shortened review cycles, and redistribution of clinical authority.

3.2.2. Reported changes in knowledge of medical team, clinical skills and self-efficacy in health professionals' measures

Advanced training in evidence-based medicine and guideline updates in diabetes management have shown significant impacts on the knowledge, clinical skills, and self-efficacy of Primary Care health professionals. These training programs are designed to enhance the understanding and application of the latest diabetes care guidelines, which are frequently updated to incorporate new research findings and technologies. The training not only improves the theoretical knowledge of healthcare providers but also translates into better clinical practices and decision-making skills. This transition is crucial for managing diabetes effectively, given the complexity and evolving nature of the disease.

Training programs like the Steno REACH Certificate Course in Clinical Diabetes Care have been shown to significantly improve diabetes-related knowledge among healthcare providers. This course includes a comprehensive curriculum covering all main aspects of diabetes care, delivered through a blend of e-learning, classroom-based learning, and clinic-based group work (Mustapha et al., 2020).

Evidence-based medicine training emphasizes the integration of clinical research into practice, which enhances the understanding of current guidelines and treatment options. This approach moves clinical practice from anecdotal experiences to a strong scientific foundation, thereby improving the quality of care provided (Herman, 2002).

Interactive and team-based learning approaches, such as those used in the DIAPREM program, have been effective in improving clinical skills. These methods encourage active participation and discussion, leading to better retention of knowledge and application in clinical settings (Kühne-Eversmann & Fischer, 2013) (Prestes et al., 2017).

Training programs that focus on evidence-based practices and guideline updates have been associated with increased self-efficacy among healthcare providers. Participants in such programs report higher confidence in their ability to manage diabetes effectively, as they are equipped with the latest knowledge and skills (Kühne-Eversmann & Fischer, 2013).

The team-based approach not only enhances learning but also fosters a sense of community and support among healthcare providers, which can boost their confidence in implementing new practices (Daly, 2003).

However, some studies note that while initial skill improvements are significant, there may be a decline over time if reinforcement is lacking. For instance, a study on nurses caring for mechanically ventilated patients found that competency levels decreased significantly over time (Elhabashy et al., 2024).

These results highlight the importance of ongoing training and reinforcement to maintain and enhance clinical skills in EBM.

While the benefits of advanced training in evidence-based medicine and guideline updates are evident, challenges remain in ensuring consistent application

across different healthcare settings. Variability in resources, patient populations, and healthcare systems can affect the implementation of new guidelines. Additionally, ongoing education and support are necessary to maintain the improvements in knowledge, skills, and self-efficacy achieved through initial training programs. These factors highlight the need for continuous professional development and adaptation to local contexts to optimize diabetes care.

3.3. Impact of practitioner education on patient clinical outcomes

3.3.1. Evidence linking improved professional competencies to better metabolic control

The management of diabetes mellitus, particularly type 2 diabetes, is a complex process that requires not only effective patient self-management but also highly competent healthcare practitioners. The relationship between practitioner education and patient outcomes has been extensively studied, with a growing body of evidence suggesting that improving professional competencies leads to better metabolic control and clinical outcomes. For instance, a randomized clinical trial evaluating the impact of diabetes education programs for community health workers found that trained health workers were able to improve patients' lipid profiles, including reductions in total cholesterol and triglycerides (Souza et al., 2017). While HbA1c reductions were observed in both intervention and control groups, the intervention group showed greater improvements in lipid metabolism, highlighting the value of targeted education for healthcare providers (Souza et al., 2017).

The impact of training interventions on patient outcomes has been most clearly demonstrated in diabetes and cardiovascular risk management, with

substantial evidence also emerging in areas such as depression care. Patient-centered medical home (PCMH) interventions have shown measurable improvements across multiple outcomes, including HbA1c, blood pressure, LDL cholesterol, depression symptoms, and hospital admissions, as confirmed in pooled trials and meta-analyses (John et al., 2020). Nurse, pharmacist, and CDE-led interventions demonstrate some of the largest HbA1c reductions, ranging from −0.6% to −1.62%, highlighting the effectiveness of role-specific empowerment compared to physician-only models (Powell et al., 2021). The BETTER trial and subsequent implementation studies reported improvements in delivery of prevention and screening actions, with implementation sites achieving nearly half of all eligible preventive measures within six months, including strong performance in hypertension and weight management (Aubrey-Bassler et al., 2019). Similarly, PACK's national roll-out has been associated with broad improvements in care quality indicators and patient outcomes when integrated into routine facility workflows (Simelane et al., 2018). Training embedded within medical education also demonstrates value: immersive ambulatory residency programs improved both clinical outcomes—patients of participating residents achieved better diabetes control (86% vs. 76%)—and enhanced resident readiness for ambulatory care practice (Graham et al., 2021).

Key features across these successful programs include clearly defined multidisciplinary roles with task-shifting authority, the integration of protocols and decision support into workflow systems, and the use of audit and feedback mechanisms to ensure treatment intensification (Powell et al., 2021; Rodriguez et al., 2024). Short follow-up intervals and locally tailored program designs, informed by qualitative research and cultural adaptation, further enhance sustainability and uptake (Rodriguez et al., 2024). While evidence is strongest in T2DM, hypertension,

and cardiovascular risk, benefits extend to depression care and select other chronic conditions such as COPD and Parkinson's disease through integrated-care models (Murtagh et al., 2021). Collectively, the literature demonstrates that training interventions are most effective when implemented as part of a multicomponent system strategy, rather than isolated educational activities, and when they directly address both provider authority and systemic barriers to treatment intensification.

Integrating dietetic services into interprofessional education models has also been shown to improve glycemic control, with HbA1c levels decreasing significantly from 11.6% to 8.3% (Rowe et al., 2023). This study emphasizes the role of interdisciplinary collaboration and education in achieving better metabolic outcomes for patients with diabetes. Furthermore, inpatient diabetes education has been associated with a 30% reduction in hospital readmissions within 30 days, underscoring the critical role of diabetes education in acute care settings (Healy et al., 2013).

Structured multidisciplinary education programs focusing on lifestyle changes and psychosocial barriers have also demonstrated significant improvements in HbA1c levels, from 8.08% to 6.56% over 12 months, alongside reductions in triglycerides and LDL cholesterol (Ranasinghe et al., 2024). These comprehensive educational interventions highlight the broader metabolic benefits of practitioner education.

Practitioner education programs often focus on improving knowledge and clinical skills, enabling healthcare providers to deliver evidence-based care more effectively (Rowe et al., 2023). For example, a study on cardiologists' education in managing cardiovascular risks in diabetes found significant improvements in their ability to select appropriate glucose-lowering agents and manage comorbid conditions (Larkin & Healy, 2015).

Educated practitioners are better equipped to empower patients with the knowledge and skills needed for effective self-management (Pourmohammad et al., 2023; Zhang et al., 2023). A study based on the Theory of Planned Behavior (TPB) found that patient-centered education improved self-care behaviors and reduced HbA1c levels (Pourmohammad et al., 2023).

Educational programs that promote interprofessional collaboration and teamwork have been shown to enhance glycemic control and reduce complications (Rowe et al., 2023; Silveira et al., 2022). Integrating dietetic services into Primary Care teams improved glycemic control and reduced emergency department visits by 79% (Rowe et al., 2023).

Culturally sensitive educational materials and interventions have also been shown to improve patient engagement and outcomes in diverse populations (Muzenda et al., 2024; Asmat et al., 2022). A study in South Africa found that culturally tailored diabetes education led to a 20% increase in patients achieving target HbA1c levels (Muzenda et al., 2024).

Effective educational strategies include multimodality education models, structured patient education programs, web-based and technology-driven education, and patient-centered care approaches. Multimodality models combining webinars, certification programs, and gamified case studies improved healthcare professionals' competency and confidence in managing cardiovascular risks in diabetes (Madhusudhan et al., 2024). Structured patient education programs, such as the X-PERT Programme, have been shown to improve glycemic control, reduce weight, and lower blood pressure and cholesterol levels (Deakin & Whitham, 2009). Web-based educational activities have enhanced healthcare professionals' knowledge and performance in managing type 2 diabetes and obesity (Okemah et al., 2023). Patient-centered care interventions, which focus on

individualized goals and shared decision-making, have also improved glycemic control and self-care behaviours (Asmat et al., 2022).

Collectively, the literature demonstrates that practitioner education—whether through multimodality programs, culturally tailored curricula, or structured interprofessional frameworks—consistently improves metabolic outcomes, self-care behaviors, and patient satisfaction across diverse populations (Muzenda et al., 2024; Asmat et al., 2022).

The strongest and most sustainable results emerge when education is embedded within multicomponent system strategies. Protocol-driven task-shifting, decision support integration, and feedback loops are the true drivers of improved HbA1c, lipid control, and reductions in hospital admissions, more so than reliance on any single cadre of providers.

For primary care practitioners, these findings are particularly salient. PCPs serve as the frontline of diabetes management, yet frequently report gaps in guideline knowledge, therapeutic confidence, and skills in addressing psychosocial barriers. By equipping PCPs with up-to-date competencies and embedding them in collaborative, feedback-rich systems, practitioner education becomes not merely an academic exercise but a transformative mechanism to elevate the quality of chronic disease care in real-world primary care settings.

4. TYPE 2 DIABETES IN THE CONTEXT OF THE THESIS

4.1. Situation of the management of type 2 diabetes in the setting of this study

According to a comprehensive 2023 report by the Knesset Research and Information Center, diabetes represents a major public health concern in Israel,

with an estimated 548,000 adults (9.8% of the population aged 18 and above) diagnosed as of 2021.This places Israel sixth among 36 OECD countries in diabetes prevalence, well above the OECD average of 6.7%. The burden is not limited to adults, as approximately 3,300 children and adolescents (0.13%) have also been diagnosed. The disease is most prevalent among individuals aged 65 and older, with striking disparities observed across ethnic and socioeconomic lines—rates are particularly high among Arab and Bedouin populations and residents of low-income areas. For instance, in the 65–74 age group, prevalence reached 37% in disadvantaged neighborhoods, compared to 28.9% in affluent areas. Although 89.7% of diagnosed adults underwent HbA1c testing in 2021 and 73.2% achieved reasonable glycemic control (HbA1c < 7–8%), the percentage of patients with poorly controlled diabetes (HbA1c > 9%) in low-income areas was nearly three times higher than in wealthier communities. (Knesset Research and Information Center, 2023)

Diabetes was the third leading cause of death in Israel in 2018, ranking significantly higher than in other Western countries. Particularly alarming is Israel's position as the OECD leader in diabetes-related lower limb amputations, with 17.6 amputations per 100,000 individuals in 2019—over 80% of which occurred in patients with diabetes. Despite national quality indicators addressing glycemic control, kidney and eye screening, and BMI monitoring, systematic diabetic foot care remains absent in community settings. In contrast, geriatric hospitals do include diabetic foot assessments within 24 hours of admission. This disparity in care models may contribute to the persistently high amputation rates and highlights the pressing need for structured educational interventions and prevention protocols, particularly in underserved populations. (Knesset Research and Information Center, 2023)

The most recent evidence indicates that disparities in diabetes care models in Israel contribute to particularly high rates of lower-limb amputation among vulnerable populations, including young adults and ethnic minorities. After a period of decline, amputation rates have begun to rise again, with the increase most pronounced among younger individuals and groups such as Arabs, Bedouins, recent immigrants, and those with low socioeconomic status (McDermott et al., 2023; Muhsen et al., 2017; Zalan et al., 2021). Studies further show that Arab patients and those from lower socioeconomic backgrounds in Israel experience higher complication rates, poorer glycemic control, and reduced access to preventive health services. Rapid lifestyle changes, obesity, and smoking are also more prevalent in these populations, compounding the risk of amputation (Muhsen et al., 2017; Zalan et al., 2021; Wilf-Miron et al., 2010). Recent recommendations emphasize the urgent need to implement multidisciplinary care models, structured patient education, and improved access to preventive health services in peripheral regions and among disadvantaged groups in order to reduce amputation rates and promote equity in diabetes care (Halabi & Tarshoby, 2025; Gallagher et al., 2024).

Israel's universal healthcare system operates through four not-for-profit health funds (Kupot Holim) mandated to provide a statutory benefits package (Health Basket) to all citizens and permanent residents under the National Health Insurance Law of 1995 (Government of Israel, 1995). These funds administer primary and secondary care services financed through a combination of general taxes and an income-related health tax (5% for individuals aged 22+) (Waitzberg & Rosen, 2020). While public healthcare is universally accessible, regional disparities in service availability and quality persist, particularly between urban centers and peripheral areas (Rosen et al., 2015).

Most healthcare professionals, including 68% of nurses, operate within the public system, with community-based care delivered through health fund clinics (Israeli Ministry of Health, 2021). Patients retain the right to choose Primary Care providers and specialists within their health fund's network, though disparities in service access remain pronounced in northern and southern regions (Waitzberg & Rosen, 2020; Rosen et al., 2015).

Despite a diabetes prevalence comparable to OECD averages (~6.5%), Israel reports lower hospitalization rates for poorly controlled diabetes, reflecting strengths in community-level chronic disease management (OECD, 2022). The Quality Indicators in Community Health Care Program tracks over 35 performance measures to promote accountability in Primary Care (Taub Center, 2022).

4.1.1.Demographic and epidemiological characteristics

Diabetes is a major public health challenge in Israel, with a prevalence of 9.8% among adults in 2021, placing the country well above the OECD average of 6.7% and ranking sixth among 36 OECD nations (Knesset Research and Information Center, 2023; OECD, 2022). Although most cases are diagnosed in older adults, the burden is increasingly evident among younger populations, particularly in disadvantaged communities. National data highlight striking disparities by ethnicity, socioeconomic status, and geographic region, which have widened in recent years (Muhsen et al., 2017; Weisband et al., 2020).

The prevalence of type 2 diabetes is significantly higher among Arab and Bedouin populations compared with Jews. For example, age-adjusted rates have been reported as 18.4% among Arabs versus 10.3% among Jews, with Arab women disproportionately affected (Jaffe et al., 2017). Forecasts suggest a continued rise in the Arab population, driven by rapid lifestyle changes, obesity, and smoking

(Zalan et al., 2021). Earlier studies also show that Arabs develop diabetes at a younger age, with one cohort finding onset at a median age of 57 compared to 68 among Jews, contributing to longer disease duration and a higher risk of complications (Kalter-Leibovici et al., 2012). Ethiopian immigrants similarly face elevated risk, with diabetes prevalence linked to dietary and lifestyle changes following immigration (Cohen et al., 1988; updated trends summarized in Muhsen et al., 2017).

Diabetes prevalence is closely tied to socioeconomic status (SES), with higher rates and poorer outcomes among low-income populations (Wilf-Miron et al., 2010). Individuals from lower SES backgrounds are less likely to achieve optimal glycemic control and are more frequently hospitalized for diabetes-related complications (Weisband et al., 2020; Sagie et al., 2019). Geographic inequities also persist: residents of peripheral regions such as the Negev face limited access to specialized care, fewer prevention services, and higher rates of advanced complications (Nadi, 2013; Halabi & Tarshoby, 2025). These inequities are particularly pronounced in the Bedouin population, where cultural and systemic barriers further exacerbate care gaps.

Gender disparities are evident across minority groups. Among Arabs, women consistently demonstrate higher prevalence than men, with reported rates of 20% versus 16.7%, respectively (Jaffe et al., 2017). Among Ethiopian immigrants, younger women also show higher prevalence compared to men, underscoring gender-specific vulnerabilities (Jaffe et al., 2016). Age is a strong determinant: while prevalence increases with age in all populations, Arabs are more likely to develop diabetes earlier in life, leading to a longer disease course and an elevated risk of long-term complications (Kalter-Leibovici et al., 2012; Knesset Research and Information Center, 2023).

The societal costs of diabetes are substantial. An evaluation by Balicer et al. (2018) estimated that 33% of Clalit Health Services' adult healthcare expenditures were attributable to diabetes, despite diabetic patients representing only 13% of members. Roughly 42% of this burden was due to indirect costs such as productivity loss, highlighting the broad economic impact. More recent analyses confirm the ongoing strain on the health system, particularly as new therapies and technologies expand care options (Taub Center, 2022; OECD, 2022).

Taken together, the evidence demonstrates that diabetes prevalence in Israel is high by international standards, with disproportionate impacts on Arab, Bedouin, Ethiopian immigrant, and low-SES populations. Earlier onset among minority groups, combined with gender-specific risks and systemic inequities in access, contribute to higher rates of complications, including cardiovascular disease and lower-limb amputation. These demographic and epidemiological patterns underscore the urgent need for targeted, culturally competent, and equity-oriented interventions to improve prevention, management, and outcomes in type 2 diabetes across Israel.

4.1.2.Current regulations or clinical guidelines

The management of Type 2 Diabetes Mellitus (T2DM) in Primary Care is guided by various clinical guidelines and recommendations from organizations such as the American Diabetes Association (ADA), World Health Organization (WHO), and local guidelines like those in Israel. These guidelines emphasize a comprehensive approach to diabetes management, focusing on individualized care, lifestyle modifications, and pharmacotherapy. The ADA's "Standards of Care in Diabetes" is a key reference, updated annually to reflect the latest evidence and best practices in diabetes management (ElSayed et al., 2024; ElSayed et al., 2023).

The ADA guidelines are updated annually and provide comprehensive recommendations for diabetes care, including treatment goals and quality of care evaluation tools (ElSayed et al., 2024; ElSayed et al., 2023).

Emphasis is placed on individualized treatment plans, incorporating lifestyle changes such as diet and exercise, and pharmacotherapy tailored to the patient's needs (ElSayed et al., 2024).

The guidelines also highlight the importance of early intervention and the use of metformin as a foundational therapy, with additional medications like SGLT2 inhibitors and GLP-1 receptor agonists considered based on cardiovascular and renal benefits (Chan et al., 2024).

WHO identifies T2DM as a major public health challenge and emphasizes the need for global strategies to manage the disease (Fu & Gilbert, 2024). The focus is on prevention through lifestyle modifications, early detection, and management of risk factors such as obesity and sedentary lifestyle (Fu & Gilbert, 2024).

In Israel, as in other countries, local guidelines are adapted from international recommendations to reflect the structure of the healthcare system and the needs of the population. While these guidelines provide a robust framework for managing T2DM, challenges remain in their implementation, particularly in Primary Care settings. The complexity of diabetes management, coupled with the rapid evolution of treatment options, requires continuous education and adaptation by healthcare providers. Additionally, the integration of new technologies, such as continuous glucose monitoring, into routine care presents both opportunities and challenges for improving patient outcomes (Winter, 2023; Basudev, 2022).

In recent years, advanced diabetes monitoring and treatment technologies have been added or expanded within the basket, including broader eligibility for Flash/CGM and hybrid closed-loop systems across additional age groups and

clinical indications, subject to detailed criteria (e.g., regular insulin use and associated clinical conditions). The expansions for 2024–2025 are anchored in Public Committee decisions and relevant Director-General circulars (MOH, 2024a, 2024b; MOH, 2025a, 2025b; MOH, 2024c).

