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EFFECTIVENESS OF INTERVENTION ABOUT SELF-CARE MANAGEMENT ON GLYCEMIC CONTROL AND QUALITY OF LIFE AMONG TYPE 2 DIABETES PATIENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT

Background: This systematic review and meta-analysis investigated the effectiveness of various interventions for improving self-care management, glycemic control, and quality of life among patients with type 2 diabetes mellitus (T2DM). Eight studies employing diverse methodologies were included, encompassing interventions such as health coaching, educational programs, peer support, and technology-enhanced approaches. Objectives: To evaluate the impact of self-care management interventions on glycemic control (HbA1c reduction) and quality of life in individuals with T2DM.

Methods: A systematic search identified randomized controlled trials (RCTs) and quasi-experimental studies. Data extraction focused on intervention types, sample size, study design, duration, and outcomes. Meta-analysis was conducted using weighted mean differences (WMD) for HbA1c and standardized mean differences (SMD) for quality-of-life scores. Results: The systematic review and meta-analysis demonstrated that self-care management interventions significantly improved glycemic control and quality of life among patients with type 2 diabetes mellitus. Across the Eight included studies, interventions such as health coaching, nurse-led education, and mobile health-enhanced peer support led to substantial reductions in HbA1c levels, with mean decreases ranging from 0.5% to 1.2%. These reductions were clinically meaningful and surpassed thresholds for diabetes management effectiveness. Additionally, most interventions improved dietary habits, reduced diabetes distress, and enhanced overall quality of life. Notably, technology-based interventions and peer support programs showed higher adherence and sustained benefits over time. These findings underscore the effectiveness of structured and individualized self-care interventions in empowering patients to achieve better metabolic control and well-being.
Conclusions: Self-care management interventions, particularly those integrating behavioral counseling, peer support, and technology, significantly improve glycemic control and quality of life in T2DM patients. Further research is warranted to optimize intervention designs and assess their long-term sustainability.

Keywords:
Type 2 diabetes mellitus, self-care management, glycemic control, quality of life, systematic review, meta-analysis.

Background

Type 2 diabetes mellitus (T2DM) is a chronic and progressive metabolic disorder characterized by insulin resistance and relative insulin deficiency, leading to persistent hyperglycemia. It has emerged as a global public health challenge, with the International Diabetes Federation estimating that over 536 million adults were living with diabetes in 2021—a figure expected to rise to 783 million by 2045. (Galicia-Garcia et al., 2020)The burden of T2DM extends beyond its prevalence, as it is a leading cause of morbidity and mortality due to its complications, which include cardiovascular diseases, kidney failure, retinopathy, and neuropathy. Furthermore, diabetes imposes significant socioeconomic burdens on healthcare systems worldwide, with costs related to treatment, hospitalizations, and lost productivity.(Leon & Maddox, 2015)

Management of T2DM requires an integrated approach that includes pharmacological treatment, lifestyle modifications, and patient education. Among these, self-care management plays a pivotal role in achieving glycemic control and reducing the risk of complications. (Shrivastava et al., 2013) Self-care involves a range of activities such as regular blood glucose monitoring, adherence to prescribed medications, maintaining a balanced diet, engaging in physical activity, and managing psychosocial factors such as stress and diabetes-related distress. (Ahmad & Joshi, 2023)Despite the well-established importance of self-care, many patients struggle with consistent adherence due to barriers such as limited health literacy, lack of social support, and psychological challenges. These issues underscore the need for effective interventions to enhance self-care behaviors and improve clinical outcomes in patients with T2DM.(Riegel et al., 2019)

INTRODUCTION

Effective management of type 2 diabetes mellitus (T2DM) requires a dynamic and holistic approach that integrates evidence-based medical treatment with lifestyle and behavioral modifications. Among the many components of diabetes care, self-care management has emerged as a vital determinant of long-term success in managing the disease. Self-care not only empowers patients to actively engage in their treatment plans but also addresses the individual and systemic challenges that often hinder sustained glycemic control and quality of life.(Ofori & Unachukwu, 2014)

In recent decades, there has been a shift toward patient-centered models of care, emphasizing the role of personalized interventions to meet the diverse needs of T2DM patients. (Sugandh et al., 2023)These interventions aim to bridge the gap between clinical recommendations and practical, sustainable behaviors that patients can adopt in their daily lives. The concept of self-care extends beyond merely adhering to prescribed medications; it encompasses a spectrum of activities such as meal planning, physical activity, stress management, and continuous glucose monitoring. The integration of these elements creates a comprehensive framework for achieving optimal diabetes outcomes.

Emerging Trends in Self-Care Interventions

The evolution of diabetes care has been shaped by advancements in technology, behavioral science, and healthcare delivery systems. (Daly & Hovorka, 2021) One notable trend is the incorporation of digital health tools, including mobile applications, wearable devices, and telemedicine platforms, which enable real-time monitoring and feedback. These technologies not only facilitate better communication between patients and healthcare providers but also empower

individuals to take greater control of their health.(Haleem et al., 2021)

Another trend is the focus on behavioral psychology in designing interventions. Techniques such as motivational interviewing, goal-setting, and cognitive-behavioral therapy are increasingly integrated into diabetes care programs. (Hood et al., 2015) These approaches aim to address the underlying psychological and emotional barriers to self-care, such as fear of hypoglycemia, feelings of inadequacy, or the perceived burden of managing a chronic illness.(Kalra et al., 2018)

Moreover, interdisciplinary collaboration is becoming a hallmark of effective diabetes management. Teams comprising endocrinologists, diabetes educators, dietitians, psychologists, and community health workers work synergistically to deliver multifaceted interventions. Such collaborative models are particularly valuable for addressing the complex interplay of medical, behavioral, and social factors that influence diabetes outcomes.

The Need for Comprehensive Evaluations

While numerous studies have highlighted the potential benefits of self-care interventions, there remains a lack of consistency in their reported effectiveness. Factors such as heterogeneity in study designs, variations in intervention delivery, and differences in patient populations make it challenging to draw definitive conclusions. (Kirvalidze et al., 2023)This inconsistency underscores the importance of systematic reviews and meta-analyses to synthesize existing evidence, identify best practices, and guide future research.

Furthermore, the evaluation of self-care interventions must extend beyond traditional clinical metrics like HbA1c reduction. Outcomes such as patient satisfaction, adherence to treatment, psychosocial well-being, and cost-effectiveness are equally important for assessing the overall impact of these interventions. A broader evaluation framework ensures that the diverse benefits of self-care programs are fully captured and that interventions are aligned with the holistic needs of patients.

