



REVITALIZING DIABETES CARE: A SYSTEMATIC REVIEW OF NUTRITIONAL INTERVENTIONS, ADHERENCE STRATEGIES, AND ADDRESSING SOCIAL DETERMINANTS OF HEALTH IN TYPE 2 DIABETES MANAGEMENT

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Abstract:

Background: There has been significant increase in global prevalence of Type 2 Diabetes (T2D). It necessitates a holistic approach to care. Therefore, this systematic review explores T2D management's multifaceted nature. Thus, emphasizes on three pivotal dimensions which include nutritional interventions, adherence strategies, and social determinants of health (SDOH). T2D's complexity is shaped by genetics, environment, and lifestyle factors. However, it requires a comprehensive approach beyond traditional pharmaceutical interventions.

Methods: Within the last decade a rigorous search strategy following PRISMA guidelines identified 29 relevant studies published. Therefore, studies were selected based on their focus on T2D management, nutritional interventions, adherence strategies, and SDOH. Thus, data were systematically assessed and extracted for quality and relevance.

Results: Nutritional interventions include dietary patterns. These are mediterranean diet, low-carbohydrate diets, and plant-based diets are included in it. They have shown promise in improving

glycemic control. It also helps in reducing cardiovascular risk factors in T2D patients. Therefore, personalized nutrition tailored to individual genetics and metabolism is emerging approach. Furthermore, patient-centered adherence strategies, such as education and goal setting, empower individuals to actively participate in their care. So, healthcare provider communication and cultural competence play critical roles. Addressing SDOH, such as income disparities and food insecurity, is integral to comprehensive T2D management. To tackle these determinants community-based programs and policy changes are essential.

Conclusion: In Managing Type 2 Diabetes, a holistic approach beyond pharmaceutical interventions is required. Therefore, nutritional interventions, adherence strategies, and consideration of SDOH are pivotal components. Certainly, emerging research highlights personalized nutrition, patient-centered care, and interventions targeting food insecurity and health literacy. To enhance the well-being of individuals with T2D, this systematic review contributes to evolving knowledge, identifies gaps, and shapes future interventions.

Keywords: Diabetes Care, Adherence Strategies, Nutritional Interventions, Type 2 Diabetes Management, Social Determinants of Health

INTRODUCTION:

The global prevalence of Type 2 Diabetes (T2D) has risen. Thus it requires a comprehensive approach to treatment. This systematic review gives information about the multifaceted nature of T2D. It mainly focuses on three pivotal approaches to management nutritional interventions, adherence strategies, and social determinants of health (SDOH). Thus, T2D's complexity demands a holistic approach beyond conventional pharmaceutical interventions.

Therefore, nutritional interventions are central T2D management such as the Mediterranean diet, low-carbohydrate diets, and plant-based diets. Thus, it holds promise related to personalized nutrition that is tailored to an individual's genetics and metabolism.

The main challenge is to ensure adherence of the patient with the given dietary recommendations. To counteract this healthcare providers use effective communication to educate the patient to reach their individual nutritional goals. Through community-based programs and policy changes T2D management can be expanded to address SDOH, income disparity, education and food insecurity.

Consequently, emerging research has highlighted the need for personalized nutrition, patient-centered care, and interventions targeting food insecurity and health literacy in the management of T2D. Thus, this systematic review aims to contribute in evolving knowledge, identifying gaps, and shaping future interventions by emphasizing on three pivotal approaches for an effective holistic approach in treatment.

LITERATURE REVIEW

Diabetes mellitus, particularly Type 2 Diabetes (T2D), remains a global health challenge with significant consequences for both individuals and healthcare systems (Unnikrishnan, Pradeepa et al. 2017). The prevalence of T2D has steadily increased over the past few decades. Thus, it makes a major public health concern. Hence, the urgency of addressing T2D lies in its multifaceted nature (Lingvay, Sumithran et al. 2022). It is characterized by a complex interplay of genetic, environmental, and lifestyle factors. The management of T2D has evolved beyond the traditional paradigm of pharmaceutical intervention (Lenzi and Filardi 2023). However, to encompass a holistic approach which includes nutritional interventions, adherence strategies, and the recognition of social determinants of health (SDOH).