In addition, the basket includes and updates type 2 diabetes medications in line with recognized indications (for example, SGLT2 inhibitors in the context of cardiovascular/renal protection and diabetes), with inclusion or expansion determined by official protocols and committee decisions (MOH, 2023a, 2023b). Public funding is provided in accordance with policies on co-payments and exemptions detailed in health-fund supervisory circulars, including updates on payment rates and targeted exemptions (MOH, 2024d; MOH, 2025c). In practice, a patient who meets the eligibility criteria and/or clinical indications is entitled to broad public coverage through their health fund, usually with only a defined co-payment (MOH, 2022; MOH, 2024d; MOH, 2025c).

Therefore, to ensure that these policy updates and expanded benefits translate into tangible improvements in patient outcomes, physicians must receive structured training, clear guidance, and ongoing orientation to apply the updated protocols appropriately and to facilitate equitable patient access to these services.

4.2. Difficulties detected in clinical practice

Many Primary Care providers lack confidence in prescribing and adjusting newer diabetes medications, leading to therapeutic inertia, a phenomenon in which treatment intensification is delayed despite clinical indications. It has also been found that reported that many Primary Care providers struggle with integrating diabetes education into routine clinical visits, leading to missed opportunities for patient engagement and self-management support. These findings highlight the

significant gaps in Primary Care training and education, necessitating structured interventions to improve provider competency and confidence in diabetes care.

Specifically, many Primary Care providers lack confidence in using newer diabetes medications because of insufficient training and knowledge gaps. One study highlighted that a massive portion of Primary Care providers do not meet treatment goals, indicating a need for improved education and training to bridge these gaps (Larkin, 2024). The introduction of new antidiabetic drugs, such as GLP-1 receptor agonists and SGLT2 inhibitors, has added complexity to treatment guidelines. This complexity can lead to hesitation among providers to intensify treatment, especially when guidelines are unclear or lack practical examples (Kurevija et al., 2024).

Primary Care providers frequently face limited opportunities for continuing professional development in diabetes care, which restricts their ability to remain aligned with evolving clinical guidelines and treatment strategies. Contributing factors include inconsistent implementation of guidelines, uncertainty regarding newer pharmacotherapies, and insufficient emphasis on patient engagement approaches. Consequently, despite significant advances in diabetes management, many providers report inadequate ongoing education, hindering their capacity to deliver evidence-based care. (Aguilar, 2024; Wang et al., 2023)

Although organizations such as the American Diabetes Association (ADA) and WHO provide evidence-based guidelines for diabetes management, many Primary Care providers do not consistently implement them. Studies suggest that provider uncertainty and lack of training in guideline adherence led to wide variations in the quality of diabetes care across healthcare settings (Kurevija et al., 2024) (Larkin, 2024).

The landscape of diabetes pharmacotherapy has evolved significantly in recent years with the introduction of SGLT2 inhibitors, GLP-1 receptor agonists, and dual GIP/GLP-1 receptor agonists. Although these medications have been shown to reduce cardiovascular and renal complications, many Primary Care providers lack adequate training to prescribe and manage them effectively (Larkin, 2024).

Furthermore, effective diabetes care extends beyond medication management; patient engagement and behavioral counselling are critical components of the long term. However, many Primary Care providers do not receive adequate training in motivational interviewing and shared decision-making, which are essential for fostering patient engagement and adherence to treatment plans (Kataria, 2024). Without these skills, providers may struggle to motivate patients to adhere to treatment plans, leading to poor health outcomes.

To address some of these practical gaps in diabetes care, nurses have become essential allies in reducing therapeutic inertia and supporting timely treatment intensification. Clinical nurse specialists and nurse practitioners can provide dose titration, support self-management, and help patients navigate complex treatment regimens, resulting in improved adherence and glycemic control (Kruger, 2012; Powell et al., 2021).

Nurses apply education, behavioural support, access facilitation, and technology to strengthen adherence; these strategies are most effective when delivered repeatedly and tailored to patient needs. Interventions often combine knowledge transfer, practical skills (e.g., insulin technique), psychosocial support, and system-level solutions such as refill coordination. Nurse-led hands-on training for insulin initiation and administration reduces barriers to starting injectable

therapy and improves persistence (Saltar, 2024). Evidence shows that nurse-led programs produce measurable short-term improvements in glycaemic control, adherence, and clinical outcomes, though long-term maintenance depends on program intensity and system support. For example, a timing theory–based nursing case-management study reported shorter hospital stays, a 16.7% higher rate of HbA1c target achievement, better self-management (including medication adherence), lower depression and anxiety scores, and fewer complications compared with routine care (Tang et al., 2025). Similarly, narrative reviews highlight that diabetes specialist nurses and nurse-led clinics are cost-effective, reduce length of stay, and improve clinical outcomes (Zhu et al., 2024). Engagement and self-efficacy are also enhanced through telenursing, DSMES, and mobile-supported programs, which have shown improvements in adherence metrics across multiple program reports and telehealth trials (Cagua et al., 2023).

While broader systemic barriers—such as inconsistent training and institutional limitations—still pose challenges, nurse-led interventions offer a viable and cost-effective strategy to enhance treatment adherence and support guideline implementation in Primary Care.

4.3. Justification of the educational intervention

4.3.1. Focusing the programme on self-efficacy and perceived quality

Focusing an educational intervention on self-efficacy is crucial because it significantly impacts the quality of care provided by healthcare professionals. Self-efficacy, defined as an individual's belief in their ability to execute behaviours

necessary to achieve specific performance attainments, influences clinical decision-making, adherence to treatment protocols, and engagement in continuous professional development (Wu et al., 2012). Higher self-efficacy among healthcare providers has been linked to greater job satisfaction, stronger professional commitment, and improved patient care outcomes (Wu et al., 2012). This is particularly important in healthcare settings where self-efficacy enhances patient-centered behaviours such as smoking cessation and adherence to healthy dietary practices (Łuszczyńska & Schwarzer, 2020).

Moreover, self-efficacy plays a pivotal role in the nursing profession, where it influences clinical performance and patient education. Nurses with higher self-efficacy demonstrate superior performance in clinical settings, reporting greater confidence in decision-making and patient interactions (Alavi, 2014; Farley, 2019). Educational interventions aimed at increasing self-efficacy have been shown to enhance patient outcomes significantly, including improved self-care behaviors among chronically ill patients (Abusubhiah et al., 2023). By targeting self-efficacy, educational programs can foster a proactive approach to disease prevention and health promotion, leading to better patient adherence and disease control outcomes (Farley, 2019). Therefore, incorporating self-efficacy into educational interventions is essential for improving the perceived quality of care and achieving better patient outcomes.

In parallel with enhancing self-efficacy, nurse practitioner-led educational interventions can play a critical role in addressing inequities in diabetes care and fostering cultural competence among Primary Care providers (PCPs). These advanced programs are particularly valuable in equipping PCPs with the skills needed to manage diabetes effectively across diverse and underserved populations. Integrating cultural competence into diabetes education allows

providers to bridge the gap between healthcare systems and patients from various cultural backgrounds, thereby supporting better patient outcomes and reducing health disparities.

For example, culturally sensitive education—delivered through programs that use multilingual materials and contextually relevant health messaging—has been associated with significant improvements in diabetes outcomes. Community health interventions in South Africa, which focused on cultural relevance, demonstrated a 20% increase in the proportion of patients achieving target HbA1c levels (Muzenda et al., 2024). Training in cultural humility also strengthens communication skills and helps PCPs develop a deeper understanding of patients' lived experiences, leading to more responsive and respectful care interactions (Dragomanovich & Shubrook, 2021). These educational elements reinforce the self-efficacy of PCPs by preparing them to navigate culturally complex clinical scenarios with confidence, while also contributing to more equitable healthcare delivery.

Additionally, the concept of "caring for the caregiver" supports the focus on self-efficacy as a foundational component of a healthy and effective healthcare workforce. Nurses with higher levels of self-efficacy are more likely to engage in caring behaviors, build collaborative professional relationships, and create supportive work environments that enhance both staff well-being and patient safety. This has been demonstrated in multiple international studies, which found significant correlations between self-efficacy and caring behavior, job satisfaction, and professional engagement (Wihardja et al., 2024; Reid, 2012).

A supportive practice environment—characterized by nurse involvement in clinical decisions, strong leadership, and institutional recognition—further reinforces self-efficacy and reduces burnout (Shen-yong, 2011; Pereira et al., 2024).

Likewise, self-care practices and psychological renewal strategies have been shown to sustain nurses' energy, motivation, and long-term commitment to quality care (Jb, 1998; Turkel & Ray, 2004).

In this context, educational interventions that explicitly address both professional skill-building and caregiver support are more likely to improve perceived quality of care. Structural empowerment, emotional management training, and cultural sensitivity education can promote self-efficacy while simultaneously enhancing compassionate, patient-centered service delivery (Manojlovich, 2005; Gonzalez et al., 2019).

In addition, focusing on perceived quality of care ensures that educational interventions address not only the technical skills of healthcare providers but also their ability to deliver patient-centered care. This approach aligns with the broader goals of healthcare systems to provide high-quality care that meets patient needs effectively. By enhancing self-efficacy and focusing on perceived quality, educational programs can promote a supportive healthcare environment that encourages patient engagement and satisfaction, ultimately leading to improved health outcomes. This is supported by the positive impact of self-efficacy on job satisfaction and professional commitment, which are critical for maintaining high-quality care (Wu et al., 2012).

Taken together, these elements reflect a cumulative process in which advanced clinical education not only enhances self-efficacy but also facilitates improvements in perceived quality and measurable outcomes. As providers build confidence in their clinical decision-making and communication skills, they become more effective at delivering patient-centered care, adapting to cultural and contextual needs, and implementing evidence-based practices. Over time, this progression translates into tangible improvements in patient satisfaction,

continuity of care, and clinical markers such as glycemic control—underscoring the strategic value of educational investment in frontline Primary Care.

4.3.2. Potential benefits in Primary Care

Enhancing self-efficacy among Primary Care providers can yield several benefits, particularly in reducing clinical inertia and increasing patient satisfaction. Healthcare providers with higher self-efficacy are more likely to take proactive steps in managing chronic conditions, thereby reducing clinical inertia and improving disease control outcomes (Farley, 2019). This proactive approach also enhances patient satisfaction by ensuring that care is tailored to individual needs and preferences, fostering a more collaborative and supportive healthcare environment.

In the context of diabetes management, Primary Care providers play a crucial role in delivering evidence-based care. However, the evolving landscape of diabetes pharmacotherapy, including advanced medications like glucagon-like peptide-1 receptor agonists (GLP-1 RAs) and sodium-glucose cotransporter-2 inhibitors (SGLT-2i), presents challenges due to suboptimal adoption in Primary Care settings (Ling et al., 2024). Inadequate knowledge of these therapies often leads to therapeutic inertia, where providers delay treatment intensification despite evidence of inadequate glycemic control (Wright & Nicholas, 2024). Structured education programs can bridge this knowledge gap, enabling Primary Care professionals to deliver personalized, guideline-directed diabetes care (Murumba et al., 2024). Such programs not only improve clinical outcomes but also enhance patient satisfaction by ensuring that care is aligned with the latest evidence-based guidelines.

Furthermore, educational interventions in Primary Care can lead to better communication and coordination of care across different healthcare settings. Providers who are confident in their abilities are more effective at advocating for their patients and facilitating seamless transitions between healthcare services (Caruso et al., 2016). Additionally, structured therapeutic education programs, often involving diabetes specialist nurses, have been shown to improve clinical, educational, and patient satisfaction outcomes in Primary Care settings. These programs empower patients with the knowledge and skills needed for effective self-management, leading to improved adherence to care and better quality of life. By focusing on self-efficacy and providing comprehensive education, healthcare systems can promote a supportive environment that encourages patient engagement and satisfaction, ultimately leading to improved health outcomes.

5. CONCEPTUAL FRAMEWORK

5.1. Relationship between advanced training and Primary Care professional's self-efficacy

Training programs that focus on evidence-based practices and guideline updates have been instrumental in enhancing self-efficacy among healthcare providers. These programs equip participants with the latest knowledge and skills, leading to increased confidence in their ability to manage diabetes effectively (Kühne-Eversmann & Fischer, 2013). The team-based approach used in many of these programs not only enhances learning but also fosters a sense of community and support among healthcare providers, which can boost their confidence in implementing new practices (Daly, 2003).

In the context of advance care planning (ACP), training programs have been shown to increase self-efficacy among Primary Care professionals. For instance, a study found that professionals with prior training and positive perceptions of ACP felt more capable of conducting these processes (Lasmarías et al., 2021). Similarly, a complex educational program for nurse practitioners demonstrated increased self-efficacy in leading ACP conversations, suggesting that structured training can effectively enhance confidence and communication skills (Geiler & Brady, 2024).

While the benefits of advanced training in evidence-based medicine and guideline updates are evident, challenges remain in ensuring consistent application across different healthcare settings. Variability in resources, patient populations, and healthcare systems can affect the implementation of new guidelines. Additionally, ongoing education and support are necessary to maintain the improvements in knowledge, skills, and self-efficacy achieved through initial training programs. These factors highlight the need for continuous professional development and adaptation to local contexts to optimize diabetes care.

Moreover, advanced training programs have shown significant potential in enhancing self-efficacy among Primary Care professionals. However, it is important to consider the variability in training needs and outcomes. Factors such as prior experience, sociodemographic characteristics, and individual perceptions can influence the effectiveness of these programs (Lasmarías et al., 2021). Furthermore, the sustainability of self-efficacy improvements over time remains a critical area for further research (Gilmore et al., 2023). Overall, tailored training interventions that address specific gaps and leverage peer interactions and feedback can further optimize self-efficacy development in Primary Care settings.

In conclusion, training programs that focus on evidence-based practices and guideline updates are crucial for enhancing self-efficacy among healthcare

providers. By fostering a supportive learning environment and addressing specific training needs, these programs can improve diabetes care outcomes and promote sustainable improvements in healthcare delivery.

5.2. Relationship between professional self-efficacy and improvement of clinical indicators

Self-efficacy is a fundamental determinant in shaping healthcare professionals' ability to deliver high-quality diabetes management, influencing both patient-centered outcomes and adherence to evidence-based clinical guidelines. Bandura's (1977) self-efficacy theory underscores that individuals are more likely to engage in goal-directed behaviors when they believe in their capability to succeed. Within the context of diabetes care, this psychological construct plays a pivotal role in ensuring that healthcare providers exhibit confidence in their ability to educate, guide, and manage patients effectively, which in turn enhances clinical outcomes (Ruano et al., 2022). Studies have consistently demonstrated that healthcare professionals with high self-efficacy are more proactive in implementing complex diabetes management strategies, including intensive glycemic control measures, patient education, and interdisciplinary collaboration (Semple & McCaughan, 2018).

Changes that address provider limitations correlate with improved decision-making and better patient glycemic outcomes. Several interventions designed to reduce provider hesitation have been shown to lower HbA1c and increase rates of appropriate treatment intensification (Powell et al., 2021; Fetzner et al., 2024). Randomized and quasi-experimental programs that supply specialist input, decision support, or structured feedback help close the loop between data and action, producing clinically meaningful HbA1c reductions (Greenwood et al., 2015;

Fetzner et al., 2024). For example, a population-health model that delivered personalized, evidence-based recommendations to primary care providers achieved an average HbA1c reduction of approximately 1%, with more than half of the cohort experiencing a decrease of at least 0.5% during the intervention period (Fetzner et al., 2024). A caveat, however, is that while the existing evidence robustly demonstrates improved clinical outcomes, there is a lack of trials directly quantifying provider self-efficacy as a continuous variable and linking it to patient outcomes or to the precise duration of treatment delays.

Furthermore, self-efficacy is directly associated with adherence to clinical practice guidelines. Research has shown that Primary Care providers with strong self-efficacy are more likely to initiate timely interventions, such as incorporating newer pharmacotherapeutic agents like sodium-glucose cotransporter-2 (SGLT2) inhibitors and glucagon-like peptide-1 (GLP-1) receptor agonists, in line with updated diabetes management protocols (Tsai et al., 2019). In contrast, clinicians with lower self-efficacy often experience hesitation in modifying treatment plans, which may lead to suboptimal glycemic control and increased risk of complications such as cardiovascular disease and nephropathy (Zamani-Alavijeh et al., 2019).

The relationship between professional self-efficacy and patient outcomes is particularly evident in diabetes self-management education (DSME) programs. These initiatives aim to enhance the ability of healthcare providers to install self-care competencies in diabetic patients, leading to improved glycemic control, reduced hospitalization rates, and enhanced patient adherence to treatment regimens (Ruano et al., 2022).

Moreover, empirical evidence suggests that structured training interventions significantly improve healthcare providers' self-efficacy, subsequently enhancing

patient-provider interactions and engagement. A study by Funnell et al. (2022) found that clinicians who underwent targeted educational interventions demonstrated greater confidence in motivational interviewing techniques, leading to better patient adherence to lifestyle modifications and pharmacologic regimens. This is critical in diabetes management, where patient adherence plays a decisive role in long-term disease control.

Beyond individual patient outcomes, provider self-efficacy also has systemic implications for healthcare efficiency and cost-effectiveness. A meta-analysis by Rubino et al. (2022) found that when Primary Care physicians and nurses exhibited high levels of self-efficacy in diabetes management, there was a measurable reduction in preventable emergency department visits and diabetes-related complications. This reinforces the idea that self-efficacy among healthcare providers serves as a key determinant of both micro-level (individual patient) and macro-level (health system) outcomes.

Despite its importance, self-efficacy among treating staff can be negatively influenced by systemic barriers such as high patient loads, lack of continuing education, and limited access to multidisciplinary support teams. Studies indicate that without ongoing reinforcement, provider self-efficacy may decline over time, particularly in rapidly evolving fields such as diabetes care (Zamani-Alavijeh et al., 2019). To counteract these challenges, evidence suggests that sustained professional development programs, mentorship models, and peer-learning networks are effective in maintaining high levels of self-efficacy among diabetes care providers (Funnell et al., 2022).

Systematic reviews and meta-analyses further confirm that multi-component, team-based, and workflow-targeted approaches are among the most effective strategies for overcoming therapeutic inertia (Powell et al., 2021).

Similarly, decision support systems and feedback loops—such as telehealth interventions that integrate remote monitoring with asynchronous educator feedback or clinical decision support tools—have consistently improved provider responses to glucose data and been associated with better glycemic control in trials (Greenwood et al., 2015; Pichardo-Lowden, 2021).

In conclusion, self-efficacy is a foundational element in ensuring high-quality diabetes management. Strengthening provider self-efficacy through structured education, guideline reinforcement, and supportive practice environments can enhance clinical decision-making, improve patient-provider interactions, and contribute to better long-term health outcomes. Future research should explore the optimal methods for embedding self-efficacy-enhancing interventions within Primary Care settings to maximize their impact on diabetes care quality and patient health.

Despite the growing body of evidence supporting the relationship between self-efficacy and quality of care, further research is needed to elucidate the mechanisms through which self-efficacy influences patient outcomes and to develop targeted interventions that enhance healthcare providers' confidence and competence. Implementing structured educational programs, mentorship initiatives, and self-efficacy-enhancing interventions within healthcare training curricula may contribute to more effective patient management and improved health outcomes.