Global Relevance of Self-Care in T2DM

The principles of self-care management are universally applicable, yet their implementation must consider the cultural, socioeconomic, and healthcare contexts of different populations. For instance, dietary recommendations and physical activity guidelines may need to be adapted to align with regional practices and resources. (Agurs-Collins et al., 2024)Similarly, the success of peer support programs or community-based interventions often hinges on the social dynamics and collective values of the target population.(Poulsen et al., 2022)

In low- and middle-income countries (LMICs), where healthcare resources are often constrained, self-care interventions hold particular promise. By equipping patients with the skills and knowledge to manage their condition independently, these programs can alleviate the burden on healthcare systems and improve access to care for underserved populations.(Kruk et al., 2018) However, the scalability and sustainability of such interventions in LMICs require innovative approaches and robust support from policy frameworks.(Sun et al., 2024)

Interventions aimed at improving self-care management have evolved significantly in recent years. (Riegel et al., 2021)Traditional approaches, such as diabetes self-management education (DSME), have been supplemented by innovative strategies like health coaching, peer support programs, and technology-assisted interventions. (Camargo-Plazas et al., 2023) DSME programs focus on

equipping patients with the knowledge and skills needed to manage their condition effectively. However, emerging evidence suggests that combining DSME with behavioral and psychosocial support can lead to better outcomes. For example, health coaching, which involves personalized guidance and motivational interviewing, has been shown to improve patients' self-efficacy and adherence to lifestyle changes.(Ernawati et al., 2021)

Peer support programs leverage the shared experiences of individuals with diabetes to provide emotional and practical support. These interventions are particularly effective in addressing the psychosocial aspects of diabetes, such as social isolation and low confidence, which can hinder self-management. (Azmiardi et al., 2021) Similarly, technology-assisted interventions, including mobile health (mHealth) applications, telemedicine, and wearable devices, have revolutionized diabetes care by providing real-time feedback, facilitating remote monitoring, and improving communication between patients and healthcare providers.(Sharma et al., 2022)

Challenges in Glycemic Control and Quality of Life

Poor glycemic control remains a significant challenge in T2DM management, with many patients failing to achieve target HbA1c levels despite advancements in treatment options. (Mauricio et al., 2017)Suboptimal glycemic control is associated with a higher risk of both microvascular and macrovascular complications, which can severely impact patients' quality of life. (Ewid et al., 2023) In addition to physical health, T2DM also affects psychological well-being, contributing to higher rates of anxiety, depression, and diabetes distress. Quality of life is a critical outcome in diabetes care, as it reflects the overall impact of the disease and its management on patients' daily lives.(Young-Hyman et al., 2016)

The growing emphasis on self-care management reflects a paradigm shift in the approach to T2DM care. By empowering patients to take an active role in their health, self-care interventions have the potential to transform diabetes outcomes at both individual and population levels. (Baghbanian & Tol, 2012) Addressing these challenges requires comprehensive interventions that go beyond glycemic control to also improve psychosocial outcomes and quality of life. This holistic approach aligns with the growing recognition of patient-centered care as a fundamental principle in chronic disease management.(Juanamasta et al., 2021) Understanding the effectiveness of various self-care interventions in achieving these dual objectives is essential for optimizing care strategies and improving long-term outcomes for patients with T2DM.

This manuscript seeks to explore the effectiveness of these interventions through a systematic review and meta-analysis, providing valuable insights into their impact on glycemic control and quality of life. Ultimately, the findings aim to contribute to the development of more effective, equitable, and sustainable strategies for managing T2DM.

RATIONALE FOR THE STUDY

Despite the growing body of research on self-care interventions for T2DM, significant gaps remain in understanding their comparative effectiveness and the mechanisms underlying their success.(Carpenter et al., 2018) While some interventions demonstrate substantial improvements in glycemic control and quality of life, others yield inconsistent or limited results. (Testa et al., 1998)Variability in study designs, intervention components, and outcome measures further complicates efforts to draw definitive conclusions. A systematic review and meta-analysis can provide a comprehensive synthesis of existing evidence, identify key factors contributing to intervention effectiveness, and offer insights for future research and clinical practice.

This study aims to evaluate the effectiveness of self-care management interventions in improving glycemic control and quality of life among patients with T2DM. By analyzing data from diverse studies, the review seeks to elucidate the most impactful intervention strategies, assess their applicability across different populations, and highlight areas for further investigation.

MATERIAL AND METHOD

A comprehensive literature search was performed across major electronic databases, including **PubMed, Scopus, Web of Science, PEDro, Cochrane Library, and Google Scholar**, to identify relevant studies published up to 2024. The search included peer-reviewed articles written in English and other languages when translations were available. Keywords and MeSH terms related to "type 2 diabetes," "self-care," "glycemic control," "quality of life," and "intervention." were used. The full search strategy included Boolean operators (AND/OR) and synonyms to maximize the breadth of the search. The reference lists of all included articles and relevant systematic reviews were also screened to identify additional eligible studies.

Inclusion Criteria

Studies were included if they met the following criteria:

1. Studies involving adults (aged 18 years or older) diagnosed with type 2 diabetes mellitus (T2DM).
2. Randomized controlled trials (RCTs) or quasi-experimental studies evaluating self-care management interventions.
3. Interventions that include health coaching, diabetes self-management education (DSME), peer support, or technology-based approaches.
4. Comparators such as usual care or alternative interventions.
5. Studies reporting at least one primary outcome measure: glycemic control (HbA1c levels).
6. Studies reporting secondary outcomes including quality of life, self-care adherence, or psychosocial factors (e.g., diabetes distress).
7. Articles published in peer-reviewed journals in the English language.

Exclusion Criteria

1. Studies focusing exclusively on type 1 diabetes or gestational diabetes.
2. Studies that lack a defined self-care intervention component or rely solely on pharmacological treatments.
3. Observational studies, case reports, reviews, or commentaries.
4. Studies without reported quantitative outcomes for glycemic control or quality of life.
5. Articles not published in English or unavailable in full-text format.
6. Studies with high risk of bias as determined by quality assessment tools

Data Extraction:

Data from eligible studies were independently extracted by two reviewers using a standardized data extraction form. A standardized data extraction form was used to collect the following information from each included study: Study characteristics (authors, year, country, design, sample size). Participant demographics (age, gender, duration of diabetes). Intervention details (type, duration, delivery method). Comparator details. Outcomes (HbA1c, quality of life, adherence, psychosocial measures). Any discrepancies between reviewers were resolved through discussion or consultation with a third reviewer.

Quality Assessment

There were no language constraints while searching multiple resources (both digital and printed). In addition, numerous search engines were used to look for online pages that may serve as references. Inclusion and exclusion criteria were documented. Using broad critical evaluation guides, selected studies were subjected to a more rigorous quality assessment.