In a previous investigation, controversies related to fructose and other sources of carbohydrates on glycemic control, it is mentioned that isocaloric exchange of fructose for carbohydrates did not significantly affect fasting glucose or insulin and reduced glycated blood proteins of less than 12 weeks duration. The authors concluded that recommendations about the optimal amount of dietary fructose remain controversial due to potential metabolic consequences that could lead to further insulin resistance and obesity (Johnson, Sánchez-Lozada et al. 2024). It is also mentioned that further research is still needed to define the optimal macronutrient content for fat, protein, and carbohydrate to attain the most beneficial lipid and lipoprotein in the general population and in those with diabetes at increased risk for cardiovascular disease (Gray and Threlkeld 2015).

In another study, despite recommendations of Standards of Medical Care in Diabetes: “All individuals with diabetes (DM1 and DM2) should be offered a referral for individualized medical nutrition therapy, preferably provided by a registered dietitian”, this is not clearly applied, and nutritional intervention is scarcely implemented, since patients with type 2 diabetes mellitus are diagnosed and managed at the primary health care level, they have no access to specialized medical nutritional therapy (Garcia-Molina, Lewis-Mikhael et al. 2020).

Yannakoulia et al, found a problem when discussing the results of their study, it is mentioned that nutritional intervention should aim at both providing knowledge and motivating patients to increase their likelihood of following the recommended course of action due to a found high non-attendance of T2DM patients to dietetic consultations (Yannakoulia, Poulia et al. 2007).

Lam Toi et al, mentions that although some food nutrients such as dietary fiber, flavonoids, and magnesium had a significant benefit for T2DM prevention, recent dietary recommendations focus on overall dietary patterns rather than single isolated nutrients because of the limitations of single-nutrient component approach (Toi, Anothaisintawee et al. 2020). For instance, matrix of foods, food processing, and food preparation is very complicated and can strongly modify the food nutrients that finally impact the health effects (Shahidi and Pan 2022). In addition, translation of nutrient-based recommendations to the public is difficult because the accurate estimation of food nutrients is too complex for the general population (Byrne, Gillman et al. 2021).

Nutrition plays a crucial role in T2D management. It is recognized that diet can significantly influence glycemic control, body weight, and overall health in individuals with T2D (Guo, Huang et al. 2020). Therefore, the traditional emphasis on glycemic control through carbohydrate counting and glycemic index has expanded to consider the broader spectrum of nutrients and dietary patterns. The dietary interventions supported by evidence, which include Mediterranean diet, low-carbohydrate diets, and plant-based diets, exhibit potential. It enhances glycemic control and mitigating cardiovascular risk factors in individuals with Type 2 Diabetes (Aroda and Eckel 2022).

Additionally, the concept of personalized nutrition has gained traction. It helps in recognizing that T2D is not a uniform condition and that individualized dietary recommendations based on genetics, microbiome, and metabolic profiles may yield more significant benefits (Guizar-Heredia, Noriega et al. 2023). Thus, this approach emphasizes the need for healthcare systems to adapt and provide tailored nutritional guidance to individuals with T2D.

A significant challenge remains in T2D management is the availability of effective nutritional interventions and its adherence to dietary recommendations (Petroni, Brodosi et al. 2021). Thus, the multifactorial nature of adherence includes patient factors, healthcare provider engagement, and the broader socio-economic context (Akthar, Nayak et al. 2023). It is essential to understand these factors in promoting adherence to dietary plans and optimizing T2D management.

Therefore, patient-centered approaches, including education, goal setting, and motivational interviewing, have shown promise in improving dietary adherence. Empowering individuals with T2D to take an active role in their care and setting achievable dietary goals can lead to better long-term outcomes. In addition to, healthcare providers' communication skills and cultural competence play a pivotal role. It also helps in enhancing adherence. Culturally tailored dietary advice and sensitivity to patients' values and beliefs can enhance a stronger patient-provider partnership, which is crucial for maintaining behavioral change (Makori 2023).

It is essential to address the social determinants of health (SDOH) that influence the disease's progression by recognizing that T2D management that extends beyond clinical interventions (Ariganjoye 2021). SDOH encompass a wide range of factors. These include income, education, employment, access to healthcare, and the physical environment (Green, Fernandez et al. 2021). Therefore, these factors can significantly impact an individual's ability to adhere to dietary recommendations and achieve glycemic control.

Individuals having low-income with limited access to nutritious food are at higher risk of T2D and its complications (Park, Nam et al. 2023). However, Food insecurity is known as the lack of consistent access to adequate food. It is associated with poor dietary adherence and glycemic control. Interventions addressing food insecurity, such as community-based food assistance programs and policy changes to improve food access, are important parts of comprehensive T2D management (Short, Gannon et al. 2023).