By prioritizing the development of professional self-efficacy, healthcare systems can strengthen provider resilience, optimize patient interactions, and improve the overall quality of care. Future research should focus on identifying the most effective strategies for enhancing self-efficacy among healthcare providers,

particularly in Primary Care, where patient-centered communication and disease management play a crucial role in long-term health outcomes.

II – JUSTIFICATION

II- JUSTIFICATION

Type 2 diabetes mellitus (T2DM) is a pressing public health challenge worldwide. With over 500 million cases globally, approximately 11% of the global adult population aged 20 to 79 years is estimated to have diabetes, and projections estimate an increase to 853 million cases by 2050, meaning that one in every eight adults will have diabetes (International Diabetes Federation,2025; Lin et al., 2022; Widyahening et al., 2022). Approximately 75% of People with diabetes are in low- and middle-income nations, and the burden of diabetes on healthcare systems continues to rise (International Diabetes Federation,2022 ;Lin et al., 2022; Li, 2025). In addition to its high morbidity and mortality, diabetes has severe economic and social consequences, including increased healthcare costs, lost productivity, and diminished quality of life for millions of individuals. Although advancements in diabetes treatment and management strategies have improved patient outcomes, the gap between evidence-based guidelines and real-world clinical practice remains a persistent challenge (Green et al., 2024).

At the heart of this challenge lies Primary Care, where most of the diabetes management occurs. Primary Care providers (PCPs), including general physicians, Primary Care nurses, and nurse practitioners, are on the frontline of diabetes diagnosis, treatment, and patient education. Despite their central role, many Primary Care professionals lack the necessary training, confidence, and resources to implement the latest clinical guidelines effectively (Aguilar, 2024) (Wang et al., 2023). Insufficient resources and support for team-based care models hinder effective diabetes management (Green et al., 2024). The inconsistent application of evidence-based treatment strategies at the Primary Care level

contributes to suboptimal glycemic control, an increased risk of complications, and higher healthcare costs. (Kurevija et al., 2024) (Green et al., 2024).

Given these challenges, there is an urgent need to enhance education and training of Primary Care professionals. While existing research has demonstrated the positive impact of patient education programs on diabetes outcomes, far less attention has been paid to structured, provider-focused education. This study is justified by the critical need to evaluate and implement a structured training program for Primary Care professionals to equip them with the latest clinical knowledge, pharmacotherapy advancements, and patient engagement strategies to improve diabetes care.

The increasing prevalence of T2DM presents a significant burden to the healthcare systems, economies, and societies worldwide. The current economic burden of diabetes is staggering. In 2021, global expenditure on diabetes management and treatment was approximately $966 billion, reflecting a 316% increase over the past 15 years (Gagliardino, 2022). This figure includes direct medical costs such as hospitalizations, medications, and complications, as well as indirect costs such as lost productivity and premature mortality ("The Price of Health.," The Lancet Diabetes and Endocrinology, 2024) (Butt et al., 2022).

In addition to economic strain, diabetes significantly contributes to morbidity and mortality. Poorly controlled diabetes is a major risk factor for cardiovascular disease, chronic kidney disease, neuropathy, retinopathy, and lower limb amputations (American Diabetes Association, 2023). Despite the availability of effective treatment strategies, many individuals with diabetes do not achieve target glycemic control, underscoring the need for improved management strategies in Primary Care (Nogueira et al. 2024).

Primary Care plays a pivotal role in chronic disease management, with diabetes being one of the most treated conditions in Primary Care settings. Primary Care professionals are responsible for the following:

- Early diagnosis and risk assessment
- Lifestyle intervention counselling (diet, exercise, weight management)
- Pharmacological management (initiating and adjusting medications)
- Long-term monitoring of diabetes complications
- Patient education and self-management support

However, many Primary Care professionals report gaps in knowledge and confidence regarding diabetes management,particularly in areas such as the following:

- Initiation and intensification of insulin therapy
- Use of newer pharmacological agents (SGLT2 inhibitors, GLP-1 receptor agonists)
- Behavioural interventions and patient adherence strategies
- Screening and management of diabetes-related complications

Given the substantial gaps in diabetes management at the Primary Care level, there is an urgent need for structured evidence-based training programs tailored to Primary Care professionals.

This study sought to address these gaps by developing and evaluating a comprehensive training program that integrates the following:

- The latest clinical guidelines (ADA, WHO, IDF recommendations)
- Advanced pharmacotherapy education (SGLT2 inhibitors, GLP-1 receptor agonists)

- Practical case-based learning (real-world patient scenarios)
- Behavioral counseling and patient engagement strategies

Screening and early intervention for diabetes-related complications. A well-designed training program can enhance provider self-efficacy, increase adherence to evidence-based guidelines, and improve patient outcomes (Larkin, 2024). By equipping Primary Care professionals with the necessary knowledge and skills, this initiative has the potential to reduce the burden of diabetes complications, lower healthcare costs, and improve the quality of life of millions of individuals worldwide.

A well-structured and evidence-based training program for Primary Care providers can have a profound impact on diabetes management at multiple levels including healthcare systems, patient outcomes, provider efficiency, and policy development. By addressing critical gaps in provider training, it contributes to enhancing the quality and accessibility of diabetes care, leading to improved glycemic control, fewer complications, and reduced healthcare costs (Alzid, 2024).

The most direct and measurable impact of improving the knowledge and confidence of Primary Care providers is improved patient health outcomes. Studies have consistently shown that well-trained providers are more likely to follow evidence-based guidelines, which leads to the following:

- Better glycemic control (lower HbA1c levels)
- Reduced risk of diabetes-related complications (retinopathy, nephropathy, neuropathy, and cardiovascular disease)
- Higher patient adherence to lifestyle modifications and medication regimens

- Lower hospitalization and emergency visit rates (ADA 2023)

Studies have shown that training programs that focus on self-care and self-management are crucial for preventing potential complications and improving the quality of life. These programs enhance patient awareness and knowledge, enabling them to manage diabetes more effectively.(Hermis & Muhaibes, 2024)

This underscores the importance of targeted provider training in diabetes management.

Diabetes is a costly disease that places significant strain on healthcare systems, insurance providers, and government budgets. This study has the potential to reduce overall healthcare expenditure by empowering Primary Care providers to manage diabetes more effectively by:

- Lowering rates of preventable diabetes complications (e.g., amputations, dialysis, and cardiovascular events)
- Fewer unnecessary specialist referrals and hospitalizations
- More efficient use of healthcare resources
- Better long-term health outcomes, reducing lifetime healthcare costs (IDF, 2022)

According to the WHO (2023), investing in Primary Care training programs for chronic disease management leads to a return on investment (ROI) of approximately 7:1, meaning that for every $1 spent on training, $7 is saved in reduced healthcare expenditures.

Grounding this study in established theoretical models is essential for explaining healthcare provider behaviour, patient-provider interactions, and chronic disease management.

One of the core objectives of this study was to improve the self-efficacy of Primary Care professionals regarding diabetes management. Self-efficacy is a well-established determinant of healthcare provider behaviour, adherence to guidelines, and clinical decision-making. By equipping Primary Care professionals with updated knowledge, structured decision-making tools, and hands-on training, this programme can:

- Increase provider confidence in prescribing and adjusting diabetes medications
- Enhance the ability to detect and manage diabetes complications early
- Improve the integration of behavioral counseling and patient education into routine visits
- Reduce therapeutic inertia in diabetes care

This study is supported by Albert Bandura's Self-Efficacy Theory, which posits that individuals' confidence in their abilities directly influences their behaviors and performance outcomes (Donkoh, 2023).

In the context of diabetes management, a lack of provider self-efficacy may leads to clinical hesitation, therapeutic inertia, and poor adherence to the guidelines (Rodriguez-Saldana, 2019; Gentile, Ceriello, & Strollo, 2016). By implementing structured training programs, this study aims to:

- Increase provider self-efficacy, leading to greater adherence to clinical best practices

- Improve patient-provider communication, fostering stronger engagement in diabetes self-management
- Encourage proactive treatment approaches, reducing delays in therapy escalation

Studies on self-efficacy and medical education have demonstrated that enhancing provider confidence through structured training significantly improves clinical performance and patient outcomes. Implementing these findings in diabetes management is essential, as research indicates that empowering healthcare professionals leads to better patient results, particularly for those newly diagnosed with diabetes . (Shoaib et al., 2023) Enhanced provider confidence has been shown to improve clinician engagement in self-management and decision-making processes, which is critical for effective diabetes care (Hawthorne et al., 2012) (Shoaib et al., 2023).

Beyond its immediate impact on Primary Care practice, this study has broader policy implications that can influence public health strategies, healthcare workforce planning, and national diabetes prevention efforts.

The findings from this study can provide valuable data to support the integration of structured diabetes education into medical and nursing school curricula, continuing medical education (CME) programs, and national clinical practice guidelines.

If successful, this program could serve as a model for large-scale implementation in:

- Government-led Primary Care initiatives

- Healthcare organization training programs
- International collaborations for chronic disease management

Evidence suggests that low-income and rural populations often receive lower-quality diabetes care due to limited provider training, fewer resources, and geographic barriers (Li, 2025). By equipping Primary Care professionals in underserved areas with specialized training, this study has the potential to reduce disparities in diabetes outcomes and promote more equitable healthcare access.

In conclusion, the rising prevalence of type 2 diabetes, coupled with the challenges of effective management in Primary Care settings, underscores the urgent need for targeted educational interventions. While patient-centered diabetes education has been widely studied, limited attention has been given to the training needs of Primary Care professionals, despite their significant role in diabetes care.

The necessity of this study is underscored by:

1. The growing global burden of diabetes and its economic, social, and healthcare consequences
2. The critical role of Primary Care providers in diabetes diagnosis, treatment, and long-term management
3. The gaps in provider knowledge and confidence, leading to inconsistent care and poor patient outcomes
4. The proven impact of structured training programs on improving provider self-efficacy, adherence to guidelines, and patient health outcomes

5. The potential to inform policy, strengthen healthcare systems, and reduce disparities in diabetes care

By developing and evaluating a structured diabetes training program for Primary Care professionals, this study aims to bridge the gap between evidence-based guidelines and real-world practice, leading to better patient outcomes, improved provider performance, and reduced healthcare costs.

Investing in Primary Care workforce development is essential to addressing the global diabetes epidemic, and this study contributes to the critical need for sustainable, high-quality, and accessible diabetes management solutions.

III – OBJECTIVES

III - OBJECTIVES

General objective

To assess the impact of an advanced training programme on knowledge, self-efficacy and perceived quality of care in Primary Care professionals, as well as its effects on metabolic control (HbA1c, glycaemia, renal function) in patients with type 2 diabetes.

Specific Objectives

1. To determine the level of knowledge and initial self-efficacy of Primary Care professionals in managing type 2 diabetes.

2. To describe the variability in specific training and previous experience of Primary Health Care professionals in Managing type 2 diabetes.

3. To identify the main weaknesses in the specific training programmes of Primary Health Care professionals in Managing type 2 diabetes.

4. To design and implement an advanced, multidisciplinary training programme for Primary Care Physicians and Nurses, focused in pharmacological update, diabetes education strategies, latest clinical guidelines, patient-centered strategies and clinical decision-making tools, for type 2 Diabetes through active methodologies (clinical cases, practical workshops, etc.).

5. To analyse the effect of this training programme on the increase of knowledge, self-efficacy and perceived quality of care of the professionals.

6. To assess the impact of the advanced training program in Primary Health professionals on the clinical parameters of the patients with type 2 diabetes treated in these centres.

IV – MATERIAL AND METHODS

IV- MATERIAL AND METHODS

4.1. Design of the study.

A longitudinal, quasi-experimental, analytical, and comparative study with a control group was carried out in Primary Care settings. A training program for nurses and physicians was developed and performed, including clinical guidelines and novel approaches to type 2 diabetes (Appendix 1). The training program with health professionals was the intervention that was implemented.

The patients assigned to this health proffesionals were allocated in a second phase depending on whether professionals followed the educational intervention or not; therefore, a cohort study was conducted (in terms of patients). The study adhered to the STROBE norms of cohort studies.

4.2. Phases of the study and educational program

The program was focused on diabetes therapy and its management for individual patients. It was the firs phase. The main goal was updating knowledge about several topics, including new drug therapies and engaging health professionals in case study simulations. These components aim to provide healthcare professionals with the necessary skills to provide evidence-based practice and patient-centered care.

The learning methodology of the educational program included theoretical exposi- tion, flipped classroom, presentation and discussion of clinical cases, and problem-based learning through workshops. The training program comprised 8 mandatory sessions (with the option to attend a missed session in another of the 4 educational program groups that were implemented). The objective of the

educational program was to engage a cohort of health professionals, comprising both doctors and nurses, in a collective learning experience. This was deemed essential to foster a collaborative approach, which is pivotal for effective chronic patient management within a healthcare context. Con- sequently, the program integrated a joint follow-up and roundtable discussion at its conclusion. The rationale behind the training program itself stipulates the necessity for joint training activities, rather than individual ones. This is since the long-term follow-up of the patient represents a common objective shared by both professional profiles.

The course featured eight three-hour sessions and was overseen by a Diabetes Nurse Practitioner (DiNP). Topics covered by the course included a review of the current treatment algorithms, oral therapy and insulin injections, diabetes complications (including cardiovascular risk factors and treatment of diabetic foot), glucose monitoring, responsiveness and motivation, diabetes in pregnancy, and the role of the multi-professional team. Attendance was mandatory for all sessions. In the second phase, patients were allocated depending on whether professionals followed the educational intervention or not.

The whole study was carried out from January 2022 to June 2023.

4.3 Primary Care Health Professionals

The study included 157 health professionals working in primary healthcare clinics (HMO Kupat Holim Meuhedet North Dist (Israel)), 77 PCPs (general practitioners and fam- ily physicians), and 80 nurses. The mean experience of the professionals was 15 ± 11 years (median = 13.5 years, IQR = 18). Professionals were divided into two groups depending on baseline knowledge about diabetes. The intervention group was composed of 77 health pro- fessionals (40 nurses, 37

practitioners), who participated in a diabetes education program. An additional group of 80 health professionals who did not participate in the education program (40 practitioners, 40 nurses) was considered as a control group. The selection criterion was to have at least 50 patients with type 2 diabetes under their care. As exclusion criteria, professionals with a previous specialty in diabetes and those who had previously taken similar courses on type 2 diabetes were excluded from the study.

The minimum required sample size was 48 individuals in each group, calculated based on a 95% confidence level and 10% confidence interval (minimum n = 96), according to the GPower 3.1 calculations (Mayr et al., 2007).

4.4. Data Collection and Instruments and Variables

Diabetes knowledge was measured with seven multiple-answer questions about a health professional knowledge about diabetes and its care, e.g., "The following answers regarding treatment with GLP1 drug group are correct", and several clinical cases (Appendix 4). Questions were developed based on current ADA guidelines and previous similar works (Elsayed et al., 2023, Ishikawa et al., 2008).

The number of correct answers was considered as the previous diabetes knowledge score (range 0–7 points, where 0 indicates a complete absence of knowledge, and a score of 7 indicates the highest level of knowledge). The questionnaire yielded a Cronbach's α of 0.63, which, although it would be desirable for it to be greater than 0.7, indicates acceptable internal consistency and is similar to previous studies (Ishikawa et al., 2008).

Those who demonstrated lower levels of previous diabetes knowledge, considered as a score lower than 3.5 points, were included in the intervention

group, while those who demonstrated higher knowledge were placed in the control group.

The self-efficacy test employed in the present study comprised six subscales (Appendix 5): mastering knowledge of diabetes treatment, belief in treatment ability, knowledge required to begin treatment with SGLT2, knowledge required to begin treatment with GLP1, perceptions about patients with type 2 diabetes management, and the care delivered at the Primary Care center. In the mastering knowledge of diabetes (12 items) dimension, participants rated their proficiency in a range of competencies, including the ability to identify, diagnose, and manage diabetes. The belief in treatment ability (5 items) scale was used to evaluate participants' confidence in their ability to identify conditions affecting diabetes balance, change drug treatments, and prevent acute conditions. Knowledge of the factors required to begin treatment with SGLT2 (7 items) and GLP1 (9 items) was based on decision making in clinical settings about the use of these drugs. The perceptions about type 2 diabetes management (12 items) referred to the opinions of professionals about how patient care should be, for example, whether it is mandatory to visit a nutritionist or whether nursing follow-up is mandatory. Finally, the care at the Primary Care center (7 items) evaluated the perception of the management of patients with type 2 diabetes at the workplace, e.g., "The level of treatment for diabetics in my clinic is insufficient".

Participants rated the questions on a Likert scale from 1 to 5. Ratings were provided from 1 (not at all) to 5 (to a very large extent). A mean score was calculated for each dimension, defined as the mean value of all the items that made up that dimension, and an overall self-efficacy score was calculated as the mean value of all the items in the scale (52 items). All scores had a range of 1–5 points. Higher scores indicate greater self-efficacy in diabetes management and treatment, with

scores of 5 reflecting enhanced self-efficacy. The Cronbach's α of the questionnaire was 0.91, which indicates a very high internal consistency.

The test employed in the present work was developed ad hoc, mainly because several items of previous works about knowledge were old-fashioned and outdated for current type 2 diabetes management. However, the following scales were used as a starting point: the Diabetes Knowledge Questionnaire (Zuñniga et al., 2023), the Revised Diabetes Knowledge Scale (Collins et al., 2011), the Diabetes Management Self-Efficacy Scale (Bijl et al., 1999), and the Diabetes Empowerment Scale (Anderson et al., 2000).

The last determination of health professionals was the perception of the quality of care. This scale evaluates the effectiveness and quality of diabetes care provided by healthcare professionals in different settings. Eccles et al. provided a framework (iQuaD) for assessing and enhancing the quality of diabetes care in various healthcare environments (Eccles et al., 2011). The present study employed an 18-item scale, with a Likert score ranging from 1 (disagree) to 5 (totally agree), based on two dimensions of the Eccles et al. iQuaD test: perceptions of treating diabetes in the community, which emphasizes understanding practice and staff characteristics that influence diabetes care in community settings, and the iQuaD dimension of treating patients with diabetes at the Primary Care clinic, which focuses on identifying factors that impact diabetes management quality at the Primary Care level (Appendix 6). An overall quality of care score was determined as the mean score of all the items (range 1–5 points). The Cronbach's α of the test was 0.87, also indicating a high reliability.

4.5. Patients with Type 2 Diabetes

Patients with a diagnosis of type 2 diabetes mellitus, HbA1c ≥ 7%, and an age range between 18 and 85 years, treated by physicians and/or nurses at several Primary Care settings took part in this longitudinal cohort study. Patients with a diagnosis of type 1 diabetes mellitus, those who were pregnant, those with severe disabilities, or those with high fluctuations in glycemic control (i.e., having more than 3 episodes of hyperglycemia and/or hypoglycemia in the 3 months before the beginning of the study), were excluded. Being treated by an endocrinologist or attending a diabetes clinic was also considered an exclusion criterion.