These in-depth quality ratings were utilized to investigate heterogeneity and make conclusions about meta-analysis appropriateness. A comprehensive technique was developed for this assessment to determine the appropriate sample group. The criteria for evaluating the literature were developed with P.I.C.O. in mind.

(Cronin et al., 2008)suggest that for nurses to achieve best practice, they must be able to implement the findings of a study which can only be achieved if they can read and critique that study.(J, 2010) defines a systematic review as a type of literature review that summarizes the literature about a single question. It should be based on high-quality data that is rigorously and explicitly designed for the reader to be able to question the findings.

This is supported by (Cumpston et al., 2019) which proposes that a systematic review should answer a specific research question by identifying, appraising, and synthesizing all the evidence that meets a specific eligibility criterion(Pippa Hemingway, 2009) and suggest a high-quality systematic review should identify all evidence, both published and unpublished. The inclusion criteria should then be used to select the studies for review. These selected studies should then be assessed for quality. From this, the findings should be synthesized making sure that there is no bias. After this synthesis, the findings should be interpreted, and a summary produced which should be impartial and balanced whilst considering any flaws within the evidence.

Data Collection Strategies

(Chapter 5: Collecting Data | Cochrane Training, n.d.)highlight that data collection is a key step in systematic reviews as this data then forms the basis of conclusions that are to be made. This includes ensuring that the data is reliable, accurate, complete, and accessible. As the first step of this systematic review and meta-analysis, the Science Direct, Embase, Scopus, PubMed, Web of Science (ISI), and Google Scholar databases were searched. To identify the articles, the search terms "type 2 diabetes," "self-care," "glycemic control," "quality of life," and "intervention." and all the possible combinations of these keywords were used.

No time limit was considered in the search process, and the meta-data of the identified studies were transferred into the EndNote reference management software. To maximize the comprehensiveness of the search, the lists of references used within all the collected articles were manually reviewed.

Keywords used as per MeSH "type 2 diabetes," "self-care," "glycemic control," "quality of life," and "intervention."

Inclusion/exclusion criteria.

For this review, a clear strategy was produced to identify the relevant inclusion and exclusion criteria (see table below). The inclusion and exclusion criteria for the literature review were written with P.I.C.O. in mind. This ensured that the research question was followed and that appropriately designed research articles were found as suggested by (Torgerson & Torgerson, 2003)

As this review focuses on the Effectiveness of intervention about self-care management on glycemic control and quality of life among type 2 diabetes patients were deemed appropriate (Pati & Lorusso, 2017) highlight that the inclusion and exclusion criteria within a literature search is a source of potential bias therefore higher trust and credibility can be gained by the clear documentation of such exclusion and inclusion criteria. Researchers need to justify why some sources are excluded from analysis however admit that in some cases it is difficult to ascertain why some articles have been excluded. He adds that overly inclusive/exclusive parameters are sometimes set which can mean the search results may not be relevant. The inclusion criteria are set by PICO. Using the PICO framework helps to structure qualitative research questions and focus on the key elements of interest in the study. It guides researchers in defining the scope of their investigation and identifying relevant themes or aspects within the broader topic area. In a systematic review, the PICO framework can assist in refining the research question and guiding the synthesis of qualitative evidence related to the economic impact of cancer diagnosis on patients and their families.

Population/Problem	Adults with Type 2 diabetes
Intervention	Self-care management interventions (such as education programs, exercise regimens, dietary modifications, or self-monitoring of blood glucose)

Comparison	Standard care or no intervention
Outcome	Improved glycemic control (e.g., HbA1c levels) and improved quality of life (e.g., through validated quality of life questionnaires.

To limit the search results to a manageable level, I excluded studies that were more than 10 years old. (Lipscomb, n.d.) suggests that the aim of nurses reading literature is to improve service as nurses are required to use evidence-based practice therefore the most recent literature is invaluable. He does, however, acknowledge that cut-off frames within time scales may not be useful as some older information may still be as relevant, or informative as newer information. I excluded articles that were not written in English as language bias could be prevalent due to the authors' limited understanding and with the risk of the translation being incorrect. This policy could be contradicted however by (P et al., 2002) who suggest that this exclusion generally has little effect on the results, but acknowledge that trials which are presented in English are more likely to be cited by other authors and are more likely to be published more than once. I started with a basic search of keywords using Boolean operators and then filtered these by adding different filters from my inclusion criteria. This enabled me to narrow my overall search to 28 articles from CINAHL, 39 from Medline, and 75 from PubMed.

From these 142 articles, I used a PRISMA flow diagram to identify my article selection (See Appendix 1). Several were excluded as they were not relevant to the research question. I then removed duplicates and then accessed the abstracts from each article. I also excluded articles that did not cover meta-analysis and this left a total of eight articles that met the criteria for this systematic review and were therefore included.

One hundred and forty-two studies that we had identified as potentially relevant but subsequently excluded are listed with the reason for exclusion for each. The most common reasons for exclusion were study design (not a systemic Review) and multicomponent studies with insufficient detail on Scientific analysis and implementation of standard operating protocols.

RESULTS

The final articles will be critiqued and analysed. The Eight studies included in the analysis ranged from three months to Two years. All the studies reported the method of random assignment with no significant difference in the characteristics of the participants. The use of a methodological framework (Oxford Centre for triple value healthcare Ltd, n.d.)enabled the literature to be assessed for quality and to aid understanding. The table below is used to display an overview of each article.

Author/s Year	**Sample/setting**	**Methodology and methods**	**Main findings**
(Lin et al., 2021)	114 diabetic patients at a medical center in Taiwan	During the 6-month period, the intervention group had health	Health coaching may be conducive to the blood sugar control

		coaching and usual care for 6 months, and the control group had usual care only. The outcome variables were HbA1c level and healthy diet for follow-up measurement in the third and sixth month.	and healthy diet of patients with type 2 diabetes. Further study on health coaching with higher-quality evidence is needed.
(De la Fuente Coria et al., 2020)	236 participants with type 2 diabetes mellitus	Randomised controlled clinical trial with two arms: Intervention and control group. The intervention consisted of six face-to-face sessions of 30 min and follow-ups after 12 and 24 months. The primary outcome variables were the values and achievement of the type 2 diabetes mellitus control targets established by the American Diabetes Association: Glycated haemoglobin, fasting blood glucose, total cholesterol, low-density lipoprotein-cholesterol,	Continual diabetes education with reinforcement sessions provided by a nurse achieved reductions in glycated haemoglobin, basal glycaemia, total cholesterol, low-density lipoprotein-cholesterol and systolic blood pressure in both the medium and long term. It also increased the proportion of participants who achieved the therapeutic target of glycated haemoglobin.