Furthermore, educational interventions that address health literacy and provide practical guidance on navigating the healthcare system can empower individuals (Little, Rosa et al. 2022). Thus, this helps to make informed decisions about their T2D management. Consequently, the management of Type 2 Diabetes is a multifaceted challenge that extends beyond pharmaceutical interventions. The critical components of effective T2D care are nutritional interventions, adherence strategies, and the recognition of social determinants of health (Świątoniowska-Lonc, Tański et al. 2021). Thus, the Emerging research emphasizes personalized nutrition, patient-centered approaches, and interventions targeting food insecurity and health literacy (Silva, Araújo et al. 2023). These are the essential pillars in revitalizing diabetes care. As we dive deeper into these dimensions, it becomes progressively clear that a holistic approach is necessary to address the diverse needs of individuals with T2D and improve their overall health outcome (Barber, Kabisch et al. 2020).

As we embark on this journey of systematic review, we will explore the nutritional interventions, adherence strategies, and the influence of social determinants of health in the management of Type 2 Diabetes. Our goal is to contribute to the growing body of knowledge in this critical field. In addition to, through an in-depth examination of existing research, we seek to identify gaps, emerging trends, and areas where future interventions and policies can make a substantial impact on T2D care.

METHODS:

The goal of this systemic review is to comprehensively evaluate and analyze the status of research on management of Type 2 Diabetes (T2D). It involves focusing on three critical dimensions such as nutritional interventions, strategies to enhance adherence and the influence of social determinants of health (SDOH). The methodology used in this study complies with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 standrads.

This systematic review seeks to thoroughly examine and assess the current body of research

Search Strategy:

A thorough search method was developed to identify relevant articles published in the last decade. The data were searched by using multiple database systems such as PubMed, PubMed Central (PMC), Science Direct Library, and Google Scholar. The keywords for search included "Type 2 Diabetes management," "Nutritional Interventions," "Adherence Strategies," and "Social Determinants of Health." To combine these terms skillfully Boolean operators "AND" and "OR" were applied effectively. The use of mesh techniques was used where applicable. The search strategies and databases are presented in Table 1.

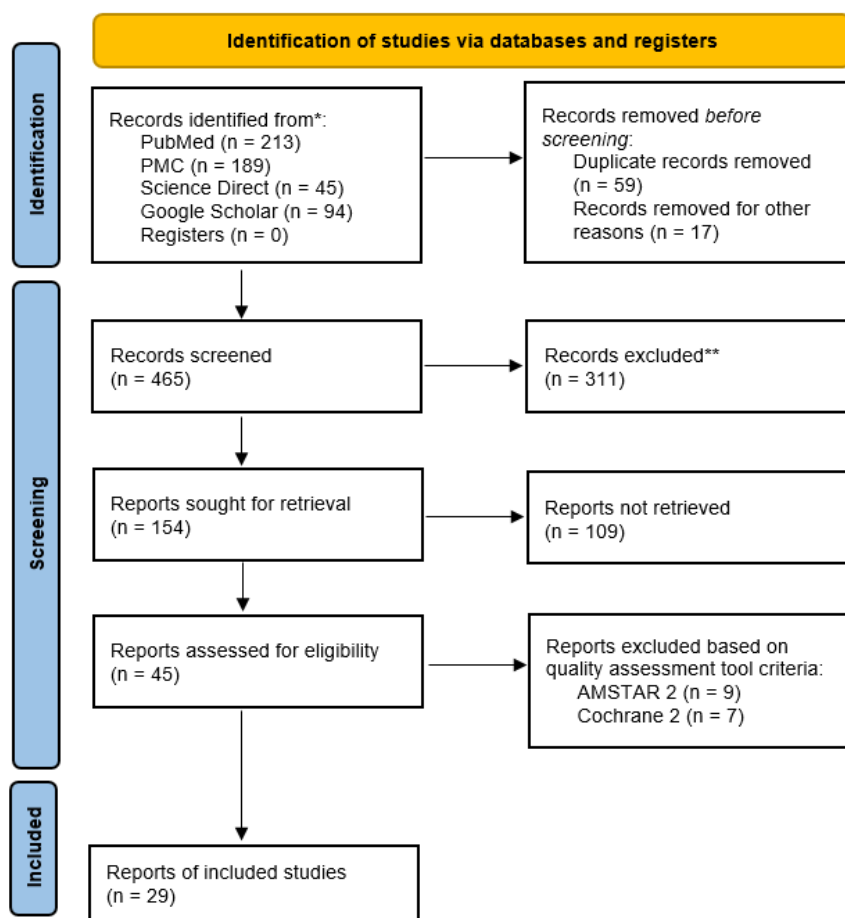
Type of Database	Keywords	Search Strategy	Filters Used	No. of Records
PubMed	Type 2 Diabetes management	"Type 2 Diabetes management" AND "Nutritional Interventions" OR "Adherence Strategies" OR "Social Determinants of Health"	Full-text Research Articles, 10 years, Humans	213
PMC	Type 2 Diabetes management	((Type 2 Diabetes management) AND (Nutritional Interventions OR Adherence Strategies OR Social Determinants of Health))	Full-text Research Articles, 10 years, Humans	189
Science Direct	Type 2 Diabetes management	Type 2 Diabetes management AND Nutritional Interventions OR Adherence Strategies OR Social Determinants of Health Published in the last 10 years	Full-text Research Articles, 10 years, Humans	45
Google Scholar	Type 2 Diabetes management	Type 2 Diabetes management AND Nutritional Interventions OR Adherence Strategies OR Social Determinants of Health Published in the last 10 years	Full-text Research Articles, 10 years, Humans	94