Patients were allocated to the intervention group and control groups depending on whether the Primary Care professional attended the advanced education program or not. Finally, 4099 patients took part in this phase of the study (2088 monitored by professionals included in the education group and 2011 monitored by professionals included in the control group).

4.6. Clinical Parameters

In order to evaluate the effectiveness of the education program on clinical outcomes of patients with type 2 diabetes, demographic and clinical data were collected from clinical records of patients with diabetes who were associated with each of the health professionals participating in the study.

These data were collected at baseline and 12 months after the end of the education program. Clinical parameters included different variables usually evaluated in Primary Care settings, including HbA1c levels, lipid metabolism parameters (total cholesterol, fasting triglycerides, non-high-density lipoprotein cholesterol), blood pressure, frequency of hypoglycemia incidents, frequency of hyperglycemia incidents, the number of purchases of prescribed diabetes medications, frequency of visits for laboratory testing, the number of appointments at the clinic attended by the patient, the number of appointments with dietitian

attended by the patient, and the frequency of foot check-ups. Other variables included age, sex, year of diagnosis, and the presence of co-morbidities.

4.7. Ethics

All patient data were anonymized and coded to avoid identification. The study adhered to the ethical principles outlined in the Declaration of Helsinki, emphasizing respect for individuals, beneficence, and justice. Ethical approval for the study was granted by the Ethical Committee of Meuhedet Health Services (approval code: 529/2021, 4 November 2020), which included a detailed study description, including design, procedures, risks, benefits, cultural and social implications, and data handling. The necessary permissions were requested before gaining access to patients' clinical data.

Regarding Primary Care staff, permission was also requested for the implementation of the training program, which required the application of different questionnaires adapted to the local language.

4.7. Statistical Analysis

Data were represented as mean ± sd unless otherwise indicated for quantitative variabless and frequency (%) for qualitative variables. Once normality was confirmed through the Kolmogorov–Smirnov test, t-tests were conducted to evaluate possible differences at baseline in age and other parameters. Changes from the baseline were evaluated by paired t-tests. Moreover, to compare the changes between those patients managed by health professionals who followed the advanced practice education versus those who did not, an independent sample t-test was conducted comparing mean changes (6-month values minus baseline values).

Additionally, an ANCOVA analysis was conducted to adjust the significance level for several covariates such as sex, age, and other baseline parameters. To confirm the effect on the main clinical variables (fasting glucose and HbA1c) while considering that patients were grouped by Primary Care specialist, who were divided into intervention and control groups, a mixed-effect model was conducted to capture variability within Primary Care staff and between groups of patients. Primary Care staff was considered as a random effect, while the educational intervention was considered as a fixed effect. To do this, change in metabolic parameters—fasting glucose and HbA1c—was established as the dependent variable, and the intervention group was the fixed independent variable. The Primary Care staff was treated as the random variable. The mathematical model used was as follows:

$$yij = \beta 0 + \beta 1 \cdot \text{Group} + uj + \in ij \quad (1)$$

where yij means the change in the metabolic parameter, $\beta 0$ is the mean change in the parameter without intervention, $\beta 1$ is the effect of educational intervention, uj is the random effect for Primary Care staff j, and $\in ij$ is the residual error for patient i of Primary Care staff j.

To verify that the assumptions of normality were met in the adjusted model, a study of the residuals was carried out. Additionally, a comparison analysis was performed with a null model (not including intervention groups), using a likelihood ratio test to verify whether the inclusion of the group variable significantly improved the model.

Finally, since Primary Care professionals were not randomly assigned to the educational intervention group, a propensity score matching (PSM) analysis was used to reduce selection bias and balance the characteristics of patients cared for by health professionals who received the educational intervention and those cared for

by professionals who did not (control group). To adjust for baseline differences between groups, the PSM technique was applied using the MatchIt package in R. The propensity model was built using logistic regression where the dependent variable was Primary Care partic- ipation in the educational intervention and the independent variables were the baseline characteristics of physicians and patients (including age, previous experience, baseline knowledge about diabetes, socioeconomic status, and patient clinical variables such as blood glucose and HbA1c).

The nearest neighbour matching method was employed with a 1:1 ratio and without replacement. The balance between groups before and after matching was assessed using propensity score distribution plots and a summary of covariate balance. After matching baseline differences between groups were significantly reduced, ensuring adequate comparability for analysis of intervention effects.

Once the matched sample was obtained, a comparative analysis of clinical outcomes in patients was performed, primarily assessing reduction in glycated haemoglobin (HbA1c) levels. To do so, a t-test was used to compare the means of the HbA1c change variable between patient groups treated by health professionals who participated in the educational intervention and those who did not.

The significance level was established at $p < 0.050$. All analyses were carried out with IBM SPSS 28.0 software and R software (4.4.2 release) (see Appendix 9 for R code).

V – RESULTS

V- RESULTS

5.1 previous knowledge

5.1.1 previous knowledge level among the overall participants:

Previous knowledge about diabetes was measured through 7-item survey. 160 Primary Care health professionals filled the survey.

The overall mean of the previous knowledge among the 160 professionals was 4 out of 7 degrees, which emphasizes that the level of knowledge about diabetes among the PC professionals was average. the IQR of the knowledge level was 3 suggesting high variability among the professionals (figure 1).

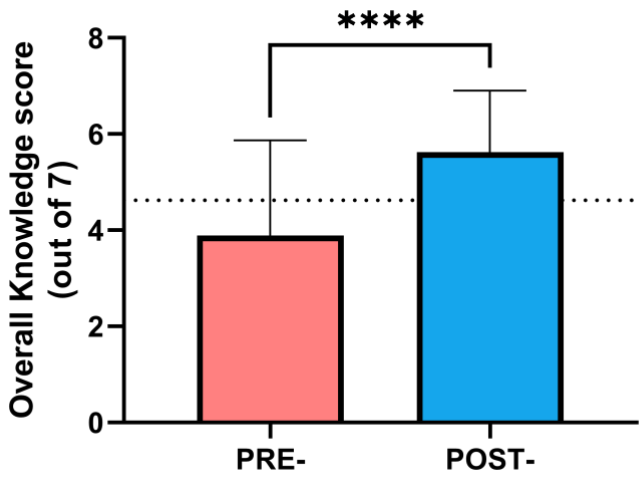


Figure 1. Changes in Knowledge about Diabetes score (out of 7) after the advance education program in the professionals allocated in the intervention group. Dotted red line represents the mean score of the control group. Statistical differences were evaluated by a paired-t test. **** $p < 0.0001$.

5.1.2 group selection:

In this research the 160 PC professionals were divided into two groups, the first group which is the control group – PC professional with high knowledge and received diabetes education, the second group is the intervention group – PC professionals with low knowledge and didn't receive diabetes education.

5.1.3 knowledge differences between pre and post intervention

In order to evaluate the improvement in diabetes knowledge after the educational intervention pointed for the intervention group, paired participants t-test was conducted, accompanied with ANCOVA test for ensuring that age nor sex affected the improvement. The t-test results showed significant difference between the knowledge level after the educational intervention (M=5.6) and previous to the intervention (M=3.2), $p<.001$. furthermore, ANCOVA analysis revealed that the improvement was independent of sex, age and professional experience (p adj=.002) (figure 1)

5.2 Self-Efficacy

5.2.1 Self-Efficacy among the overall participants

Self-efficacy was evaluated through 5-point scale questionnaire, the overall self-efficacy among the whole participants of PC professionals showed high degree with mean of 3.7 (higher than the medium degree 3 out of 5-point scale), with small standard deviation of 0.4 accounting for low variability of self-efficacy among the PC professionals.

Worth to mention that in the questions related to drug treatment a high mastery level was observed among the overall participants, however the highest

scores were observed in staff perception regarding diabetes treatment in the community, as we can see that 67.5% of the participants agreed that a new diagnosis was a window of opportunity to balance diabetes, also 54% agreed that every patient must be referred to a nurse. In contrast, only 2% of the participants considered that the level of treatment for diabetes in the clinic was insufficient.

The self-efficacy questionnaire has 6 dimensions: mastery, skills, SGLT2, GLP1, perceptions and care at PC center. The skills dimension registered the highest score among the participated PC professionals with mean of 3.9 (compared to the medium level of 3 out of 5-point scale) and 0.7 standard deviation. Care at the PC clinic dimension registered the lowest level with mean equals to 3.3 - yet higher than medium level compared to the 5-point scale, also with small standard deviation of 0.4 showing the low variability among the participants.

5.2.2 Comparing groups and within intervention group

In order to check the differences between control group self-efficacy and pre intervention group status, independent two samples t-test was applied, the results showed significant superiority of the control group over the intervention prior the educational intervention in the overall self-efficacy and in each one of the 6 dimensions, $p<.0001$.

However, looking at the difference between the status of self-efficacy after the educational intervention and the status of it prior to the intervention, the paired t-test showed significant improvement ($p<.001$) regarding the overall score

and 5 dimensions out of 6 dimensions of self-efficacy, where care at the Primary Care clinic dimension registered insignificant improvement (p=.761) (figure 3).

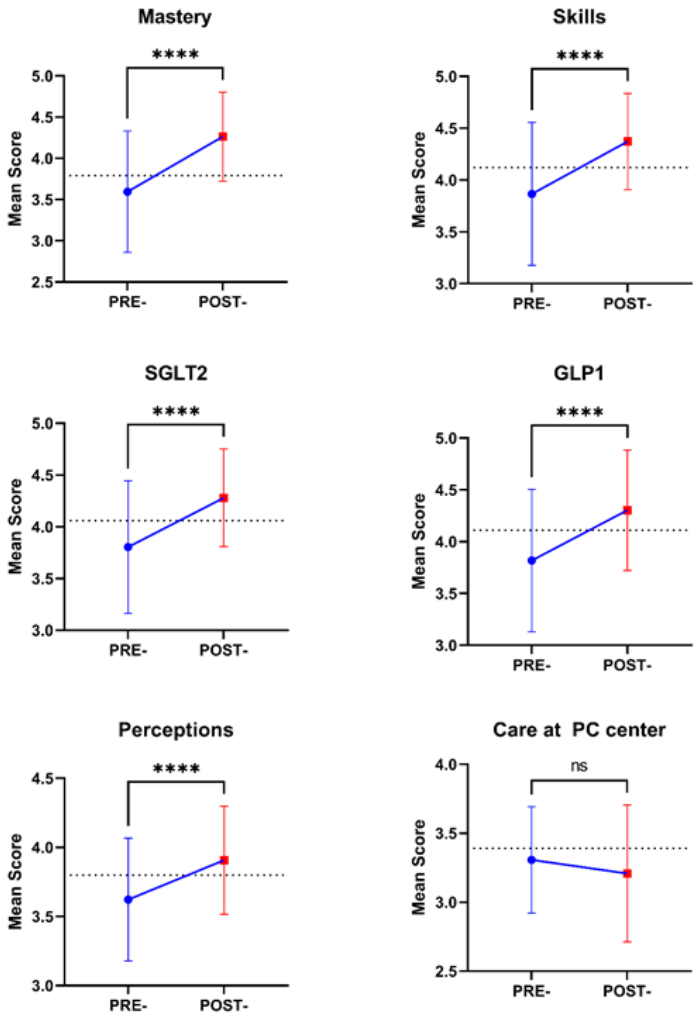


Figure 2 Changes in the mean score of the different dimensions of the self-efficacy test

Changes in the mean score of the different dimensions of the self-efficacy test (out of 5) after the advance education program. Dotted line represents the mean score

of the control group. Statistical differences were evaluated by a paired-t test. **** p < 0.0001; ns: not significant differ-ences.

5.3 Self-Perceived Quality of Diabetes Care

5.3.1 comparing groups and within intervention group

The self-perceived quality of diabetes care questionnaire is a 5-point scale.

In order to examine the difference between control group and pre-intervention group scores in self-perceived quality of diabetes care, independent two samples t-teat was conducted, the results showed that both groups registered similar scores ($p>.05$), where control group showed a mean of 4.1 against a mean of 3.8 for the pre-intervention group. Worth mentions that the standard deviation of both groups at the baseline scores were equal (0.4).

In order to assess the improvement in self-perceived quality of care after the educational intervention, paired t-test was conducted, the results showed significant difference between the post level ($M=4.2$) compared to the prior level ($M=3.8$), $p<.05$, registering a mean improvement of 10% (figure 3).

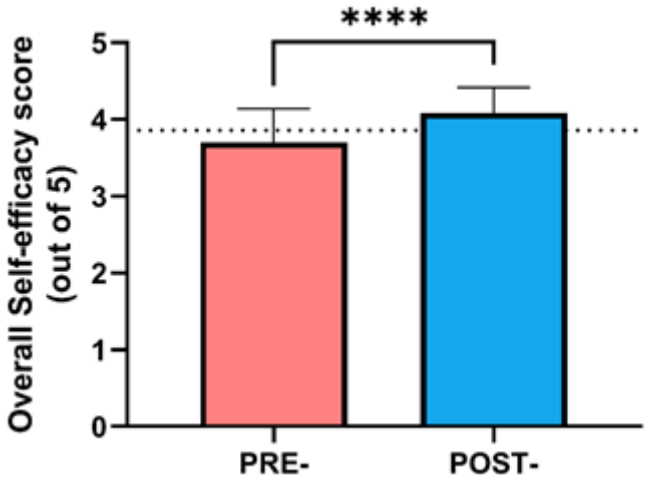


Figure 3. Changes in perceived quality of care scores

Changes in perceived quality of care scores (out of 5) after the advanced education program in the professionals allocated in the intervention group. The dotted line represents the mean score of the control group. Statistical differences were evaluated through a paired t-test. ****p<.0001.

5.4 baseline clinical characteristics of patients with type 2 diabetes

5.4.1 participated patients and grouping

In the research 4099 patients were included, 2011 of them took part of the control group, where 2088 allocated to the intervention group. The control group patients get the care from the control group PC professionals, and the intervention similarly get the care from the intervention group of PC professionals.

5.4.2 baseline characteristics differences between groups

in order to check the baseline clinical and sociodemographic characteristics differences of patients with type 2 diabetes in control group versus intervention

group prior to experiment, independent two sample t-test was carried out (table 2).

Table 2. Baseline clinical and sociodemographic characteristics of patients with type 2 diabetes according to the allocation group of their health professional in charge (Clinical parameter changes after intervention in both the control and experimental groups)

Characteristics	Total population (n=4099)	Control group (n=2011)	Intervention group (n=2088)	*t*	*p* (sig)
Age (years)	63 ± 11	64 ± 11	63 ± 12	0.798	0.424
Weight (kg)	85.3 ± 16.5	85.8 ± 16.6	84.8 ± 16.4	1.828	0.068
BMI (kg/m^2)	30.11 ± 6.88	30.57 ± 6.94	29.67 ± 6.80	3.991	<0.001
Duration of diabetes (years)	6 ± 2	7 ± 2	6 ± 2	2.047	0.041
SBP (mmHg)	131 ± 16	131 ± 15	131 ± 16	-0.199	0.842
DBP(mmHg)	76 ± 9	76 ± 8	75 ± 9	2.373	0.018
Fasting Glucose (mg/dl)	135 ± 47	135 ± 45	136 ± 50	-0.748	0.454
HbA1c (%)	7.1 ± 3.1	7.0 ± 1.4	7.2 ± 4.1	-2.533	0.110
Triglycerides (mg/dl)	166 ± 140	166 ± 166	167 ± 110	-0.313	0.754
Total cholesterol (mg/dl)	173 ± 42	173 ± 44	173 ± 41	-0.070	0.944
Non-HDL (mg/dl)	129 ± 41	129 ± 42	129 ± 40	-0.647	0.518
LDL (mg/dl)	97 ± 34	97 ± 35	97 ± 34	0.048	0.962
eGFR (mL/min/1.73m^2)	79.7 ± 19.7	78.8 ± 19.6	80.6 ± 19.8	-2.787	0.005

Data represent mean ± sd. BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HDL: high-density lipoproteins; LDL: low-density lipoproteins. eGFR: estimated glomerular filtration rate. Differences between control and intervention groups were evaluated by a t-test.

the results as seen in table 2 implies the following:

1. Age: non-significant difference in age was observed (t=0.798, p=.424), where control group patients registered a mean of 64 with 11 years standard deviation, and intervention group showed a mean of 63 with 12 years standard deviation.

2. Weight: none-significant difference in weight was observed (t=1.828, p=.068), control group patients registered a mean weight of 85.8 with 16.6 standard deviation, close weight were registered by the intervention patients' group (M=84.8, SD=16.4).
3. BMI: the intervention group showed significantly higher BMI (M=29.67, SD=6.80) than control group patients (M=30.57, SD=6.94), t=3.991, p<.001.
4. Duration of diabetes: the control group patients registered significantly higher duration of diabetes (M=7, SD=2) compared to intervention groups' duration years of diabetes (M=6, SD=2), t=2.047, p=.041.
5. SBP (mmHg): control and intervention groups showed similar SBP levels, where both registered a mean of 131 mmHg, t=-0.199, p=0.842.
6. DBP (mmHg): control group patients showed significantly higher DBP levels (M=76, SD=8) compared to intervention patient group (M=75, SD=9), t=2.373, p=.018.
7. Fasting glucose (mg/dL): Insignificant difference was observed between control group patients' glucose level (M=135, SD=45) and the intervention group patients (M=136, SD=50), t=-0.748, p=.454.
8. HbA1c (%): Insignificant difference was observed between control group patients' HbA1c level (M=7.0, SD=1.4) and the intervention group patients (M=7.2, SD=4.1), t=-2.533, p=.11.
9. Triglycerides (mg/dL): Insignificant difference was observed between control group patients' triglycerides level (M=166, SD=166) and the intervention group patients (M=167, SD=110), t=-0.313, p=.754.
10. Total cholesterol (mg/dL): similar mean cholesterol levels were observed among both control and intervention group patients (M=173) with close variability (SD=44 vs SD=41 subsequently) , t=-0.070, p=.944.

11. Non-HDL (mg/dL): similar mean Non-HDL levels were observed among both control and intervention group patients (M=129) with close variability (SD=42 vs SD=40 subsequently) , t=-0.647, p=.518.
12. LDL (mg/dL): similar mean LDL levels were observed among both control and intervention group patients (M=97) with close variability (SD=35 vs SD=34 subsequently) , t=-0.070, p=.944.
13. eGFR (mL/min/1.73m^2): the intervention group patients showed higher eGFR level (M=80.6, SD=19.8) compared to the control group patients' (M=78.8, SD=19.6), t=-2.787, p=.005, worth mention that the variability is quit close in both groups.

5.4.3 hypothesis testing: better metabolic control in the patients managed by professionals who underwent advanced practice education (experiment group).

In order to test the hypothesis above, firstly the clinical parameters were evaluated after the educational intervention took place. In order to compare the effectiveness of diabetes management, mean changes were compared through a forest plot (figure 4), After 12 months of the educational program receiving, both control and intervention groups experienced improvements in most metabolic parameters, except for total cholesterol and LDL plasma levels, where they remained similar.

significant improvement after the educational intervention was observed in fasting glucose, glycosylated hemoglobin and renal function (p<.001). worth mentions than the highest improvement was at the fasting glucose level.