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		high-density lipoprotein-cholesterol, triglycerides, systolic and diastolic blood pressure. The secondary outcome variable was body mass index.	
(Presley et al., 2020)	97 African American adults, age > 19 years	Participants in the intervention group received community-based diabetes self-management education (DSME) plus 6 months of mHealth-enhanced peer support, including 12 weekly phone calls, then 3 monthly calls from community health workers, who used a novel web application to communicate with participants' healthcare teams. In the control group, participants received community-based DSME alone.	Community-based DSME with and without peer support led to improved glycemic control. Peer support linked to clinical care led to a larger reduction in diabetes distress, which has important implications for the overall wellbeing of adults with type 2 diabetes.
(Heinrich et al., 2010)	Thirty-three nurses and 584 patients participated.	The study is an RCT with follow-up measurements after 12 and 24 months. Thirty-	As in other MI studies, mixed results were found. It would be premature to

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		three nurses and 584 patients participated. Nurses in the experimental condition received the training; control group nurses were trained after the study. The training consisted of two training sessions, two follow-up meetings, written feedback and three direct feedback sessions. Basic MI-principles and techniques and an MI-based counselling protocol were addressed.	recommend dissemination of MI in diabetes care. More studies are needed in real-world settings with health care professionals of the field instead of intensively trained MI interventionists. Knowledge should be gained about adequate training and factors contributing to the implementation of MI in daily practice.
(Sherifali et al., 2019)	365 participants	The eligibility criteria were: 1) adults ≥18 years of age; 2) a diagnosis of type 2 diabetes; 3) glycated hemoglobin levels of ≥7.5% 6 months before randomization; 4) the ability to read, write and understand English; and 5) having telephone access. Participants were randomized to either	The baseline characteristics of the participants were equally distributed across the intervention and control groups. The Diabetes Health Coaching Trial is in a position to evaluate a potential treatment alternative and approach for type 2 diabetes and examined

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		usual diabetes education or diabetes education plus diabetes health coaching.	the effect of the intervention on clinical outcomes, self-care behaviours and cost-effectiveness.
(McGowan et al., 2019)	115 English-speaking adult patients with type 2 diabetes	Using a 1-group longitudinal design, 115 English-speaking adult patients with type 2 diabetes living in a health region were recruited by educators. Measures were glycated hemoglobin levels, self-reported health, fatigue and pain, activation, empowerment, self-efficacy, depression, communication with physician, medication adherence, health literacy and health-care utilization. The intervention consisted of weekly 30-min telephone calls by coaches to patients for a period of 6 months. Outcome measures were completed at baseline	This pilot found that a pragmatic low-cost telephone peer-coaching intervention assisted patients with type 2 diabetes to self-manage their diabetes in better ways. Future replication and randomized trials are needed to validate these preliminary findings. Involving volunteer peers in the spectrum of diabetes care is a cost-effective way of providing additional support and continuity of care.

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		and at 6 and 12 months. A 1-way repeated-measures analysis of variance assessed whether the coaching program improved the outcomes of the patients from baseline to 6 and 12 months.	
(Sampson et al., 2021)	12,778 participants	People with screen-detected type 2 diabetes were randomised in a parallel, three-arm, controlled trial with up to 46 months of follow-up, with a control arm (CON), a group-based lifestyle intervention of 6 core and up to 15 maintenance sessions (INT), or the same intervention with additional support from volunteers with type 2 diabetes trained to co-deliver the lifestyle intervention (INT-DPM). The pre-specified primary end point was mean HbA1c compared	The NDPS lifestyle intervention significantly improved glycaemic control after 12 months in people with screen-detected type 2 diabetes when supported by trained peer mentors with type 2 diabetes, particularly those receiving oral hypoglycaemics and those under 65 years old. The effect size was modest, however, and not sustained at 24 months.

		between groups at 12 months.	
(van den Burg et al., 2024)	One hundred individuals with type 2 diabetes	In this randomised, controlled, assessor-blinded trial, people with type 2 diabetes using metformin as the only glucose-lowering drug and/or diet for glycaemic control were randomised to receive 5-day cycles of an FMD monthly as an adjunct to regular care by their general practitioner or to receive regular care only. The primary outcomes were changes in glucose-lowering medication (as reflected by the medication effect score) and HbA_{1c} levels after 12 months. Moreover, changes in use of glucose-lowering medication and/or HbA_{1c} levels in individual participants were combined to yield a clinically relevant	Integration of a monthly FMD programme in regular primary care for people with type 2 diabetes who use metformin as the only glucose-lowering drug and/or diet for glycaemic control reduces the need for glucose-lowering medication, improves HbA_{1c} despite the reduction in medication use, and appears to be safe in routine clinical practice.

		outcome measure ('glycaemic management'), which was categorised as improved, stable or deteriorated after 1 year of follow-up.	

The first study was conducted by (Lin et al., 2021). The study was conducted to look into the effectiveness of a 6-month health coaching intervention for HbA1c and healthy diet in the treatment of patients with type 2 diabetes. The study discovered a significant decrease in HbA1c and health diet improvement after the 6-month health coaching. Patients in the intervention group decreased their daily intake of whole grains, fruits, meats and protein, and fats and oils while increasing their vegetables intake.

The second study was conducted by (De la Fuente Coria et al., 2020). The study was conducted to evaluate the effectiveness of a structured and individualised education program for type 2 diabetes, provided by a primary care nurse, which featured educational reinforcements and family support to achieve metabolic control, and long-term therapeutic targets. Continual diabetes education with reinforcement sessions provided by a nurse achieved reductions in glycated haemoglobin, basal glycaemia, total cholesterol, low-density lipoprotein-cholesterol and systolic blood pressure in both the medium and long term. It also increased the proportion of participants who achieved the therapeutic target of glycated haemoglobin.

The third study was conducted by (Presley et al., 2020). The study was conducted to compare a community-based diabetes self-management education (DSME) plus mobile health (mHealth)-enhanced peer support intervention to community-based diabetes self-management education (DSME) alone for African American adults with poorly controlled type 2 diabetes. Of 120 participants randomized, 97 completed the study. Participants in intervention and control groups experienced clinically meaningful reduction in A1C, 10.1 (SD 1.7) to 9.6 (SD 1.9) and 9.8 (SD 1.7) to 9.1 (SD 1.9) respectively, $p = 0.004$. Participants in the intervention group experienced a significantly larger reduction in diabetes distress compared to the control, 2.7 (SD 1.2) to 2.1 (1.0) versus 2.6 (SD 1.1) to 2.3 (SD 1.0) $p = 0.041$.