Inclusion and Exclusion Criteria:

Our study conducted a rigorous selection process to ensure the inclusion of relevant and high-quality research in the systematic review. The management of type 2 Diabetes (T2D) with a specific emphasis on the factors effecting nutritional interventions, adherence strategies, and with a focus of social determinants of health (SDOH) require were also included in our articles. Irrespective of age or gender, studies included patients diagnosed with Type 2 Diabetes to meet these criteria.

Therefore, the intervention scope regarding research in investigation of nutritional methods for management of T2D includes dietary patterns, personalized nutrition strategies, and dietary recommendations. The strategies to improve patient adherence to dietary guidelines and helping patient to adopt careful consideration regarding to T2D are important. Consequently, the research which examines the social determinants of health also includes income disparities, factors depending on education, status of employment, and food security of T2D management. On the other hand, those studies which are not following these parameters and are not related to the T2D management or not addressing the specified dimensions were excluded from consideration. Furthermore, the articles which are not related to research, conference abstracts, and those studies that lack substantial content were considered ineligible for inclusion. To facilitate analysis and to maintain consistency, the articles that are available in English language were considered for this systemic review.

Figure: 1



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021; 372:n71. doi: 10.1136/bmj.n71

Data Extraction and Analysis:

The selected articles were systematically collected and analyzed for data collection. We documented the key information such as study design, sample size, methodology, results, and conclusions. Thus, the quality and significance of each article were evaluated to make sure that only high-quality research contributed to of the review.

Table: 2

S. No	Title of Study	Type of Study	Summary of Findings
1	Almonds & Type 2 Diabetes	Meta-Analysis	Almond-based diets increase gut microbiota producing short-chain fatty acids, lower HbA1c and BMI; no significant effect on fasting blood glucose.
2	Glycemic Index & Type 2 Diabetes	Meta-Analysis	Low-Gastrointestinal diets improve HbA1c in some studies, mixed results in fasting blood glucose; significant differences in HbA1c and fasting blood glucose in meta-analysis.
3	Pharmacist-Led Diabetes Care	Randomized Trial	Pharmacist-led care lowers A1c, blood pressure, BMI, and waist circumference; improves medication adherence and self-care; no significant differences in lipid values.
4	Adapting Medication for Type	Review Article	Supports adapting diabetes medications with