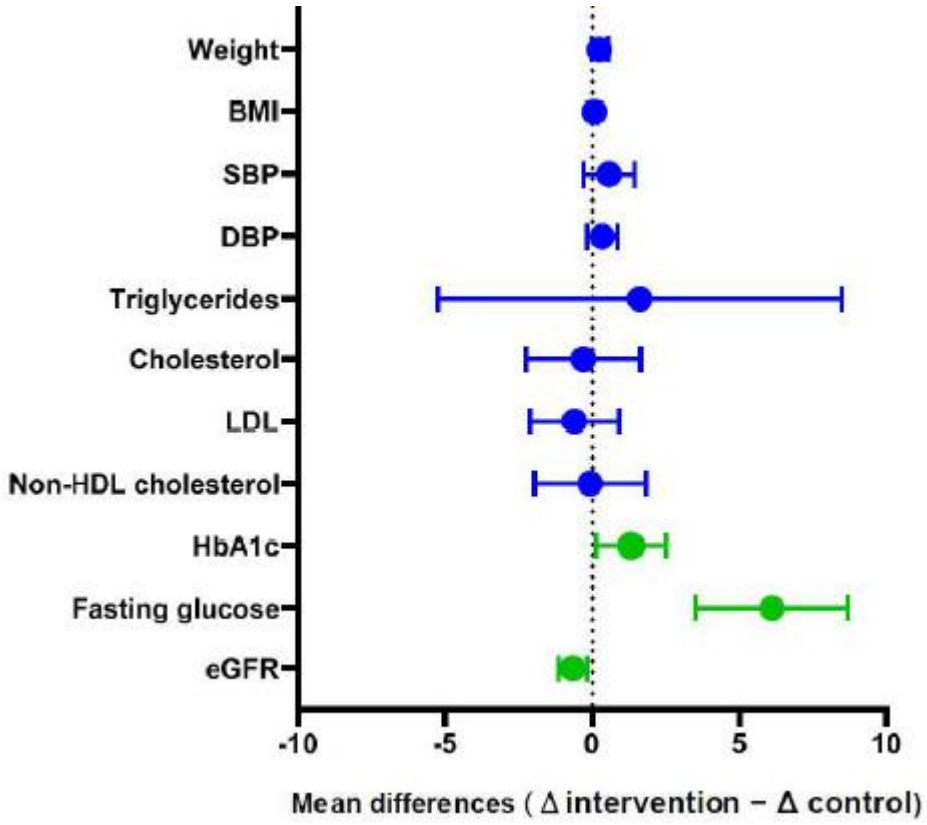


Figure 4. Forest plot showing changes in metabolic parameters

Forest plot showing changes in metabolic parameters (mean differences) between those patients treated by clinical staff of intervention group and by clinical staff in the control group. each point represents the mean difference, and the error bars indicate the 95% confidence interval. A positive value indicates greater improvement in the intervention group compared to the control group. Those variables with statistically significant difference are shown in green.

Furthermore, to assess the effect of educational program participation on the HbA1c and fasting glucose, a linear mixed model (MLM) was conducted, where

PC professionals considered as random effects, and educational program as fixed effect (table 3).

For HbA1c model, the restricted information criterion of maximum likelihood (REML) converged at 10594.4, indicating model fit. As for the random effects, an intercept variance of 0.003666 was observed for the health professionals' random effect, with standard deviation of 0.06055, indicating that variability is low. Regarding the fixed effects, the participation of educational program in the model of predicting HbA1c was found significant (estimate: -0.19793, SE=0.03131, t=-6.321, p<.001).

The results suggests that patients managed by intervention PC professionals group achieved better clinical outcomes, by reducing the level of HbA1c.

For fasting glucose model, Regarding the fixed effects, the participation of educational program in the model of predicting fasting glucose was found significant (estimate: -0.6.094, SE=1.321, t=-4.614, p<.001). the results suggests that patients managed by PC professionals in the intervention group fulfilled improvement in clinical outcomes, by reducing glucose levels at fasting status.

Table 3. Data derived from the mixed effect analysis regarding HbA1c and fasting glucose

Dependent variable **HbA1c** (Fixed effects):

	Estimate	**Std. Error**	**Df**	**t value**	**Pr(>|t|)**
Intercept	-0.08832	0.02295	578.71981	-3.849	0.000132
GROUP	-0.19793	0.03131	3680.69538	-6.321	$2.91e^{-10}$

Likelihood Ratio Test:

	Npar	**AIC**	**BIC**	**logLik**	**Chisq**	**Df**	**Pr(>Chisq)**
Null_model	3	10629	10647	-5311.3			
Model	4	10591	10616	-5291.5	39.746	1	$2.893e^{-10}$

Dependent variable **Fasting glucose** (Fixed effects):

	Estimate	**Std. Error**	**df**	**t value**	**Pr(>|t|)**
Intercept	-3.312	0.984	553.687	-3.365	0.00818
GROUP	-6.094	1.321	3737.442	-4.614	4.07^{e-06}

Likelihood Ratio Test:

	Npar	**AIC**	**BIC**	**logLik**	**Chisq**	**Df**	**Pr(>Chisq)**
Null_model	3	18988	19007	-9491.2			
Model	4	18979	19004	-9485.5	11.461	1	0.0007108

These results underscore the importance of participation in the training program as a significant predictor of changes in the evaluated clinical parameters (HbA1c and fasting glucose levels). Incorporating the educational program into the model led to a significant improvement in model fit, as demonstrated by the information criteria and the likelihood ratio test (Table 3).

Further, in order to test the differences in clinical outcomes between patients treated by PC professionals who participated the educational intervention and those who didn't participate, matching analysis was carried out comparing propensity scores distributions and densities between the research groups, also comparing clinical outcomes through Welch's t-test.

we can see the below figures 5a and 5b, where it presents the distributions of propensity scores before and after matching for both control and intervention groups. Figure 4a displays histograms comparing the distributions of propensity scored in the groups before and after matching, showing that the initial differences between the groups decreased significantly after matching.

Figure 4b presents the superposition of the propensity score densities between the post-intervention and control groups after matching, indicating an adequate balance between both groups after applying the PSM.

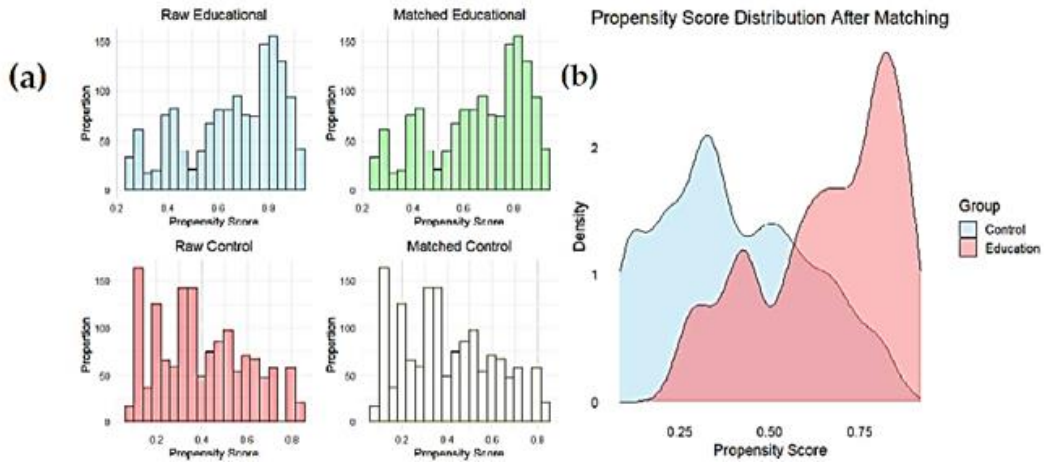


Figure 5. (a)Histograms of the propensity score distribution for the educational intervention and control groups, before and after matching. The figure shows how the initial differences between the two groups are reduced after propensity score matching. (b) shows the density plot of the propensity score after matching, showing the overlap between the educational intervention and control groups. The greater overlap indicates a good balance between the groups, which improves comparability between them.

The post-matching analysis showed significant differences in clinical outcomes between patients treated by PC professionals who participated the educational intervention and those who didn't participate.

Worth mentions, HbA1c levels among patients managed by the intervention group had significantly greater reduction (M=-0.33) compared to patients managed by the control group (M=-0.11), mean difference =0.21, 95%CI=[0.14, 0.29], p<.001, meaning that the intervention patient group reduced their HbA1c level by 0.21 compared to the control group, also . the further Welch's t-test confirmed that this difference between the groups was statistically significant (t=5.452, p<.001), indicating a positive effect of the educational program on the patients' clinical outcomes.

VI – DISCUSSION

VI - DISCUSSION

The present study aimed to evaluate the effectiveness of an advanced practice education program for Primary Care professionals in multiple domains related to the management of T2DM. Specifically, the intervention targeted professional knowledge, self-efficacy, perceived quality of care, and clinical outcomes among patients. It was hypothesized that participation in the educational program would lead to: (1) significant improvements in the metabolic indicators of patients treated by trained professionals; (2) increased adherence to evidence-based treatment guidelines; (3) enhanced self-efficacy among providers regarding pharmacologic and multidisciplinary diabetes management; and (4) an overall improvement in perceived quality of care at the Primary Care level.

This study demonstrated that an advanced practice education program for Primary Care professionals produced measurable and sustained improvements across several aspects of diabetes management. At the provider level, participants showed significant gains in knowledge, pharmacologic literacy, and self-efficacy, particularly in initiating and adjusting therapy with GLP-1 receptor agonists and SGLT2 inhibitors. Providers also reported enhanced quality of care, including clearer patient communication, greater confidence in clinical decision-making, and more consistent multidisciplinary collaboration. At the patient level, treatment delivered by trained providers was associated with statistically significant improvements in glycemic control, lipid profiles, renal function, blood pressure, and body weight over a 12-month follow-up period. Taken together, these findings highlight the dual impact of the intervention—empowering providers while

simultaneously improving patient outcomes—and underscore the value of structured education as a durable strategy for strengthening diabetes care in real-world Primary Care settings.

Through a longitudinal quasi-experimental design incorporating a 12-month observation period in routine primary care, this study provides a perspective seldom examined in prior research which has predominantly focused on short-term follow-up. This real-world duration is a key strength, as it allowed us to capture not only immediate educational effects but also sustained clinical improvements in patient outcomes. In this respect, the study both corroborates the established body of literature showing that professional development enhances chronic disease management (Powers et al., 2020; Rowe et al., 2025) and advances the field by evidencing durable effects in everyday clinical practice.

The intervention consisted of a structured, eight-week educational program designed to provide Primary Care physicians and nurses with updated clinical knowledge, competencies, and interdisciplinary tools to optimize T2DM care. The primary aim of the program was not only the acquisition of knowledge but also the enhancement of clinical confidence and decision-making skills in the realm of complex, personalized diabetes management. The training aimed to equip providers with the tools to convert guidelines into patient-centered care plans by integrating both theoretical and practical elements within a collaborative framework. This methodology aligns with prior research emphasizing the efficacy of integrating didactic and experiential learning modalities in enhancing clinical decision-making and personalized care (Abubakari et al., 2011; Rowe et al., 2023). Bain et al. (2014) asserted that interactive, interdisciplinary training promotes enduring modifications in clinical behavior and improves care personalization. The results align with our findings, indicating that participants experienced increased

confidence and competence in pharmacologic decision-making and personalized care planning after the program.

The program appeared to make a real difference in how providers approached diabetes care. The study documented a statistically significant increase in healthcare providers' self-efficacy following participation in the advanced diabetes education program. In fact, five out of six domains of self-efficacy measured in the study showed statistically significant improvement.—This improvement was particularly evident in domains related to initiating or adjusting pharmacologic treatment, managing diabetes-related complications, and engaging in interprofessional collaboration. These findings are consistent with prior literature demonstrating that structured professional development enhances provider confidence and autonomy in chronic disease management (Clark et al., 2021). Evidence from Primary Care also suggests that effective diabetes management programs contribute to greater knowledge and self-efficacy among both general practitioners and advanced practice nurses (Weekes & Lembke, 2021).

According to Bandura's self-efficacy theory (1997), belief in one's ability to act is a critical determinant of whether knowledge translates into behavior. Our findings reflect this principle: it was not only about acquiring knowledge but about applying it with greater confidence in real clinical settings. Higher provider self-efficacy has consistently been linked to more timely treatment intensification, frequent counselling, and adherence to guideline-recommended care (Bandura, 1997; Alzawahreh & Ozturk, 2024). A recent quality-improvement study in the United Kingdom illustrates this dynamic. When locally tailored discharge guidance for multiple daily insulin injections was introduced, pediatric doctors reported a dramatic increase in prescribing confidence—from a mean of 1.9 to 4.0

on a five-point Likert scale —despite no major change in their baseline knowledge baseline knowledge levels (Shoaib et al., 2023). The key factor was not additional content but improved accessibility and usability of existing guidance, which enhanced self-efficacy and enabled behavior change. In the context of diabetes care, where therapeutic inertia and fragmented services remain persistent barriers, such findings underscore the importance of interventions that build provider confidence alongside knowledge.

Moreover, a growing body of research confirms that structured professional development enhances self-efficacy among Primary Care providers. Lasmarías et al. (2021) demonstrated that clinicians who had undergone prior training and held favorable views of advanced care processes reported greater confidence in applying them in practice. Similarly, Geiler and Brady (2024) showed that a multifaceted educational program for nurse practitioners significantly increased their confidence in leading complex, patient-centered conversations. These findings suggest that interventions targeting self-efficacy- particularly those involving collaborative teams and focused education substantially enhance provider performance and patient engagement.

In addition to enhanced self-efficacy, the program significantly improved provider knowledge, as demonstrated by an increase in knowledge test scores from 3.2 to 5.6 points ($p < 0.001$). Participants demonstrated greater familiarity with novel pharmacologic agents such as SGLT2 inhibitors and GLP-1 receptor agonists, and increased awareness of the cardiovascular and renal benefits associated with these therapies. This is a critical development, given that current international guidelines, including those issued by the American Diabetes Association and the European Association for the Study of Diabetes, recommend these agents for individuals with T2DM and comorbid cardiovascular or kidney disease, regardless

of glycemic status (American Diabetes Association, 2024; Davies et al., 2022). These observations are consistent with the findings of Kühne-Eversmann and Fischer (2013), which demonstrated that targeted training equips professionals with contemporary clinical knowledge and practical skills, thereby strengthening their capacity to manage diabetes and other chronic conditions effectively.

Enhanced pharmacologic literacy among providers enables more individualized, pathophysiology-based treatment strategies. Indeed, studies show that when Primary Care teams receive focused education on contemporary antidiabetic medications, they are more likely to prescribe them appropriately and integrate them effectively into broader care models (Bieszk et al., 2017). For instance, a quasi-experimental study by Ahmed et al. (2021) found that provider education on GLP-1 and SGLT2 therapies resulted in a 35% increase in appropriate prescribing over a 12-month period (Yun et al., 2025).

Moreover, growing evidence supports the notion that knowledge gains at the individual level contribute to organizational change. Educational interventions not only strengthen clinical competencies but also promote institutional uptake of evidence-based care practices through peer influence, leadership modelling, and protocol integration (Lee et al., 2022). In this study, knowledge improvements were accompanied by increased confidence in clinical decision-making and more proactive management of comorbidities such as hypertension and dyslipidaemia-both of which are essential components of comprehensive diabetes care.

Although the educational intervention led to a statistically significant increase in provider self-efficacy across multiple domains, no significant variation in self-efficacy improvements was observed across different Primary Care clinics, suggesting that the impact of the intervention was consistent regardless of site-

specific characteristics. This consistency may reflect the standardized structure of the training or a common baseline level of educational need among participating providers. Nonetheless, self-efficacy related to routine in-clinic decision-making, particularly regarding insulin adjustment and day-to-day glycemic control, did not exhibit equivalent gains, underscoring the need for additional reinforcement in these areas.

While such consistency can be interpreted as a strength of the intervention- indicating scalability and broad applicability- it also highlights the importance of exploring contextual moderators that may shape individual or team-level responses to educational programs. Future research could further investigate how clinic size, leadership culture, or prior training exposure might influence differential outcomes.

In conclusion, the documented increases in both provider knowledge and self-efficacy underscore the crucial role of structured education in improving diabetes care delivery. By equipping providers with current, evidence-based knowledge and reinforcing their confidence in its clinical application, such programs support more timely, personalized, and effective management of diabetes in Primary Care settings. These changes not only yield direct benefits to patient outcomes but also address systemic challenges such as clinical inertia and fragmented care.

Despite the introduction of new clinical guidelines for T2DM, significant disparities persist in providers' knowledge and their treatment of patients. Research indicates that individuals who utilize guidelines possess greater knowledge about diabetes and make superior decisions compared to those who do not employ them (Corriere et al., 2014). Clinical inertia, defined as a physician's

failure to initiate or escalate treatment, when necessary, remains a significant challenge in the effective management of T2DM (Pantalone et al., 2020). This inaction may occur at any stage of diabetes management, ranging from delaying lifestyle modifications to postponing insulin or advanced pharmacological treatment. This may result in extended durations of inadequate blood sugar regulation and an increased likelihood of both microvascular and macrovascular complications (Okemah et al., 2018). Therapeutic inertia is particularly pronounced in Primary Care environments, where physicians frequently hesitate to escalate treatment despite patients failing to achieve glycemic targets (Davies et al., 2022). Factors that complicate adherence to contemporary evidence-based guidelines include insufficient knowledge of new pharmaceuticals, time constraints, uncertainty regarding clinical scenarios, and concerns about patient noncompliance (Andreozzi et al., 2020; Okemah et al., 2018).

A thorough narrative review revealed that therapeutic inertia frequently results in treatment adjustment delays of 1-7 years, during which patients continue to face the detrimental effects of chronic hyperglycemia, substantially elevating morbidity and mortality risks (Rodriguez et al., 2024). Another recent survey of Primary Care clinics in Europe revealed that over 40% of physicians delayed escalating treatment for more than six months, despite patients' blood sugar levels exceeding established guidelines (Ampudia-Blasco et al., 2021). Similarly, although the duration of treatment delays was not quantified in years, our baseline findings revealed that prior to the intervention, providers reported a tendency to postpone treatment intensification, particularly with novel agents, even in the presence of suboptimal glycemic control. Following the structured education program, providers expressed increased confidence in intensifying treatment, particularly

regarding the initiation or modification of GLP-1 receptor agonists and SGLT2 inhibitors. The noted post-intervention improvements in pharmacologic confidence indicate that the program effectively addressed this therapeutic inertia, aligning with Andreozzi et al. (2020), who recommend focused education to mitigate provider reluctance, and supported by Rodriguez et al. (2024), who emphasize provider empowerment as central to overcoming therapeutic delay. This suggests that structured provider education directly mitigates therapeutic inertia, a key barrier in T2DM management.

Ongoing professional development is an integral component of chronic disease management infrastructure, particularly in Primary Care environments that serve as the first point of contact for most patients with T2DM. The study indicated that healthcare providers, rather than patients, primarily observed significant enhancements in treatment quality following the educational intervention.