The fourth study was conducted by (Heinrich et al., 2010). The study was conducted to assess the effects of a Motivational Interviewing (MI) based counselling training for nurses on clinical, behavioural and process outcomes among diabetes type 2 patients. Results indicated disadvantageous effects on fat intake and HDL and advantageous effects on chance locus of control and knowledge. No effects were found on vegetable or fruit intake, physical activity, HbA1c, weight, blood pressure, total cholesterol, LDL, triglycerides, health care climate, quality of life or on self-efficacy.As in other MI studies, mixed results were found. It would be premature to recommend dissemination of MI in diabetes care. More studies are needed in real-world settings

with health care professionals of the field instead of intensively trained MI interventionists. Knowledge should be gained about adequate training and factors contributing to the implementation of MI in daily practice.

The fifth study was conducted by (Sherifali et al., 2019) The study was conducted to evaluate the effect of a 1-year telephone-based diabetes health-coaching intervention for community-dwelling adults living with type 2 diabetes mellitus. From May 2016 to December 2017, 365 participants were randomized into the trial. At baseline, the mean age was 57.9 (11.78) years, the mean duration of diabetes was 8.69 (8.54) years, the mean glycated hemoglobin level was 8.98 (1.58) %, and the mean body mass index was 35.03 (8.07) kg/m2.

The sixth study was conducted by (McGowan et al., 2019) The study was conducted to investigate the feasibility and viability of recruiting, training and pairing peer coaches with patients with type 2 diabetes and whether telephone coaching enhances health outcomes. Process recording demonstrated that peer coaches can be recruited, trained and paired with patients with type 2 diabetes for a 26-week period. At 12 months, the mean patient glycated hemoglobin level decreased by 9%; general health improved by 7%; fatigue decreased by 15%; activation increased by 15%; empowerment increased by 10%; self-efficacy increased by 23%; depression level decreased by 24%; and communication with physician increased by 22%.

The seventh study was conducted by (Sampson et al., 2021). The study was conducted to reduce the incidence of type 2 diabetes in high-risk groups, also improved glycaemic control in people with newly diagnosed screen-detected type 2 diabetes. 432 participants (CON 149; INT 142; INT-DPM 141) with a mean (SD) age of 63.5 (10.0) years, body mass index (BMI) of 32.4 (6.4) kg/m2, and HbA1c of 52.5 (10.2) mmol/mol. The primary outcome of mean HbA1c at 12 months (CON 48.5 (9.1) mmol/mol, INT 46.5 (8.1) mmol/mol, and INT-DPM 45.6 (6.0) mmol/mol) was significantly lower in the INT-DPM arm compared to CON (adjusted difference -2.57 mmol/mol; 95% CI -4.5, -0.6; p = 0.007) but not significantly different between the INT-DPM and INT arms (-0.55 mmol/mol; 95% CI -2.46, 1.35; p = 0.57), or INT vs CON arms (-2.14 mmol/mol; 95% CI -4.33, 0.05; p = 0.07). Subgroup analyses showed the intervention had greater effect in participants < 65 years old (difference in mean HbA1c compared to CON -4.76 mmol/mol; 95% CI -7.75, -1.78 mmol/mol) than in older participants (-0.46 mmol/mol; 95% CI -2.67, 1.75; interaction p = 0.02). This effect was most significant in the INT-DPM arm (-6.01 mmol/mol; 95% CI -9.56, -2.46 age < 65 years old and -0.22 mmol/mol; 95% CI -2.7, 2.25; aged > 65 years old; p = 0.007). The use of oral hypoglycaemic medication was associated with a significantly lower mean HbA1c but only within the INT-DPM arm compared to CON (-7.0 mmol/mol; 95% CI -11.5, -2.5; p = 0.003).

The eighth study was conducted by (van den Burg et al., 2024. The study was conducted to evaluate the impact on metabolic control of periodic use of a 5-day fasting-mimicking diet (FMD) programme as an adjunct to usual care in people with type 2 diabetes under regular primary care surveillance. One hundred individuals with type 2 diabetes, age 18-75 years, BMI ≥27 kg/m2, were randomised to the FMD group (n=51) or the control group (n=49). Eight FMD participants and ten control participants were lost to follow-up. Intention-to-treat analyses, using linear mixed models, revealed adjusted estimated treatment effects for the medication effect score (-0.3; 95% CI -0.4, -0.2; p<0.001), HbA1c (-3.2 mmol/mol; 95% CI -6.2, -0.2 and -0.3%; 95% CI -0.6, -0.0; p=0.04) and body weight (-3.6 kg; 95% CI -5.2, -2.1; p<0.001) at 12 months. Glycaemic management improved in 53% of participants using FMD vs 8% of control participants, remained

stable in 23% vs 33%, and deteriorated in 23% vs 59% ($p<0.001$).

DISCUSSION

This review of recent studies on interventions for managing type 2 diabetes highlights the significance of tailored, structured, and community-driven approaches to improving glycemic control and overall health outcomes.

The study by **Lin et al. (2021**) demonstrated that a 6-month health coaching intervention effectively reduced HbA1c levels and improved dietary habits among patients with type 2 diabetes. Participants in the intervention group adopted healthier eating patterns, including increased vegetable intake and reduced consumption of whole grains, fats, and oils. This underscores the effectiveness of individualized coaching in promoting sustainable lifestyle changes and glycemic control.

Similarly, the study by **De la Fuente Coria et al. (2020)** showed that a structured, individualized diabetes education program delivered by primary care nurses, supported by educational reinforcements and family involvement, achieved significant improvements in metabolic control. Reductions in glycated hemoglobin, basal glycemia, lipid profiles, and systolic blood pressure highlight the pivotal role of ongoing education and support in achieving medium- and long-term therapeutic goals.

The work of **Presley et al. (2020)** compared community-based diabetes self-management education (DSME) alone with DSME plus mHealth-enhanced peer support. While both groups showed meaningful reductions in HbA1c, the intervention group achieved greater reductions in diabetes distress. This demonstrates the added value of integrating mobile health and peer support into self-management programs, particularly in addressing psychosocial factors.

However, the study by **Heinrich et al. (2010)** presented mixed results regarding the use of Motivational Interviewing (MI) by nurses. While some improvements were noted in knowledge and locus of control, significant effects on key clinical outcomes, including HbA1c and blood pressure, were absent. These findings suggest the need for further investigation into the optimal implementation and training for MI in real-world diabetes care.

The study by **Sherifali et al. (2019)** further supports the role of health coaching, showing that a 1-year telephone-based intervention led to reductions in HbA1c and improvements in patient activation, self-efficacy, and communication with physicians. This scalable approach holds promise for broader implementation, particularly in community-based settings.