	2 Diabetes to a Low Carbohydrate Diet		low-carb diets, emphasizes safe reduction in primary care settings.
5	The Effect of Dietary Fiber on Gut Microbiota, Lipid Profile, and Inflammatory Markers in Patients with Type 2 Diabetes	Systematic Review and Meta-Analysis	Dietary fiber increases beneficial gut bacteria, decreases total cholesterol and BMI; no significant effects on other parameters.
6	The Effect of Prebiotics and Oral Anti-Diabetic Agents on Gut Microbiome in Patients with Type 2 Diabetes	Systematic Review and Network Meta-Analysis	Prebiotics reduce HbA1c significantly; no significant differences in fasting blood glucose, BMI, and specific gut bacteria genera; anti-diabetic agents also reduce HbA1c.
7	Precision Nutrition: Personalized Approaches for Metabolic Syndrome	Review	Emphasizes personalized nutrition in preventing and managing metabolic syndrome, covering nutrigenomics, deep phenotyping, metabolomics, and microbiota profiling.
8	Low-Carb Diet vs. Diabetes Management in Overweight Adults	Randomized Controlled Trial	Very low-carb ketogenic (LCK) diet yields better HbA1c reduction, weight loss, and less medication use compared to moderate-carb, calorie-restricted, low-fat (MCCR) diet.
9	Medication Adherence in Children and Adolescents with Type 2 Diabetes	Prospective Observational Study	Explores barriers to oral medication adherence in young type 2 diabetes patients, identifies common barriers and effective strategies.
10	Psychosocial Factors in Oral Antidiabetic Medication Adherence	Prospective Study	Investigates psychosocial determinants of adherence in type 2 diabetes, predicts adherence intention through attitude, subjective norm, and past behavior.
11	Predicting Antidiabetic Drug Adherence in Adults with Type 2 Diabetes	Prospective Study	Uses the Theory of Planned Behavior to predict adherence, finds attitude, subjective norm, and past behavior influence adherence intention.
12	Behavioral Science Contributions to Medication-Taking in Type 2 Diabetes	Narrative Review	Examines the role of behavioral and psychosocial research in type 2 diabetes medication-taking, suggests interventions focusing on behavioral and psychosocial aspects.
13	Self-Monitoring of Blood Glucose in Type 2 Diabetes	Systematic Review & Meta-Analysis	Structured self-monitoring of blood glucose (SMBG) in type 2 diabetes which is non-insulin-treated results in moderate HbA1c reduction and improved self-efficacy.
14	Home Telemonitoring for Type 2 Diabetes	Systematic Review & Meta-Analysis	Home telemonitoring for type 2 diabetes shows a significant HbA1c reduction (~0.50%) with telemedicine; calls for more robust trials.
15	CSII Pumps for Type 1 and Type 2 Adult Diabetics	Evidence-Based Analysis	Analyzes efficacy of CSII pumps vs. MDI for type 1 and type 2 adult diabetics, finds some reduction in HbA1c, insignificant changes in mean blood glucose.
16	Behavioural interventions for type 2 diabetes	Evidence-Based Review	Behavioural interventions may help in improving glycemic control in adults with type 2 diabetes.
17	Community-based care for the management of type 2	Evidence-Based Review	Multidisciplinary community care may reduce HbA1c levels in T2DM patients.
18	Psychological interventions for diabetes-related	Randomized Controlled	Psychological interventions have no significant impact on diabetes-related distress but may improve self-efficacy and HbA1c levels.
19	Incorporating Social Determinants into Type 2 Diabetes Care	Qualitative	Social determinants affect self-management; feelings, mental health, priorities matter. Support from professionals, community, and personal networks is vital. Formal integration can transform care.
20	SDOH Impact on Type 2 Diabetes in South Asian Adults	Qualitative	Service providers identify social, economic, and systemic factors affecting South Asian adults with T2D; suggest culturally appropriate

			support and policy changes.
21	SDOH Integration in Indigenous Australian T2D Care	Qualitative	Indigenous Australians stress holistic care, including SDoH; call for culturally responsive service, education, and support for enhanced T2D management.
22	SDOH and Racial/Ethnic Disparities in Youth-Onset T2D	Review	Racial/ethnic disparities exist in youth-onset T2D. Negative SDOH, low income, education, and high youth stress are common. Future research should explore SDOH's role in T2D disparities.
23	Incorporating SDoH in Individual T2DM Care	Qualitative	SDoH impact T2DM self-management. Integrating SDoH at the individual level could enhance care.
24	Identifying and Responding to SDoH in T2DM	Literature	Limited methods to address SDoH in T2DM care. Identifying SDoH-related barriers is crucial for tailored interventions.
25	SDoH and Clinical Outcomes in Lebanese Adults with T2DM	Cross-Sectional	Food insecurity, living conditions, and transportation influence T2DM outcomes in Lebanese adults.
26	(Poly)phenols and T2DM Management	Meta-Analysis	(Poly)phenols may lower glucose levels in individuals with T2DM or at risk. Enhanced effect when combined with anti-diabetic drugs.
27	Behavioral Approaches to Nutrition and T2DM	Review	Tailored nutrition interventions are vital for managing T2DM, considering individual needs and cultural context. Collaborative goal-setting and motivational interviewing can enhance patient self-efficacy. Social determinants of health should be considered.
28	Improving Adherence to Anti-diabetic Medications in Sub-Saharan Africa	Systematic Review	The review aims to assess interventions to enhance the adherence to anti-diabetic medications in type 2 diabetes patients in sub-Saharan Africa.
29	Efficacy of Ketogenic Diets on Type 2 Diabetes	Systematic Review	Ketogenic diets (KD) can lead to improved HbA1c, reduced medication usage, and sustained weight loss in type 2 diabetes patients. Adequate support and medical supervision are essential for KD effectiveness.