They noted improved clarity in medication explanations, heightened responsiveness to patient inquiries, and greater professional confidence in managing diabetes complications. Notably, participants also indicated a more consistent application of a multidisciplinary care model, collaborating with nurses, dietitians, and mental health professionals.

These reported improvements align with previous research demonstrating that training in patient-centered communication and interprofessional collaboration can substantially enhance providers' perceptions of care quality. A meta-analysis by Goh et al. (2022) found that interventions grounded in the Chronic Care Model, integrating structured education and collaborative workflows, were consistently associated with higher provider-perceived quality of care.

For instance, the randomized trial by du Pon et al. (2020) demonstrated that training practice nurses in structured patient engagement techniques, such as collaborative agenda setting and encouraging patient questions, not only improved patient self-efficacy but also significantly enhanced nurses' own perceptions of the consultation quality and effectiveness. Providers reported a greater sense of professional competence and felt that their care became more patient-centered as a result.

This aligns with broader evidence from interventions based on the Chronic Care Model (CCM) in Primary Care. A 2022 systematic review and meta-analysis of 17 CCM-based trials in adults with T2DM found that when CCM elements include structured provider education and interprofessional collaboration, providers consistently report increased confidence in care delivery, better coordination with team members, and improved perceived quality of care- even when patient-reported satisfaction was not the primary focus (Goh et al., 2022). These findings indicate that educational programs geared toward enhancing provider communication skills and team-based workflows can effectively shift providers' orientation from reactive to proactive management (Yao et al., 201).

According to Donabedian (1988), quality in healthcare can be understood through three interrelated domains: structure, process, and outcome. Although Donabedian's model was not explicitly incorporated into the study design, it offers a valuable conceptual lens for interpreting the provider-reported improvements in perceived quality of care. Of these, improvements in the process domain- such as communication clarity, interdisciplinary collaboration, and shared decision-making- are considered pivotal in facilitating high-quality outcomes.

As outlined in Donabedian's framework, our study documented a significant improvement in the perceived quality of care as reported by the participating professionals. Following the intervention, providers expressed greater confidence in their ability to deliver patient-centered care, provide comprehensive medication counseling, and collaborate effectively with other members of the care team. These improvements were reflected in significantly higher scores on the self-perceived quality of care measure derived from the iQuaD framework. Together, these results suggest that the intervention contributed not only to technical skill enhancement but also to broader systemic improvements in how care is conceptualized and delivered within the Primary Care context.

The current study contributes to the growing body of evidence supporting the integration of advanced education programs within Primary Care settings. By examining both provider- and patient-level outcomes, it supports that continuous professional development is not only beneficial but essential for addressing the evolving complexities of diabetes care.

The findings of this study provide robust empirical support for the initial hypotheses, affirming the effectiveness of a structured, nurse-led educational intervention in improving multiple dimensions of diabetes care in the Primary Care setting. The program yielded measurable improvements in both provider- and patient-level outcomes, reflecting the multifaceted impact of advanced practice education on chronic disease management. These improvements were sustained across a 12-month follow-up period, underscoring the intervention's potential to bring about durable and clinically meaningful changes.

Patients treated by providers involved in the intervention exhibited statistically significant enhancements in various metabolic parameters. Significant

reductions were observed in fasting blood glucose, HbA1c, and lipid profile indicators, including total cholesterol, LDL, non-HDL cholesterol, and triglycerides. Moreover, favorable alterations in renal function were noted, demonstrated by a statistically significant rise in eGFR, alongside improvements in anthropometric and cardiovascular parameters, including body weight and blood pressure. Although certain changes were minimal in absolute terms, specifically, a mean decrease of 0.33% in HbA1c and a weight reduction of 0.45 kg - these alterations remain clinically significant.

Comparable results have been documented in prior research. Yu et al. (2022) evidenced that nurse-led educational programs markedly enhanced glycemic control and patient self-management, remarking a 0.32% decrease in HbA1c after intervention. Likewise, Sun et al. (2025) demonstrated that organized diabetes education interventions facilitated enduring metabolic enhancements and improved treatment compliance, documenting reductions between 0.54% and 0.92% in controlled trials. The distinguishing feature of the current study is its focus on provider-centered training and its effectiveness in attaining simultaneous improvements for both professionals and patients over a continuous 12-month duration. This dual effect corroborates previous findings by Rowe et al. (2023), who highlighted the significance of ongoing education in augmenting chronic care delivery via enhanced confidence, clinical decision-making, and interdisciplinary collaboration. Collectively, these findings underscore the value of advanced practice education programs as instruments for professional advancement and as strategic mechanisms to enhance population-level outcomes in chronic disease management, especially for complex and widespread conditions such as T2DM.The clinical improvements documented across multiple metabolic and cardiovascular parameters provide meaningful evidence for the efficacy of the

educational intervention. In particular, the statistically significant reduction in HbA1c (-0.33%), though modest in absolute terms, is clinically meaningful. Previous research consistently demonstrates that even small decreases in HbA1c are associated with substantial reductions in diabetes-related complications and long-term morbidity. These findings are supported by Fang et al. (2020), who reported that targeted diabetes education led to significant improvements in fasting glucose levels and overall quality of care in primary healthcare settings. Similarly, Bağriaçik and Bayraktar (2022), in a systematic review of randomized controlled trials, concluded that individualized, face-to-face educational programs, particularly those incorporating long-term follow-up and peer support, consistently improved metabolic control, including HbA1c, BMI, and LDL cholesterol.

These findings reinforce the validity of our observed HbA_1c decrease of 0.33%, indicating that targeted provider education can effectively contribute to optimizing glycemic control and metabolic risk in patients with T2DM. As such, the observed change supports the clinical value of empowering healthcare providers with targeted educational and therapeutic skills that influence glycemic management over time. This conclusion is substantiated by a recent systematic review and meta-analysis, which found that provider-led educational interventions in patients with T2DM resulted in an average HbA1c reduction of approximately 0.83% (95% CI: -1.17 to -0.49), underscoring the effectiveness of structured educational programs in improving glycemic control (Shiferaw et al., 2021).

In addition to improved glycemic control, this study documented statistically significant reductions in key lipid parameters, including total cholesterol (-5.27 mg/dL), LDL cholesterol (-3.67 mg/dL), non-HDL cholesterol (-

4.52 mg/dL), and triglycerides (-7.21 mg/dL), all with $p < .001$. These improvements likely reflect increased clinical attention to cardiovascular risk factors among providers who participated in the intervention, including more consistent implementation of guideline-recommended therapies such as statins or SGLT2 inhibitors (Muluk et al., 2023). Even modest reductions in these lipid markers have been shown to confer measurable cardiovascular protection. For example, a large meta-analysis by the Cholesterol Treatment Trialists' Collaboration found that each 1 mmol/L (≈38.7 mg/dL) reduction in LDL-C with statins reduced major vascular events by 22%, with benefits observed even among those with baseline LDL <100 mg/dL (Velidakis et al., 2024). Even modest improvements in triglyceride levels have been shown to correlate with significant cardiovascular benefits. A comprehensive meta-analysis of 15 randomized controlled trials including over 20,000 participants with T2DM found that SGLT2 inhibitors reduced hospitalization for heart failure by 32% and cardiovascular mortality by 15%, while also moderately reducing triglyceride levels (weighted mean difference ≈ -0.10 mmol/L) (Cardoso et al., 2021).

Together, the lipid profile improvements observed in this study, though modest in absolute magnitude, carry substantial clinical relevance. They likely reflect enhanced clinical vigilance and more consistent application of evidence-based cardiovascular risk reduction strategies by Primary Care providers. Sustained across time and broader patient populations, such changes may contribute to a meaningful reduction in atherogenic burden and a decreased incidence of cardiovascular events among individuals with T2DM. These findings underscore the critical role of structured educational interventions in equipping providers with up-to-date pharmacological knowledge and decision-making tools,

ultimately fostering higher-quality, risk-targeted care and improved long-term health outcomes.

Notably, the observed decrease in LDL and non-HDL cholesterol represents a shift toward guideline-directed lipid targets for patients at moderate-to-high cardiovascular risk. According to the American Diabetes Association and the American College of Cardiology, individuals with T2DM who are aged 40-75 or have additional risk factors should receive statin therapy targeting LDL-C <70 mg/dL (ADA, 2024; Grundy et al., 2019). These findings imply that the intervention may have not only increased provider awareness of lipid management protocols but also improved their capacity to act on abnormal laboratory results in a timely and evidence-based manner.

Kidney function, as measured by eGFR, demonstrated a modest yet statistically significant improvement following the intervention (mean increase from 75.4 to 76.5 mL/min/1.73m²; $p < .001$). Given that eGFR typically declines progressively in individuals with T2DM, particularly those with comorbid hypertension, this finding is notable. Although specific medication data were not collected, the improvement may reflect better clinical management practices encouraged by the training program, including closer monitoring of renal parameters and increased adherence to guidelines that recommend nephroprotective strategies. Evidence from large trials supports the renoprotective effects of ACE inhibitors and SGLT2 inhibitors in appropriate populations. For example, in the CREDENCE trial, canagliflozin reduced the risk of ESRD, doubling serum creatinine, or renal/cardiovascular death by 30% among patients with T2DM and CKD (Perkovic et al., 2019). Thus, the positive trend in eGFR observed in this study may signal earlier detection of renal decline and a greater readiness to act on

abnormal values, both of which are critical in delaying diabetic kidney disease progression.

The lack of significant change in urinary albumin/creatinine ratio, despite modest improvement in eGFR, may be attributed to several contextual factors. Albuminuria is an early marker of diabetic kidney disease, and substantial reductions are typically observed only after prolonged or targeted interventions (McGill et al., 2021). For example, in the AWARD-7 trial involving patients with T2DM and chronic kidney disease, weekly dulaglutide (1.5 mg) slowed the decline in eGFR but only showed significant benefit in macroalbuminuric patients over a 12-month period, not diminishing albuminuria in those with lower baseline levels (Tuttle et al., 2020). Similarly, robust reductions in albuminuria through ACE inhibitor therapy have been demonstrated only after sustained use, as seen in studies of ramipril where significant microalbuminuria reduction occurred only after two years of treatment (Felix Kröpelin et al., 2016). Given that our educational intervention targeted general diabetes management over a relatively short 12-month follow-up without a specific emphasis on renal pharmacotherapies, the stability of albuminuria aligns with expectations.

This result does not reduce the observed renal stabilization and instead suggests that longer-term follow-up or more intensive, kidney-focused interventions would be required to elicit meaningful albuminuria changes. This suggests that while short-term educational interventions can positively influence provider behaviour and general management, reflected in stable or improved eGFR, more prolonged or focused efforts may be required to impact albuminuria. Since the intervention primarily aimed to enhance general diabetes care without a specific emphasis on renal care algorithms, the absence of significant albuminuria

change is not unexpected and does not detract from the broader clinical benefits observed in this study.

In our study, participants exhibited statistically significant reductions in both systolic and diastolic blood pressure- mean decreases of 1.24 mmHg and 0.87 mmHg, respectively ($p < .001$)-alongside a modest but significant mean weight loss of 0.45 kg ($p < .001$). While these individual changes may seem small, they are clinically relevant when observed at the population level in a Primary Care setting. Real-world data show that even modest weight loss of 0.5-1 kg in individuals with T2DM is associated with meaningful improvements in insulin sensitivity and glycemic control, as demonstrated in a U.S. cohort study of nearly 1.5 million patients with T2DM, where modest sustained weight loss yielded significant metabolic benefits over one and five years. Concurrently, large meta-analyses have consistently found that even small reductions in systolic blood pressure yield substantial cardiovascular risk reduction: a 5 mmHg lower systolic pressure was linked to a 10% lower risk of major cardiovascular events (Canoy et al., 2022).

These outcomes likely stem from enhanced provider-driven lifestyle interventions- such as improved dietary counselling and physical activity promotion- combined with optimized antihypertensive medication management, potentially including earlier initiation of ACE inhibitors or ARBs. Educational initiatives of this nature, which reinforce guideline-based targets and interprofessional patient follow-up, have been shown to produce meaningful reductions in weight, blood pressure, and HbA1c in patients with T2DM (Tey et al., 2024). Taken together, these results underscore the dual behavioural and pharmacologic impact of our educational intervention, highlighting its potential to foster gradual yet clinically important improvements in cardiometabolic risk among Primary Care populations.

The observed changes likely stem from enhanced provider engagement in lifestyle counselling and improved adherence to antihypertensive prescribing guidelines- particularly regarding Angiotensin Converting Enzyme (ACE) inhibitors and Angiotensin Receptor Blockers (ARBs). Training interventions similar to ours, which emphasize evidence-based targets and interprofessional coordination, have been shown to foster more proactive clinical behavior. For instance, a meta-analysis of Primary Care and community-based interventions targeting cardiovascular risk factors found that programs combining patient education, goal-setting, and regular follow-up resulted in significant reductions in blood pressure, body weight, and HbA1c among patients with T2DM (Simões Corrêa Galendi et al., 2022). Similarly, a systematic review of Chronic Care Model implementations in Primary Care confirmed consistent improvements in hypertension control and metabolic outcomes, reinforcing the value of provider training and structured care pathways (Goh et al., 2022). These outcomes suggest that our educational program not only enhanced individual provider knowledge but also cultivated durable behavior change manifesting in earlier interventions and more consistent patient support, ultimately contributing to measurable health improvements.

Overall, the observed improvements in glycemic, lipid, renal, and cardiovascular markers combined with stabilization of renal structural markers- suggest that educational interventions directed at Primary Care professionals can yield meaningful benefits across key dimensions of diabetes care.

While direct patient-reported adherence was not assessed in the current study, providers reported enhanced patient engagement, more regular follow-up practices, and increased implementation of pharmacologic guidelines and lifestyle counselling protocols, all strongly suggesting improved treatment adherence.

These behavioral shifts- reported by clinicians and indirectly reflected in improved clinical parameters-suggest greater alignment with recommended diabetes care pathways.

The intervention's emphasis on multidisciplinary care and personalized medication education likely contributed to these outcomes. For example, better patient understanding of treatment rationale has been associated with improved adherence in diabetes care, particularly when providers actively engage patients during consultations (Peimani et al., 2020). Structured provider training may have improved communication clarity, reduce therapeutic inertia, and increased timely treatment adjustments- all of which are essential to maintaining adherence among patients with chronic conditions (Tiktin et al., 2016).

Empirical evidence supports these interpretations. A systematic review and meta-analysis of diabetes-focused interventions found that complex, multi-component programs- including patient education, reminders, and provider feedback- were more effective in improving medication adherence and glycemic control than simpler interventions (Sapkota et al., 2015). Additionally, a randomized trial of pharmacist-led reminders and monitoring demonstrated that real-time feedback significantly increased refill adherence in patients with T2DM (Bekele et al., 2021). Moreover, provider-facing interventions, including audit-and-feedback, structured education, and decision support, have been shown to increase adherence rates by 10-20%, particularly in chronic disease management settings (Sapkota et al., 2015).

Although further studies are warranted to directly assess patient-reported adherence, the convergence of improved clinical markers and provider-reported engagement suggests a durable behavioral shift that is likely to benefit long-term

diabetes outcomes. These findings underscore the potential of structured educational interventions to foster not only provider competence but also adherence-promoting practices within routine Primary Care.

In summary, the intervention resulted in significant enhancements, encompassing clinical indicators like HbA1c and lipid profiles, as well as improved provider self-efficacy, augmented clinical knowledge, and perceived quality of care. These findings bolster the argument for advanced practice education as an effective and significant method for enhancing diabetes management in Primary Care. These improvements can also be interpreted through the lens of Donabedian's model of healthcare quality. The intervention addressed all three domains: the structure component was enhanced via provider training and resource allocation; process improvements were evident in more proactive clinical decisions, team-based collaboration, and clearer communication; and outcome gains were reflected in better metabolic indicators and reported patient care quality. This alignment reinforces the multidimensional impact of the intervention and supports its potential for integration into broader system-level quality initiatives (Donabedian, 1988). Eventually, it highlights the role of provider education in fostering adherence-promoting practices.

A distinctive element of our program was its implementation by a certified DiNP, who conducted interactive sessions and fostered collaborative learning. NPs were central to the successful delivery of the educational intervention. Providers highlighted the value of NP-led sessions, noting their emphasis on clear, evidence-based teaching and the use of practical, case-based discussions; particularly in complex areas such as pharmacologic management with SGLT2 inhibitors and GLP-1 receptor agonists. Participants also emphasized that the NPs' applied guidance and clinical expertise were instrumental in enhancing their confidence,

especially regarding medication decision-making. Participants frequently cited the NP's practical guidance and clinical insight as important in boosting their confidence, especially when making medication decisions. These reports align with recent findings indicating that NP-led diabetes education improves interdisciplinary collaboration and clinical outcomes (Li et al., 2025).

The current study demonstrated sustained clinical and behavioral improvements in a real-world Primary Care setting, achieved through a scalable, nurse-led educational model. This positions the intervention as both practical and impactful in everyday healthcare delivery. These findings add to growing evidence that NP-led education contributes not only to provider competence, but to better patient outcomes as well (Li et al., 2025; Roschkov & Chik, 2021). Additionally, Massimi et al. (2017) reported that community-based nurse-led education programs led to a 0.15% reduction in HbA1c, while Yu et al. (2022) observed a more pronounced decrease of 0.32% in patients newly diagnosed with T2DM following structured, nurse-led self-management training. Furthermore, educational interventions that integrate nurse leadership with interdisciplinary collaboration and updated pharmacological guidance have been associated with improved treatment satisfaction and patient-provider communication (Rowe et al., 2023).

NPs are increasingly recognized for their leadership in chronic disease management, particularly in structured outpatient diabetes programs. For example, Roschkov and Chik (2021) evaluated a NP-led multidisciplinary diabetes clinic in Canada and found that such a model improved care continuity, glycemic control, and provider collaboration. Providers expressed high trust in the NP's leadership and clinical decision-making.

Furthermore, NP-led educational initiatives show strong potential for future scale-up, especially in Primary Care settings. In a telehealth-based protocol

for T2DM management, NPs significantly improved glycemic control and care coordination without increasing resource utilization (Momin et al., 2022). This suggests that NPs are well-positioned to lead ongoing professional development efforts, particularly in community-based or resource-limited environments

Although the original intervention did not formally evaluate perceptions of NPs' roles, the positive feedback documented by providers reinforces existing literature. NPs serve as key facilitators of evidence-based diabetes care, and their integration into educational leadership roles offers a scalable model for improving provider performance and chronic disease outcomes (Li et al., 2025; Momin et al., 2022).

The findings from this study underscore the feasibility and value of integrating structured, nurse-led diabetes education programs within Primary Care settings. The observed improvements in clinical outcomes, provider knowledge, and treatment adherence support the broader implementation of such initiatives across both local and international healthcare systems. Given the increasing prevalence of T2DM and the documented gaps in provider preparedness, replicating this intervention model can help address systemic barriers such as therapeutic inertia, fragmented care, and inconsistent application of guidelines.