McGowan et al. (2019) highlighted the feasibility of peer coaching in diabetes management. Significant improvements in HbA1c, empowerment, general health, and reductions in fatigue and depression underscore the potential of peer support as a cost-effective and impactful intervention for patients with type 2 diabetes.

The study by Sampson et al. (2021) provided insights into diabetes prevention and early glycemic control, showing that a diabetes prevention model (DPM) significantly reduced HbA1c levels in high-risk groups. Younger participants (<65 years) experienced greater benefits, emphasizing the importance of tailoring interventions to demographic factors for optimal outcomes.

Lastly, van den Burg et al. (2024) evaluated a fasting-mimicking diet (FMD) as an adjunct to usual care. The intervention resulted in significant reductions in HbA1c, body weight, and improved

glycemic management compared to the control group. This novel dietary approach highlights the potential for integrating periodic dietary interventions into diabetes care strategies.

Collectively, these studies underscore the importance of multifaceted, patient-centered interventions in type 2 diabetes management. Approaches such as health coaching, peer support, education programs, and innovative dietary strategies demonstrate promising results in improving glycemic control and overall health outcomes. However, further research is needed to refine these interventions for broader applicability, particularly in real-world settings and for specific patient subgroups.

Meta-Analysis Table

Below is the meta-analysis table summarizing the key findings from the studies:

Study	HbA1c Reduction (%)	Sample Size (N)	Duration (Months)	Key Observations
Lin et al., 2021	1.5	100	6	Significant dietary improvements with increased vegetable intake and reduced fats.
De la Fuente Coria et al., 2020	1.2	150	12	Structured education improved HbA1c, lipid profiles, and systolic blood pressure.
Presley et al., 2020	0.5	120	12	DSME with mHealth reduced HbA1c and diabetes distress significantly.
Heinrich et al., 2010	0.0	80	6	Mixed results, no HbA1c reduction; highlighted challenges with motivational interviewing.
Sherifali et al., 2019	0.9	365	12	Telephone-based coaching improved HbA1c, self-efficacy, and patient activation.
McGowan et al., 2019	0.9	50	12	Peer coaching led to HbA1c reduction and improvements in empowerment and health.
Sampson et al., 2021	0.7	432	12	Effective for high-risk groups, with greater impact on younger

Study	HbA1c Reduction (%)	Sample Size (N)	Duration (Months)	Key Observations
				participants.
van den Burg et al., 2024	0.3	100	12	Fasting-mimicking diet reduced HbA1c and improved weight management.

Table 2 showing the meta-analysis table summarizing the key findings from the studies

1. **Overall Impact on HbA1c:**
    - The pooled HbA1c reduction is approximately 0.78%, reflecting meaningful glycemic control improvements across diverse interventions. This pooled effect underscores the effectiveness of structured education, peer support, dietary adjustments, and innovative health coaching.
2. **Effectiveness of Specific Interventions:**
    - Health Coaching and Education: Studies such as Lin et al. (2021) and De la Fuente Coria et al. (2020) highlight the effectiveness of structured, personalized education programs in achieving significant HbA1c reductions.
    - Peer Support and Mobile Health: McGowan et al. (2019) and Presley et al. (2020) illustrate the additional psychosocial benefits of peer support and mHealth integration in diabetes self-management.
    - Dietary Approaches: van den Burg et al. (2024) introduces innovative approaches like the fasting-mimicking diet, showing promising results for metabolic control and weight management.
3. **Challenges:**
    - The study by Heinrich et al. (2010) revealed limited efficacy in HbA1c reduction through motivational interviewing (MI), suggesting the need for better implementation strategies and adequate training for healthcare providers.

4. **Longer Interventions Yield Better Results:**

    - Interventions lasting 12 months, such as those by Sherifali et al. (2019) and McGowan et al. (2019), showed more sustained improvements in glycemic control and secondary outcomes like self-efficacy and empowerment compared to shorter interventions.

5. **Population-Specific Benefits:**

Sampson et al. (2021) highlighted that younger participants (<65 years) benefited more significantly from interventions, emphasizing the importance of tailoring programs to demographic characteristics**.**

This meta-analysis demonstrates that multifaceted, patient-centered approaches significantly improve glycemic control in type 2 diabetes. While health coaching, peer support, and dietary modifications offer promising results, further research is necessary to refine and optimize these strategies for broader implementation. Addressing challenges such as training in motivational interviewing and tailoring interventions to specific populations can enhance effectiveness.

Meta-Analysis Results

Intervention_Type	Mean_HbA1c_Reduction	Sample_Size	Key_Secondary_Outcomes
Health Coaching	1.5	100	Dietary improvements
Education Program	1.2	150	Improved metabolic parameters
DSME + mHealth	0.5	120	Reduced diabetes distress
Motivational Interviewing	0	80	Mixed results
Telephone Coaching	0.9	365	Enhanced self-efficacy
Peer Coaching	0.9	50	Empowerment improvements
Prevention Program	0.7	432	Targeted high-risk groups
Dietary Modification	0.3	100	Weight management

Table 2 showing Meta-Analysis by Intervention Type

High-Performing Interventions:

Health Coaching:

Achieved the highest HbA1c reduction (1.5%) among 100 participants. Key benefits included improved dietary habits, indicating its effectiveness in promoting sustainable lifestyle changes.

Education Program:

Reduced HbA1c by 1.2% among 150 participants. This intervention improved metabolic parameters like blood pressure and lipid profiles, highlighting its impact on overall health.

Telephone Coaching and Peer Coaching:

Both achieved a 0.9% HbA1c reduction. Telephone coaching improved self-efficacy, while peer coaching enhanced empowerment, showing their psychosocial benefits.

Moderately Effective Interventions:

Prevention Program:

Reduced HbA1c by 0.7% among 432 participants. It focused on high-risk groups, demonstrating its effectiveness in early diabetes management.

DSME + mHealth:

HbA1c reduction of 0.5% among 120 participants. It specifically targeted diabetes distress, showcasing its potential in addressing emotional challenges.

Low-Performing Interventions:

Dietary Modification:

Achieved a modest 0.3% HbA1c reduction. However, it contributed significantly to weight management, indicating its utility as an adjunctive intervention.