RESULTS

The importance of a holistic approach in managing Type 2 Diabetes (T2D) our research emphasizes the systemic review of 29 studies. The myriad of factors such as genetic factors, environment, and lifestyle influence T2D which is a complex condition. The ambiguous nature of T2D is insufficient to address by only conventional pharmaceutical interventions. Thus, the care for T2D management goes beyond medications by focusing on the overall well-being of individuals is recognized by this approach.

The efficacy of various nutritional interventions in the management of T2D is well supported by the data from our review. For instance, in individuals with T2D, the diet which is almond-based has been shown to increase the amount of short-chain fatty acid-producing gut microbiota, lower HbA1c, and reduce BMI. Although the outcomes of fasting blood glucose have been mixed but the improvement in HbA1c levels is demonstrated by low-GI diets,. Moreover, to increase Bifid bacterium abundance and to decrease LPS, total cholesterol, and BMI dietary fiber has been shown to be beneficial.

The patient adherence to dietary guidelines remains a significant challenge in the management of T2D. Thus, the findings in our research emphasis on the multifactorial nature of adherence, encompassing patient-related factors, the involvement of healthcare providers, and the socio-economic environment. The treatment led by pharmacists has been shown to reduce A1c compared to usual care, lower blood pressure, BMI, and waist circumference. It also helps to improve

medication adherence and self-care activities. Therefore, by executing the structured self-monitoring of blood glucose (SMBG) improved self-efficacy and reduction in HbA1c is shown.

On the progression of Type 2 Diabetes our systemic review emphasizes the important impact of social determinants of health (SDOH). For instance, it has been identified that food insecurity is a significant SDOH. SDOH is associated with poor dietary adherence and glycemic control. Therefore, food security interventions have been recognized as essential components of a comprehensive approach in the management of Type 2 Diabetes which include food assistance programs that are community based.

DISCUSSION

In our review of 29 studies the importance to adopt a comprehensive approach to Type 2 Diabetes (T2D) management has been highlighted. T2D is no longer solely a medical issue but rather a complicated condition. It is influenced by genetics, environmental, and lifestyle conditions. Therefore, the conventional approach of relying completely on pharmaceutical treatments is insufficient to meet the complicated requirements of individuals with T2D.

The significant evidence highlighting the effectiveness of nutritional interventions in Type 2 Diabetes (T2D) management is being emphasized in our systematic review. Additionally, to the conventional emphasis on glycemic control, different dietary patterns have emerged as powerful tool in the improvement of glycemic control and overall health outcomes in individuals with T2D.

In management of T2D the patient adherence to dietary recommendations remains a continuous challenge. Our study highlights the adherence of multifaceted nature. It include patient-related factors, engagement of health care provider, and socio-economic status. However, to improve adherence significantly, patient-centered approaches such as education, goal setting, and using motivational interviewing techniques have demonstrated their potential.

The significant impact of social determinants of health (SDOH) on the development of Type 2 Diabetes is emphasized in our systematic review. Therefore, SDOH encompass wide range of factors which include income disparities, employment, education and food insecurity. To follow dietary recommendations and in achievement of glycemic control these factors have a substantial impact on an individual's ability. So, in the comprehensive management of T2D, food security interventions such as community-based food assistance programs have been integral part.

CONCLUSION:

In conclusion, our systematic review emphasizes the value of taking a comprehensive approach in the management of Type 2 Diabetes (T2D). The main factors of effective T2D care include Nutritional interventions, patient-centered adherence strategies, and consideration of social determinants of health (SDOH). Thus, nutritional interventions show promise, as different dietary patterns demonstrating favorable effects on glycemic control. However, patient-centered approaches offer potential solutions but adherence remains a challenge. To emphasize the need for interventions that address these factors the considerable impact of SDOH, including food insecurity that significantly affect the outcomes of T2D. In future, it is essential for both research and clinical practice to integrate these aspects for the enhancement of the management related T2D and to improve the well-being of individuals affected by this condition.

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