Scalability is a key strength of this educational model. The program’s success in a routine care environment, with limited reliance on external resources, demonstrates its adaptability to other clinical contexts, including rural, under-resourced, or multidisciplinary settings. Similar structured educational initiatives have been shown to be both scalable and cost-effective, with long-term benefits to patient health outcomes and provider performance (Lee et al., 2022). Furthermore,

a meta-analysis concluded that training interventions targeting Primary Care professionals improved chronic disease outcomes while simultaneously reducing unnecessary specialist referrals and hospital admissions (Zhang et al., 2025).

The sustainability of such programs depends on institutional commitment to continuous professional development and integration of evidence-based learning into clinical routines. Integrating NPs in educator roles can support long-term adoption and reinforce a culture of shared learning. As supported by international Primary Care research, when education is delivered in context, by professionals who deeply understand the clinical setting and its specific challenges, long-term behavior change among providers is more likely. One theory-informed systematic review of barriers and facilitators to clinical behavior change by Primary Care practitioners concluded that 'environmental context and resources' and 'social influences' are key domains influencing successful implementation. Interventions aligned with these contextual factors- such as education delivered by peer professionals within the clinical environment- were associated with sustained practice change (Mather et al., 2022).

From a workforce development perspective, structured training interventions in Primary Care enhance clinical decision-making, reinforce interprofessional collaboration, and reduce variation in care quality. These models contribute to health system resilience by building capacity for Primary Care providers to manage complex conditions such as T2DM, thereby reducing unnecessary specialist referrals and improving continuity of care. A recent systematic review and meta-analysis demonstrated that interprofessional collaboration interventions in Primary Care significantly improved patient-reported outcomes related to satisfaction, self-management behaviours, and mental well-being among those with T2DM (Nurchis et al., 2022). Such

collaborative models are also associated with better control of glycemic and blood pressure levels (Lee et al., 2021), underscoring their role in strengthening frontline clinical practice.

Furthermore, task-sharing initiatives, where clinical duties are redistributed among physicians, nurses, and allied health staff, support sustainable workforce development. Evidence from low- and middle-income settings indicates that such task-sharing approaches yield moderate improvements in diabetes control and timely care delivery (Tesema et al., 2025). These strategies not only build provider confidence but also optimize the use of healthcare resources.

These outcomes align with global strategic frameworks. The WHO has emphasized the importance of workforce education, task-sharing, and multidisciplinary care models as essential components of robust primary healthcare systems capable of addressing chronic disease burdens effectively (WHO, 2019). By aligning local training programs with these international priorities, health systems can achieve greater equity, sustainability, and resilience in diabetes care delivery.

Thus, this intervention not only achieved short-term clinical and behavioral improvements but also laid the foundation for broader policy and practice transformations. It provides a practical framework for future workforce education efforts aimed at improving chronic disease outcomes through local empowerment, interprofessional collaboration, and evidence-based care delivery.

VII – LIMITATIONS AND FUTURE WORK

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As in any other research, the present work has some limitations that deserve consideration. The use of a non-validated test for determining the different variables may limit the generalization of these results. In this regard, we must comment on several issues; on the one hand, there are no previous validated versions in Hebrew, the original language in which the study was carried out. And above all and most importantly, type 2 diabetes is a pathology whose therapeutic approach is constantly changing, so we found it necessary to introduce specific items for the management of certain drugs, such as SGLT2 inhibitors or GLP1 analogues, whose information was not in the previously validated tests. In addition, we did not find specific tools for Primary Care that fit the objectives of the study. In any case, the high reliability value that our data showed allow us to confirm that the data obtained are reliable. Moreover, it is important to consider the potential bias when selecting providers with a lower level of knowledge for the intervention. This could be viewed as a selective bias; however, as this was a quasi-experimental study based on an educational intervention, the per-protocol allocation procedure was based precisely on the previous knowledge of health providers, since the objective of the intervention was to increase knowledge of those with higher needs. Additionally, a higher baseline HbA1c level in the patients of the intervention group could represent another potential source of bias, as it may indicate greater opportunities for improvement. However, the data derived from ANCOVA analysis to adjust for this potential confounder did not modify the significance level associated with the effect of the intervention.

The training sessions took place out of the working hours, for three hours per week. The inability to integrate training into regular working hours is a significant limitation, as it can have a negative impact on health professionals' participation in continuing education programs. Finally, we also wanted to comment on the sample size of health professionals. Although the patients who took part in the study fit within the appropriate parameters, the number of professionals was smaller, although sufficient according to the sample size requirements.

Although the program was well-received, long-term sustainability, cost-effectiveness, and scalability were not directly evaluated and warrant future research.

Future studies should consider employing randomized controlled designs, integrating patient-centered outcome measures, and evaluating cost-benefit aspects to inform broader implementation strategies. Another line of research in future could be to investigate the association between enhancing healthcare professionals' self-efficacy and the sustained metabolic outcomes in patients with type 2 diabetes. Furthermore, exploring the integration of advanced technologies, such as telemedicine platforms and clinical decision-support systems, as adjuncts to conventional training programs could provide insights into their potential to improve both professional performance and patient outcomes. Such research would contribute to the optimization of educational strategies, fostering more effective and equitable healthcare delivery for individuals managing type 2 diabetes.

Practical Applications and Research Gaps

The findings of this study offer critical insights for enhancing diabetes care in Primary Care settings through structured, nurse-led training programs. To translate these findings into real-world clinical improvements, several practical steps are essential.

First, successful integration of the training program into clinical practice requires organizational commitment and leadership support. Primary Care clinics should appoint clinical champions—preferably nurse practitioners (NPs) or experienced diabetes educators—to lead the training and tailor the content to the specific needs of the clinical staff and patient populations. Interactive learning strategies, including case-based discussions, peer feedback, and scenario-based exercises, should be prioritized to enhance learner engagement and facilitate practical application.

Resource allocation is a critical factor in ensuring the sustainability of the program. Clinics must allocate protected time for staff to participate in training, provide access to updated clinical guidelines and patient education tools, and invest in digital platforms that support ongoing learning and knowledge reinforcement. Embedding the training into broader quality improvement processes—through supervision, audits, and inter-professional collaboration—will support long-term behavioral change.

Program impact should be evaluated through a structured monitoring framework. Key performance indicators may include provider self-assessments, adherence to clinical guidelines, patient retention in follow-up, and measurable clinical outcomes. Periodic reassessment and refresher training should be scheduled to ensure the longevity of program benefits and to adapt to evolving

clinical standards. Monitoring mechanisms must be flexible to accommodate the introduction of new therapeutic options and guidelines.

From a health systems perspective, this nurse-led training model enhances frontline clinical competencies, fosters inter-professional coordination, and reduces variation in care delivery. By equipping Primary Care providers to manage complex chronic conditions such as type 2 diabetes mellitus (T2DM), the intervention supports healthcare system resilience, reduces unnecessary specialist referrals, and strengthens continuity of care. These outcomes align with global health priorities—including the WHO 's emphasis on workforce education and multidisciplinary care models for addressing chronic disease burdens (WHO, 2019). Furthermore, the scalability of NP-led training programs, particularly in resource-limited settings, positions this approach as a viable and sustainable solution to improve diabetes care equity worldwide.

Despite these advancements, several research gaps remain and warrant further investigation:

Long-term sustainability: The 12-month follow-up in this study limits understanding of the intervention's durability. Future research should examine whether observed improvements in provider behavior and patient outcomes are maintained over several years, and whether periodic reinforcement is required.

Lack of patient-reported outcomes: While provider-level outcomes were evaluated, the study did not assess patient-reported measures such as satisfaction, perceived involvement, or understanding of care. Inclusion of patient perspectives in future studies would enable a more comprehensive assessment of intervention effectiveness and patient engagement.

Economic evaluation: The cost-effectiveness of the training program was not analyzed. Future investigations should evaluate potential healthcare savings associated with reduced hospitalizations, better complication control, and decreased reliance on specialist referrals.

Technology integration: Future studies could explore the integration of advanced technologies—such as telemedicine platforms and clinical decision-support systemas adjuncts to conventional training. These tools may further enhance provider performance and improve patient outcomes.

This study presents a strong case for implementing structured, nurse-led training programs to improve diabetes management in Primary Care. When supported by strategic planning, appropriate resources, and continuous evaluation, such interventions have the potential to transform chronic disease care. Addressing the identified research gaps and embracing innovations in health education will help optimize future programs for broader, equitable, and sustainable impact.

VIII – CONCLUSIONS

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This study provides robust evidence that an advanced training program led by a DiNP can substantially enhance provider knowledge, self-efficacy, perceived quality of care, and adherence to evidence-based guidelines, with corresponding improvements in patient outcomes. Statistically significant reductions were observed in HbA1c, fasting blood glucose, and lipid parameters, alongside a modest improvement in estimated glomerular filtration rate. These clinical gains, coupled with strengthened provider confidence and more consistent application of multidisciplinary care, highlight the program's effectiveness in addressing the complex challenges of type 2 diabetes management in Primary Care settings and underscore the value of targeted educational interventions for high-burden chronic diseases.

The study established that Primary Care professionals exhibited different baseline levels of knowledge and self-efficacy in managing T2DM, with notable deficiencies in familiarity with novel pharmacologic agents and guideline-directed care. Pre-intervention assessments revealed a mean knowledge test score indicated significant gaps in understanding current T2DM management strategies, particularly regarding SGLT2 inhibitors and GLP-1 receptor agonists. Similarly, self-efficacy scores were suboptimal in domains related to pharmacologic decision-making and inter-professional collaboration. These findings highlight the critical need for ongoing competency assessments to identify and address knowledge

deficits, particularly in rapidly evolving fields such as diabetes care, where adherence to updated guidelines is essential for optimal patient outcomes.

The analysis of variability in prior training and experience revealed substantial heterogeneity among Primary Care professionals in their exposure to T2DM-specific education. Professionals with limited prior training or experience in diabetes management demonstrated lower baseline knowledge and self-efficacy, particularly in the application of advanced pharmacotherapies and patient-centered care strategies. This variability underscores the importance of tailored educational interventions that account for differing levels of expertise and experience. The findings suggest that standardized and follow-up training programs, such as the one implemented, can effectively bridge these gaps, ensuring a more uniform level of competence across diverse Primary Care settings.

The study identified several limitations in current training programs, including insufficient focus on newer pharmacologic options, limited incorporation of patient-centered strategies, and minimal use of active learning methods. Many participants were unfamiliar with the cardiovascular and renal benefits of newer agents like SGLT2 inhibitors and expressed reluctance to initiate or intensify treatment—a pattern associated with clinical inertia. These gaps contributed to suboptimal adherence to guidelines and inconsistent management of complications. The findings support the need for comprehensive, evidence-informed training programs that emphasize practical, current, and interactive content.

The design and implementation of the advanced, multidisciplinary training program proved highly effective in addressing the identified weaknesses. The eight-week intervention, delivered through interactive methodologies such as case-

based discussions and practical workshops, was led by a certified Diabetes Nurse Practitioner and aligned with international guidelines. The program's focused on pharmacologic updates, patient-centered strategies, and clinical decision-making tools empowered providers to translate evidence-based knowledge into practice. High participant satisfaction with the program's relevance and pedagogical approach further supported was successful implementation, highlighting the feasibility of nurse-led educational models in Primary Care settings.

Significant improvements were noted across all measures. Knowledge test scores improved, with marked gains in understanding new therapies and their cardiovascular and renal advantages. Self-efficacy improved in five out of six domains, particularly in pharmacologic decisions and team-based collaboration. Participants reported increased confidence in initiating and adjusting medications such as GLP-1 receptor agonists and SGLT2 inhibitors. The perceived quality of care also improved, as measured by the iQuaD framework, reflecting enhanced communication, medication counseling, and interdisciplinary care delivery. These outcomes illustrate the program's effectiveness in fostering both cognitive and behavioral competencies required for optimal diabetes care.

The intervention resulted in statistically significant improvements in key metabolic and cardiovascular indicators among patients. Reductions were observed in HbA1c , fasting glucose, total cholesterol , LDL cholesterol, non-HDL cholesterol, and triglycerides . Additionally, improvements were seen in eGFR, systolic and diastolic blood pressure, and a mean weight loss. While these changes were modest in absolute terms, they are clinically meaningful due to their association with reduced risk of both microvascular and macrovascular complications. The absence of change in urinary albumin/creatinine ratio may

reflect the need for longer-term or more targeted interventions to address early markers of diabetic kidney disease.

In Summary, this study presents compelling evidence that a structured educational program led by DiNP can meaningfully enhance the capacity of Primary Care professionals to manage type 2 diabetes and achieve better clinical outcomes for their patients. The findings highlight the value of continuous professional development in addressing knowledge gaps, overcoming therapeutic inertia, and improving the quality of care. By demonstrating a clear link between health care provider's education and improved health outcomes, this research supports broader implementation of such programs to strengthen Primary Care systems worldwide. Future studies should explore long-term sustainability, patient-reported outcomes, and cost-effectiveness to further validate and optimize this approach.

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X – APPENDIXES

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APPENDIX 1. Educational program Information

The objective of the educational programme was to enhance the knowledge baseline primary care professionals with regard to the optimal management of diabetes, as part of a future initiative to improve the quality of diabetes care at the provincial level.

The training programme comprises a series of sessions. 8. It was mandatory for all participants to attend all sessions.

It was recommended that cases for consultation be presented by the attending health professionals.

It was recommended that health professionals apply the instructions and lessons learned during each session, commencing from the outset. Complex cases were presented for discussion as part of the training programme.

The venue and date of the event are as follows: The sessions were held on Mondays between 6:30 pm and 9:30 pm. Each session lasted three hours and was developed at the county executive office. The meetings were conducted by a provincial diabetes forum, which included the participation of diabetes consultants. After the conclusion of the course, a follow-up and roundtable discussion were conducted.

The Diabetes School Program

The first session of the programme commenced with the following agenda items: "Setting a Diabetes Framework". Greetings and opening remarks – District Medical Director, District Manager. A review of the updated therapeutic algorithm in type 2 diabetes of 2021, with an emphasis on setting treatment goals and preventing cardiovascular morbidity. A review of oral medication, with guidance on selecting the most appropriate drug for the patient.

Second session. "The right shot for the right patient"

Basal Insulin / GLP-1: instructions for selecting the most appropriate injectable drugs for each patient

Third Session: "Diabetes Complications - Recent Updates" Cardiovascular complications - CVOT studies Diabetic kidney and the effect of diabetes drug treatments on kidney disease - how to protect the kidney beyond ACE and ARB The nurse's role in a primary care clinic for optimal care and follow-up

Fourth Session: "Diabetes Complications - Diabetes Is Not Just Sugar - Cardiovascular Risk Factors" Dyslipidemia - important progress in the treatment besides statins Balancing blood pressure in diabetics - new guidelines Case discussions

Fifth Session: "Technology, Motivational Interview, Obesity and Pre-Diabetes" Technology tasting and diabetes - Continuous monitoring of blood glucose levels- Beyond glycosylated hemoglobin. Tools for improving the responsiveness of medical clinics - a motivational interview Obesity and pre-diabetes - Can diabetes be prevented, is there room for pre-diabetes medication

Sixth Session: "Diabetic Foot" Diabetic neuropathy - diagnosis, treatment Diabetic foot - the nurse's role, manner of examination and follow-up according to current guidelines

Seventh Session: "Pregnancy and Diabetes" Pregnant hyperglycemia - pre-pregnancy diabetes / gestational diabetes - diagnosis and treatment Nurse monitoring of gestational diabetes in primary care

Eighth Session: "Multi-Professional Team" Dieticians and their role in managing the treatment Social workers and their role in managing the care Physiotherapists and their role in managing the treatment Health workshops - their contribution in providing tools to deal with diabetes Certificate distribution and summary feedback

The following questionnaires appendixes (no. 2-5) were employed to collect data from Primary Care professionals

APPENDIX 2. Part I. General Information

Questionnaire number _____ (for office completion),
Date___ ____ _____

Staff Questionnaire: Treatment of diabetes in the community for the purpose of testing self-efficacy and knowledge in the field

Dear staff member, greetings!
You are asked to participate in a study aimed at examining the **Relationship between the contribution of diabetes training by a clinical nurse specialist in diabetes and the Diabetes Forum for satisfaction, self-efficiency and knowledge update in managing Diabetes treatment in Meuhedet health fund, and the subsequent quality of diabetes care in the Northern District.**

The questionnaire is anonymous. The information will be used for research purposes only. The questions and statements in the questionnaires are worded in masculine language but refer to both genders.

Your opinion is important for future improvement in the diabetes school program
Thanks for the cooperation!

Part A. Demographics:
Please, fill in the blanks or circle the correct answer:

Type of employment: 1) Self-employed 2) Employee
Sex : Male /Female
Age _____
Professional experience in years_____
Did you get any Professional training in Diabetes YES / NO _____

APPENDIX 3. Part II. Knowledge Questionnaire

In this section, you are asked to answer the following 7 questions, choose the most appropriate answer to each question:

1. **The following answers regarding treatment with GLP-1 drug group are correct EXCEPT for:-**
   A. Inhibits glucagon secretion
   B. Accelerates insulin release
   C. Accelerates gastric emptying
   D. Reduces the feeling of hunger

2. **Side effects of treatment with ACTOS Includes: everything EXCEPT:**
   A. Weight gain
   B. Edema
   C. Can cause liver dysfunction
   D. Decrease in HDL
   E. Increases the chance of bone fractures.

3. **DPP4 Inhibitors vs. Agonists of GLP1RA:**
   A. Lowers HBA1C equally
   B. Lose weight equally
   C. Causes far fewer side effects
   D. Safer cardiovascular aspect

4. **58 years old, with a background of type 2 diabetes, receiving treatment with metformin and insulin according to the basal-bolus regimen. Released from the hospital a month ago with a recommendation to add EMPAGLIFLOZIN to the treatment after being hospitalized due to myocardial infarction. The patient turns to you due to general weakness and abdominal pain. He is panting – has deep and fast breaths. Sugar is 220 mg / dl. How will you act?**

   A. I will calm him down. The patient appears to be having an anxiety attack

B. I will check for ketones in the urine, if negative, I will send him home
C. Probably dehydrated , I'll send him to the emergency room for a Saline IV
D. I'll send him to the emergency room, with suspicion of diabetic ketoacidosis.

5. **Dan, 35, is single. Diagnosed two years ago with type 2 diabetes. No background disease, no diabetes is known in the family . HbA1C = 8.5% (half a year ago HbA1C = 7.2%), BMI = 22kg / h². Treated w. Eucrease 50/500 X 2/d.According to him, he engages in physical activity and adheres to a healthy diet. Complains of signs of hyperglycemia. How would you define his condition and what is the recommended treatment?**

A. Worsening the balance of type 2 diabetes, it is recommended to add a type of GLP1 agonist treatment
B. As it seems it is probably a type of LADA diabetes therefore it is recommended to start insulin therapy and stop oral therapy.
C. The worsening of the balance of type 2 diabetes is apparently due to not adhering to a healthy lifestyle so additional oral medication should be added.
D. Apparently this is a type of LADA diabetes and therefore it is recommended to add a prep. from the SGLT2 family

6. **For a patient who complained of symptoms of hyperglycemia, a random blood test was performed in which a sugar value above 215 mg% was found. The result indicates:**
   A. Carbohydrate Intolerance - IGT (Impaired Glucose Tolerance)
   B. Perform a diabetes load test
   C. Diagnosis of type 2 diabetes
   D. Diagnosis of type 1 diabetes

7. **A patient who is overweight and has no background diseases, underwent a recent blood test and was found to have fasting blood sugar levels of 120 mg /% and glycated hemoglobin of 7.2%. The doctor**

gave a prescription for Metformin 850 mg 3 / day Tab. What are the problems with providing this treatment?