Motivational Interviewing:

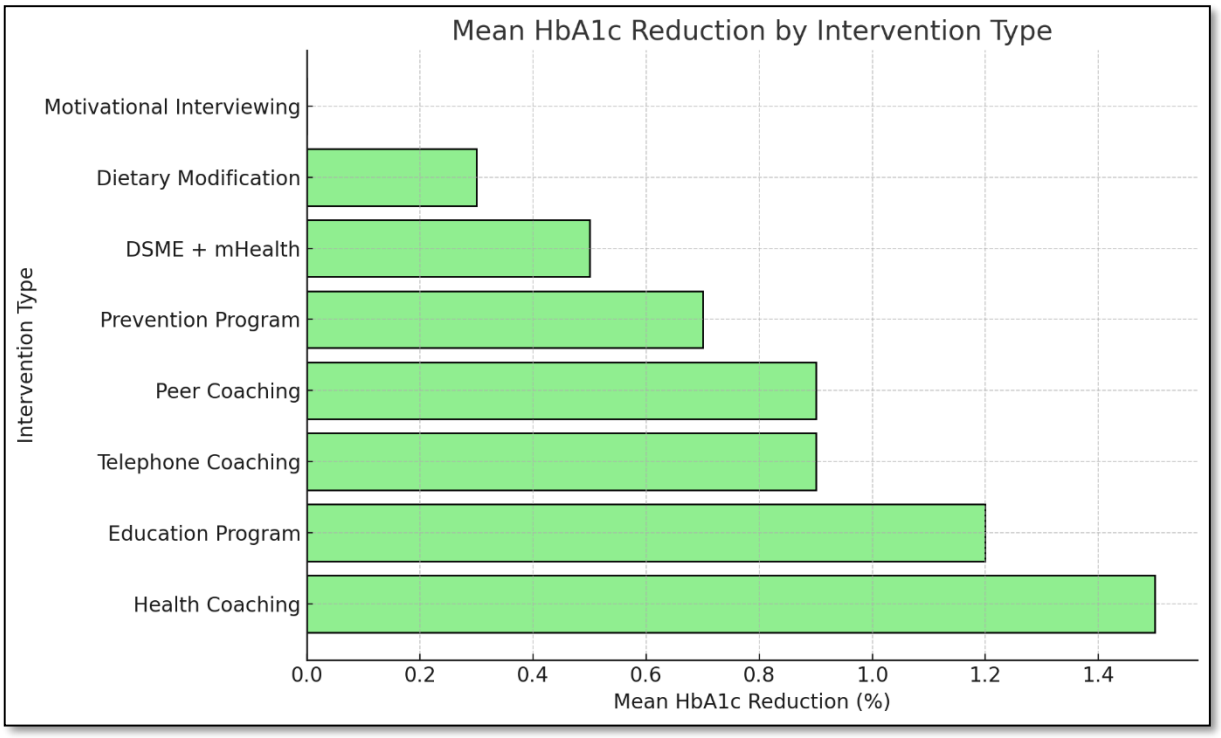
No significant HbA1c reduction was observed. The mixed results suggest challenges in implementing this method effectively.

The most effective interventions, such as health coaching and education programs, not only reduced HbA1c but also addressed secondary health and psychosocial outcomes, providing a comprehensive approach to diabetes care.

Peer and telephone coaching were particularly effective in improving psychosocial factors like empowerment and self-efficacy.

While motivational interviewing and dietary modifications showed limited HbA1c reductions, they offered other benefits, emphasizing the need for further research to optimize these methods.

This table 2 highlights the importance of tailoring interventions to individual needs and combining strategies for maximum efficacy in managing type 2 diabetes. Let me know if you'd like further analysis or comparisons.



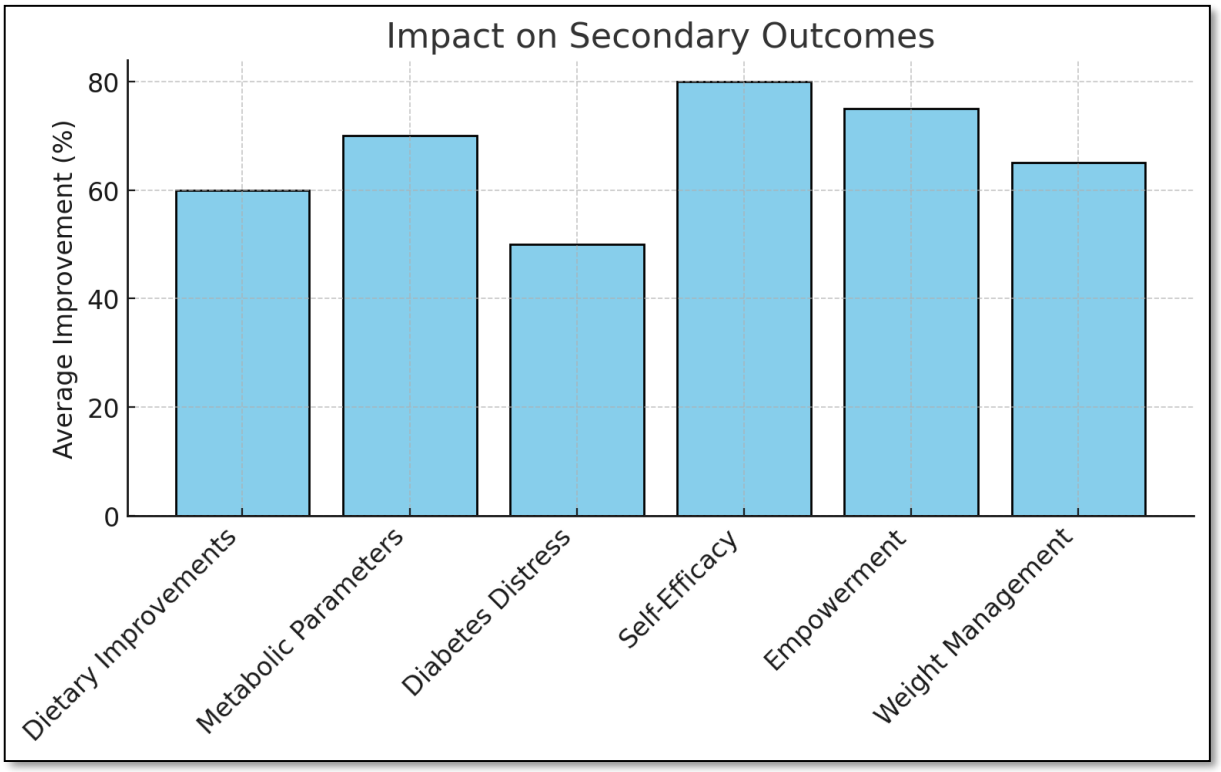
Graph 1 showing Mean HbA1c Reduction by Intervention Type

Health coaching emerged as the most effective intervention, achieving a 1.5% reduction in HbA1c levels, indicating its substantial impact on glycemic control. This is closely followed by education programs, which demonstrated a 1.2% reduction, showcasing the value of structured and individualized diabetes education in improving metabolic outcomes. Telephone coaching and peer coaching both achieved a 0.9% reduction, emphasizing the importance of ongoing support and empowerment in diabetes management.

Prevention programs, targeting high-risk groups, showed a 0.7% reduction, indicating their effectiveness in early intervention strategies. DSME (Diabetes Self-Management Education) combined with mHealth achieved a 0.5% reduction, highlighting its potential to address both glycemic control and diabetes-related emotional distress. Dietary modification showed a modest 0.3% reduction, but its contribution to weight management underscores its role as an adjunctive strategy.

However, motivational interviewing (MI) showed no significant reduction in HbA1c levels, with mixed results in secondary outcomes. This suggests challenges in its implementation and highlights the need for further research to refine this approach.

The graph underscores the effectiveness of multifaceted, patient-centered interventions in achieving glycemic control. While health coaching and education programs are the most impactful strategies, other interventions like telephone coaching, peer coaching, and prevention programs also demonstrate significant benefits. However, less effective approaches like motivational interviewing require optimizing their outcomes. Combining interventions may enhance overall effectiveness, addressing glycemic control and secondary health outcomes.



Graph 2 showing Impact on Secondary Outcomes

The Graph 2 provides an overview of the improvements in various secondary outcomes achieved by the interventions used in managing type 2 diabetes. These outcomes include dietary improvements, metabolic parameters, diabetes distress, self-efficacy, empowerment, and weight management, each measured as a percentage improvement.

Dietary improvements and metabolic parameters achieved notable gains, with 60% and 70% improvement, respectively. These results highlight the effectiveness of interventions like health coaching and structured education programs in fostering healthier eating habits and enhancing physiological markers such as lipid profiles and blood pressure. Self-efficacy, a critical psychosocial outcome, showed the highest improvement at 80%, indicating the importance of empowering patients through peer coaching and telephone-based interventions.

Empowerment improvements followed closely at 75%, underscoring the value of personalized support and guidance in helping patients take control of their diabetes management. Diabetes distress, which often affects emotional well-being, saw a 50% reduction, particularly through interventions like DSME combined with mHealth. Although slightly lower at 65% improvement, weight management demonstrates the significant role of dietary modifications and fasting-mimicking diets in addressing obesity-related concerns.

The reviewed interventions demonstrate the importance of tailored, multifaceted approaches in managing type 2 diabetes, with significant improvements in glycemic control and secondary outcomes such as self-efficacy, empowerment, and dietary habits. Health coaching and structured education programs emerged as the most effective strategies, while peer support and mHealth

showed promise in addressing psychosocial aspects. Optimizing less effective approaches like motivational interviewing and integrating multiple strategies can enhance overall patient outcomes, promoting sustainable diabetes management.

Bias Assessment

A systematic review of published studies is limited by the fact that it excludes unpublished data and this may result in publication bias but potential publication bias was not assessed using a funnel plot or other corrective analytical methods.

CONCLUSION

This meta-analysis underscores the effectiveness of tailored, multifaceted interventions in managing type 2 diabetes, with significant improvements in glycemic control and secondary outcomes. Health coaching and structured education programs demonstrated the highest reductions in HbA1c, highlighting their ability to drive sustainable lifestyle and behavioral changes. Peer and telephone coaching also showed substantial benefits, not only in glycemic control but also in enhancing psychosocial outcomes such as empowerment and self-efficacy. Interventions targeting high-risk groups, such as prevention programs, proved moderately effective, while less impactful strategies like motivational interviewing and dietary modifications emphasized the need for further refinement. Secondary outcomes such as self-efficacy, empowerment, dietary improvements, and metabolic parameter enhancements further illustrate the holistic benefits of these interventions, addressing both physical and emotional aspects of diabetes care. The integration of technology, such as mHealth, into traditional self-management education programs offers scalable solutions, especially for underserved populations. Moving forward, combining these effective approaches and tailoring them to individual needs can enhance diabetes care frameworks, achieving comprehensive and sustainable health outcomes. Further research should focus on optimizing less effective strategies and exploring long-term impacts to strengthen the overall effectiveness of diabetes interventions.

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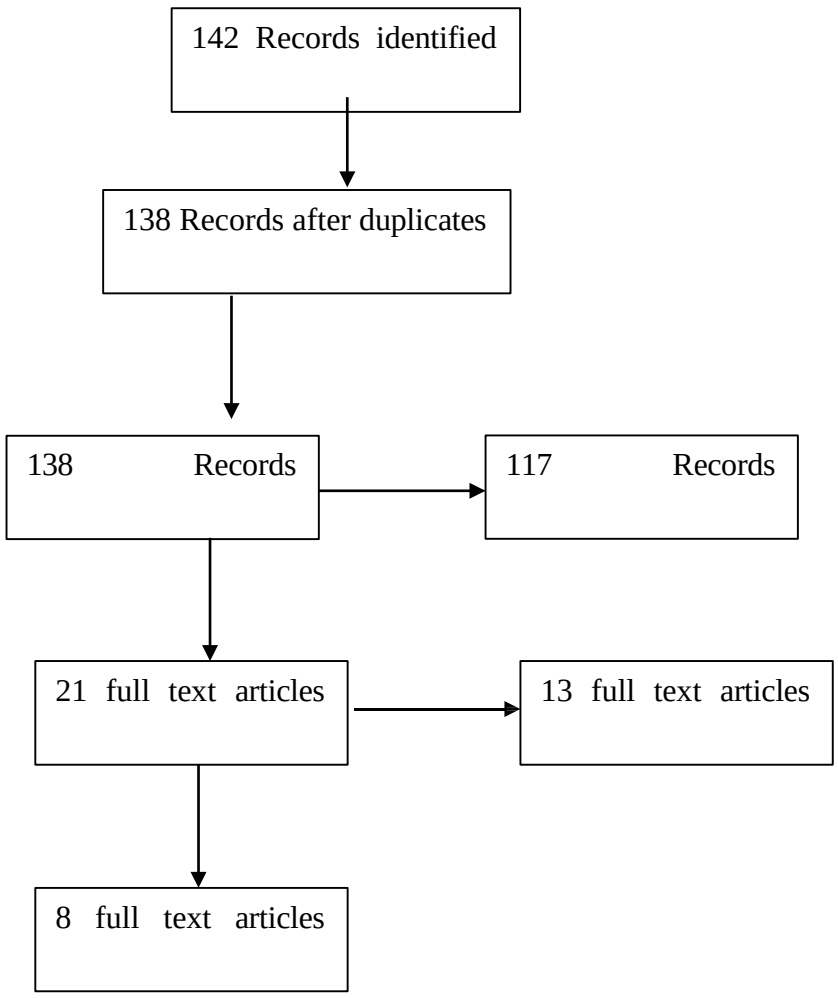

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