A. The dose of the drug should be increased gradually (over about a month) due to fear of hypoglycemia.
B. The dose of the drug should be increased gradually (over a period of about a month) due to concern about gastrointestinal side effects.
C. The dose of the drug should be reduced to once a day due to fear of weight gain with the drug and the patient's weight should be monitored
D. Giving three servings a day may impair the patient's liver function.

APPENDIX 4. Self-Efficacy Questionnaire

Part III. Degree of Self-Efficacy

The following statements express areas of knowledge regarding diabetes. You are asked to indicate your degree of mastery of knowledge regarding the diagnosis and treatment of diabetes as reflected in your current position, according to the following scale:

Not at all	Slightly	Moderately	To a large extent	To a very large extent
1	**2**	**3**	**4**	**5**

	Not at all	Slightly	Moderately	To a Large Extent	To a very large extent
I master the knowledge about ...	1	2	3	4	5
Detection and diagnosis of diabetes	1	2	3	4	5
Identification, treatment and diagnosis of hypoglycemic state	1	2	3	4	5
Starting insulin treatment	1	2	3	4	5
Starting treatment with GLp-1	1	2	3	4	5
Decision on choosing oral therapy for diabetes	1	2	3	4	5
Decision on target value	1	2	3	4	5
HbA1C per patient	1	2	3	4	5
Decision on target values in fasting and two hours after food	1	2	3	4	5

Control of short - lasting and long lasting insulin types	1	2	3	4	5
Control of the GLP-1 types	1	2	3	4	5
Control of all oral therapies	1	2	3	4	5
Control of up-to-date guidelines for treatment selection including research update	1	2	3	4	5
Identification of complications and damage to target organs	1	2	3	4	5

The following statements relate to belief in your ability to perform ongoing tasks in the context of your role in the community according to the scale from 1 - Not at all up to 5 – To a very large extent.
I believe I can ....

	Not at all	Slightly	Moderately	To a Large Extent	To a very large extent
Identify a factor that affects the balance of diabetes	1	2	3	4	5
Identify situations that cause a state of imbalance to the patient	1	2	3	4	5
Medication change	1	2	3	4	5
Prevent hypoglycemic conditions in the patient	1	2	3	4	5

Effectively treat severe hypoglycemic condition	1	2	3	4	5

You are asked to address the following statements, which examine the knowledge required to begin treatment with SGLt2. To what extent will the following statements influence the decision to choose the treatment?

	Not at all	Slightly	Moderately	To a Large Extent	To a very large extent
A patient who is a bus driver	1	2	3	4	5
Patient with a cardiovascular background	1	2	3	4	5
Elderly patient	1	2	3	4	5
A Patient with additional background diseases (comorbidities)	1	2	3	4	5
HbA1C Level	1	2	3	4	5
High fasting sugar values	1	2	3	4	5
GFR between 45 and 60	1	2	3	4	5

You are asked to address the following statements, which examine the knowledge required to begin treatment with GLP-1. To what extent will the following statements influence the decision to choose treatment?

	Not at all	Slightly	Moderately	To a Large Extent	To a very large extent
Treated with BMI 28 and HbA1C = 7.5%	1	2	3	4	5
Patient with a cardiovascular background	1	2	3	4	5
Elderly patient	1	2	3	4	5
Family History of Medullary Thyroid Cancer	1	2	3	4	5
Level HbA1C	1	2	3	4	5
High fasting sugar values	1	2	3	4	5
Sugar values after meals are high	1	2	3	4	5
GFR less than 15	1	2	3	4	5
History of Pancreatitis	1	2	3	4	5

The following statements relate to the perceptions of the staff regarding the treatment of diabetes in the community. You are asked to rate your agreement with the statements listed below, according to the following scale:

	Not at all	Slightly	Moderately	To a Large Extent	To a very large extent
A new diagnosis is a window of opportunity to balance diabetes and	1	2	3	4	5

prevent the development of complications					
It is better for the patient to be exposed to hyperglycemia than to hypoglycemia	1	2	3	4	5
	1	2	3	4	5
Treatment with two medications if the patient came to me for the first time with HBA1C over 7.5%	1	2	3	4	5
Diabetic complications must be identified, otheriwse cannot be treated	1	2	3	4	5
Every patient must be referred to a dietitian	1	2	3	4	5
Every patient must be referred to a nurse	1	2	3	4	5
To acheive a balanced state, patients must always start insulin and then change the treatment	1	2	3	4	5
Diabetes balance is the role of the endocrinologist	1	2	3	4	5
The level of HbA1C does not influence	1	2	3	4	5

the choices of diabetes treatment					
Before proceeding with treatment, the patient's adherence to treatment should be determined	1	2	3	4	5
Patient participation in the choice of treatment	1	2	3	4	5
Including a family member as a source of support for the success of the treatment	1	2	3	4	5

In this chapter you are asked to rate your consent regarding the treatment of diabetes in your clinic:

	Not at all	Slightly	Moderately	To a Large Extent	To a very large extent
Medication is always adjusted to the actual sugar level	1	2	3	4	5
A patient with long-acting insulin must always check fasting sugar levels	1	2	3	4	5
Long-term insulin injection is given only in the evening	1	2	3	4	5
A patient started insulin and reports that he knows the treatment, send him anyway for	1	2	3	4	5

guidance or is not needed.					
The level of treatment for diabetics in my clinic is insufficient	1	2	3	4	5
A balanced patient may consider discontinuing diabetes treatment	1	2	3	4	5
The feet of each diabetic patient must be examined at least once a year	1	2	3	4	5

APPENDIX 5. ***Quality of Care*** **Questionnaire**

Part IV. Treatment of diabetes in the community for the purpose of testing of quality of care provided by nurses:

Part B. The following statements relate to the perceptions of the nurses regarding the approach to diabetic patients, and the quality of provided medical care for diabetes. You are asked to rate your agreement with the statements listed below, according to the following scale:

Disagree	**Agree to a small extent**	**Agree to a moderate extent**	**Strongly agree**	**Totally Agree**
1	**2**	**3**	**4**	**5**

According to my impression, in my work at the clinic ...

	Not at all	Slightly	Moderately	To a Large Extent	To a very large extent
The patients receive a full explanation from me about the periodic tests they need to perform	1	2	3	4	5
I have a proactive approach when dealing with diabetic patients	1	2	3	4	5
Nurses dedicate enough time to talking to a diabetic patient when performing a follow-up	1	2	3	4	5
Nurses are available for patient inquiries	1	2	3	4	5

and complaints related to diabetes, even outside of working hours					
Nurses encourage the integration of family members as part of the treatment process	1	2	3	4	5
Sometimes I fail to give optimal care because of the workload	1	2	3	4	5
My care as a nurse addresses the needs of patients	1	2	3	4	5
Patients are given a comprehensive explanation of diabetes medication	1	2	3	4	5
The treatment I give in the clinic is safe and high-quality for the patient	1	2	3	4	5
Nurses encourage patients to ask questions and find out about problems or side effects in the treatment they receive	1	2	3	4	5
The quality of treatment I provide in diabetes is based on the level and	1	2	3	4	5

quality of my knowledge in the field					
The nurses work skillfully and professionally in diabetes	1	2	3	4	5
I contribute to improving the quality of treatment for diabetes patients	1	2	3	4	5
I regularly invite patients for follow-ups to maintain a regular therapeutic sequence	1	2	3	4	5
I as a nurse make sure to perform a foot estimate for each patient according to the procedure	1	2	3	4	5
To improve the quality of treatment, I seek the help of an attending physician	1	2	3	4	5
To improve the quality of treatment, I check each patient's level of responsiveness and treatment adherence, including the purchase of medication	1	2	3	4	5
To improve the quality of treatment, I refer every diabetic patient to a multi-	1	2	3	4	5

professional team as needed as to dietitian					

Regards.

APPENDIX 6. Clinical parameter changes after intervention in both the control and experimental groups

	Control group (n = 2011)			
	Baseline	Post-intervention	Change (IC95%)	$P_{post\text{-}base}$
Weight (kg)	83.7 ± 16.8	83.2 ±16.6	0.68 (0.51-0.86)	<0.001
BMI (kg/m²)	29.35 ± 7.06	29.11 ± 7.01	0.24 (0.03 – 0.18)	<0.001
SBP (mmHg)	132 ± 16	131 ±16	0.63 (0.05-1.21)	0.034
DBP (mmHg)	76 ± 8	76 ±8	0.12(-0.21-0.45)	0.483
Fasting Glucose (mg/dl)	133 ± 43	130 ±43	3.06 (1.58-4.54)	<0.001
HbA1c (%)	6.9 ± 1.3	6.8 ±1.3	0.77 (0.04-0.11)	<0.001
Triglycerides (mg/dl)	162 ± 152	154 ±96	8.34 (3.54-13.14)	<0.001
Total cholesterol (mg/dl)	173 ± 43	173 ±41	0.11(-1.14-1.37)	0.859
Non HDL (mg/dl)	128 ± 42	127 ±39	1.54 (0.31-2.77)	0.014
LDL (mg/dl)	97 ± 35	97 ±35	-0.53 (-1.045-0.93)	0.916
eGFR (mL/min/1.73m²)	75.1 ± 20.5	76.3 ±21.4	-9.34 (-1.23-0.63)	<0.001

	Intervention group (n = 2088)			
	Baseline	Post-intervention	Change (IC95%)	$P_{post\text{-}base}$
Weight (kg)	85.9 ± 17.0	85.1 ±16.7	0.83(0.63-1.03)	<0.001
BMI (kg/m²)	30.34 ± 7.16	30.05 ± 7.07	0.29(0.04 – 0.22)	<0.001
SBP (mmHg)	131 ± 16	129 ±15.4	1.21(0.64-1.79)	<0.001
DBP (mmHg)	76 ± 9	75 ± 9	0.43(0.79-0.78)	0.016
Fasting Glucose (mg/dl)	137 ± 51	127 ± 40	9.58(7.70-11.47)	<0.001
HbA1c (%)	7.2 ± 3.9	6.84 ± 1.16	0.41 (0.25-0.58)	<0.001
Triglycerides (mg/dl)	171 ± 124	164 ±140	7.14(2.38-11.90)	0.003
Total cholesterol (mg/dl)	173 ± 41	173 ± 51	0.49 (-1.22-1.32)	0.940
Non HDL (mg/dl)	131 ± 40	129 ± 41	1.53(0.3-2.75)	0.014
LDL (mg/dl)	97 ± 34	97 ± 35	0.090 (-0.91-1.09)	0.861
eGFR (mL/min/1.73m²)	82.2 ± 20.4	83.8 ± 21.1	-1.56 (-1.89 - -1.23)	<0.001

Data represent mean ± sd. BMI: body mass index; SBP: systolic blood pressure; SBP: diastolic blood pressure. eGFR: Estimated glomerular filtration rate. Statistical differences were evaluated by a paired t test.

APPENDIX 7. STROBE

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	YES (in Abstract)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	YES
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	YES
Objectives	3	State specific objectives, including any prespecified hypotheses	YES
Methods			
Study design	4	Present key elements of study design early in the paper	YES
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	NO (for anonymization)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	YES
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	YES
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	YES
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	YES

Bias	9	Describe any efforts to address potential sources of bias	YES
Study size	10	Explain how the study size was arrived at	YES
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	YES
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	YES
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	YES
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	YES
		(b) Indicate number of participants with missing data for each variable of interest	YES
		(c) Summarise follow-up time (eg, average and total amount)	YES
Outcome data	15*	Report numbers of outcome events or summary measures over time	YES
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	YES

		(*b*) Report category boundaries when continuous variables were categorized	YES
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	YES
Discussion			
Key results	18	Summarise key results with reference to study objectives	YES
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	YES
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	YES
Generalisability	21	Discuss the generalisability (external validity) of the study results	YES
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	YES

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

APPENDIX 8. R code

R Code

```
#Load Libraries
library(haven)
library(dplyr)
library(lme4)
library(lmerTest)
library(ggplot2)
library(ggeffects)

# Load SPSS file
#data <- read_sav("/ruta/al/archivo/**********.sav")
data <- read_sav("G:/**********.sav")

# Check variables and types with str()
str(data)

# To ensure that categorical variables are factors and numeric variables remain
# as numbers, do the following:
data <- data %>%
  mutate_if(is.labelled, as_factor)
# Check variables again
str(data)
```

```
# Fitting the model using lmerTest
model <- lmer(var1 ~ Group + (1 | Professional), data = data)

# Get the summary with p-values
summary(model)

# Checking the model assumptions: Normality and Homoscedasticity
# Extract the residuals from the fitted model
residuales <- residuals(model)

# Histogram of the residuals
hist(residuales, main = "Histograma de los residuales", xlab = "Residuales", breaks
= 30)

# QQ-plot to verify normality
qqnorm(residuales)
qqline(residuales, col = "red")

# Shapiro-Wilk normality test
shapiro.test(residuales)
#To check homocedasticity
# Plot of fitted values versus residuals
plot(fitted(modelo), residuales,
    main = "Valores ajustados vs Residuales",
```

```
    xlab = "Valores ajustados",
    ylab = "Residuales")
abline(h = 0, col = "red")

# Comparison with a null model
# Fitting the null model without the Group variable
modelo_nulo <- lmer(change_var1 ~ (1 | Professional), data = data)

# Compare the full model with the null model using ANOVA (Likelihood Ratio Test)
anova(modelo_nulo, modelo)
```

APPENDIX 9. Helsinki Committee Approval

No. 529/2021

Form No. 7

Certification of translation

I, the undersigned RAAED KABAHA

Notary holding license no 212385

hereby certify that I am fluent in the

Hebrew and English languages

And that the document attached to this certification and marked with the letter/ number A is a translation to the English language of:

☐ a copy that is not the original and is not a true copy of the original

photocopy of a copy that is not the original and is not a true copy of the original

drawn up in the Hebrew language attached to this certification and marked with the letter B

In witness whereof, I hereby certify the faithfulness of said translation by my own signature and seal, this day 10/01/2021

Notary fee 244.53 NIS.

Signature _____

Notary's seal

מספר סידורי: 529/2021

טופס מס' 7

אישור נכונות תרגום

אני החתום מטה, כבהה ראאד

נוטריון בעל רישיון מספר 212385

מצהיר בזאת כי אני שולט היטב בשפות

עברית ו אנגלית

וכי המסמך המצורף לאישור זה והמסומן באות A

הוא תרגום לשפה האנגלית של:

☐ העתק שאינו המקור ואינו העתק מאושר של המקור

העתק צילומי של העתק שאינו המקור ואינו העתק מאושר של המקור הערוך בשפה העברית מצורף לאישורי זה ומסומן באות B

לראיה אני מאשר את דיוק התרגום האמור בחתימת ידי ובחותמי, היום 10/01/2021

שכר נוטריון: 244.53 שקלים חדשים

חתימה _____

חותם הנוטריון

A

Meuhedet

To be Healthy and Stay Healthy

Procedure for medical research involving human subjects 2020

Form 16

Approval of the Helsinki Committee (Medical Research)

November 4, 2020

In honor of
Main researcher: Bushra Yunis
District Diabetes Nurse - Northern District
Meuhedet

Subject: Approval of the Helsinki Committee

We are convinced that the medical research, details of which are listed below, does not contradict the principles of the Declaration of Helsinki, public health regulations (medical experiments involving human subjects) 1980 and procedure for medical experiments involving human subjects (Procedure 14).

This approval is an intermediate step in the medical research approval process. The researcher may start conducting the research only after receiving the approval of the director (Form 17).

Details of the study

Application number at the institutional committee: 05-24-08-20
Research topic: Contribution of physicians and nurses training program in achieving a balanced state in type 2 diabetes patients in the Northern District, is this the right model?
Name of researcher: Bushra Yunis

Research documents

Name/Protocol code: 05-24-08-20	Version: 2	Date: 05-24-08-20
Consent form	Version:	Date:

[Approval of Conditions/and Limitations]

Condition/limitation: The information collected about the patients will be aggregative

[The following exceptions of the procedure have been approved]

Exception: Exemption from signing the consent form by staff members	The reason: The doctor is the one being checked and not the patient

The approval is given as

☒ "Special" medical experiment

☐ A "non-special" medical experiment, and therefore requires further approval from the Ministry of Health.

Name of the Chairman of the committee	Signature	Discussion date	Approval date
Prof. Anton Heiman	(+) Prof. Anton Heiman	04/11/20	04/11/20

The copy:
Director of the medical institution
The developer / his representative in Israel
Department of Clinical Trials

Meuhedet
Prof. Anton Heiman , the Chairman (+)
Approval of the Helsinki Committee

B

מאוחדת

טופס 16

אישור ועדת הלסינקי (מחקר רפואי)

04 בנובמבר , 2020
י"ז בחשון התשפ"א

לכבוד
החוקרת הראשית: בושרה יונס
אחות סוכרת מחוזית – מחוז צפון
מאוחדת

הנדון: אישור ועדת הלסינקי

שוכנענו שהמחקר הרפואי, אשר פרטיו מופיעים להלן, אינו נוגד את עקרונות הצהרת הלסינקי, תקנות בריאות העם (ניסויים רפואיים בבני-אדם) תשמ"א-1980 ונוהל לניסויים רפואים בבני-אדם (נוהל 14).

אישור זה הינו שלב ביניים בהליך אישור המחקר הרפואי. החוקר רשאי להתחיל בביצוע המחקר רק לאחר קבלת אישור המנהל (טופס 17).

פרטי המחקר

מספר הבקשה בוועדה המוסדית: 05-24-08-20
נושא המחקר: השפעת תוכנית הכשרה לרופאים ואחיות על רמת איזון סוכרת סוג 2 במחוז צפון, האם זה המודל הנכון?
שם היזם: בושרה יונס

מסמכי המחקר

שם/סימון פרוטוקול: 05-24-08-20	גרסה: 2	תאריך: 05-24-08-20
טופס הסכמה:	גרסה:	תאריך:

[האישור בתנאים/במגבלות]

תנאי/מגבלה: המידע שיאסף על המטופלים יהיה אגרגטיבי

[אושרו החריגות הבאות מהנוהל]

החריגה: פטור מהחתמה על הסכמה מדעת של אנשי הצוות	הסיבה: בודקים את הרופא ולא את המטופל.

האישור ניתן כ

☒ניסוי רפואי "מיוחד".

☐ניסוי רפואי "לא מיוחד", ולכן נדרש גם לאישור נוסף של משרד הבריאות.

שם יו"ר הוועדה	חתימה	תאריך הדיון	תאריך האישור
פרופ. אנטוני היימן		4/11/20	4/11/20

מאוחדת
פרופ' אנטוני היימן
יו"ר ועדת הלסינקי
קופת חולים מאוחדת

העתק:
מנהל המוסד הרפואי
היזם / נציגו בארץ
המחלקה לניסויים קליניים