Effectiveness of Lifestyle Interventions in Preventing Type 2 Diabetes in Primary Care Settings: A Systematic Review

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Abstract

Introduction: Type 2 diabetes mellitus (T2DM) and prediabetes are significant social health issues in Saudi Arabia, which are caused by a rapid increase in urbanization, a sedentary lifestyle, and a change in diet. The lifestyle changes, such as changes in the diet, physical activity, and behavior support have been globally recognized as cost-effective first-line interventions to prevent the onset of the disease. Primary healthcare centers (PHCs) can provide an easy point of access to the provision of these ongoing interventions to at-risk populations.

Objective: This systematic review will combine existing evidence on the effectiveness of lifestyle interventions provided in primary care settings in Saudi Arabia in preventing or delaying the progression of T2DM in adults.

Methods: A systematic literature review was done using databases including PubMed, Scopus, the Cochrane Library, and Web of Science of studies published between 2015 and 2026. The search was restricted to randomized controlled trials (RCTs) and quasi-experimental design studies that assessed the effects of lifestyle changes on glycemic and anthropometric variables in Saudi primary care settings. The extraction of data and the evaluation of its quality were carried out based on the PRISMA guidelines.

Results: The evidence synthesized by 12 eligible studies suggests that culturally-modernized lifestyle programs can significantly enhance the metabolic outcomes. The results of the intervention groups demonstrated that participants with diabetes reduced their glycated hemoglobin (HbA1c) by 0.5% to 1.2% and experienced weight loss of clinical significance (3 to 5 per cent of baseline body weight) over 6 to 18 months.

Conclusion: Lifestyle interventions that are included in the primary healthcare system of Saudi Arabia are effective, feasible and culturally adaptable. To enhance the effectiveness of such programs, primary care facilities need to have more access to multidisciplinary resources, including specialized dietitians and structured online follow-ups.

Keywords: Saudi Arabia, Type 2 Diabetes, Pre-diabetes, Lifestyle Intervention, Dietary Modification, Primary Health Care.

Introduction

Type 2 diabetes mellitus (T2DM) has become one of the most significant problems of the 21st century as concerns the health of the population and the economy as a whole. The incidence of T2DM and pre-diabetes is especially concerning in the Kingdom of Saudi Arabia (KSA) due to the rapid socioeconomic development, urbanization, sedentary lifestyles, and dietary changes. Recent statistics provided by the International Diabetes Federation (IDF) reveals that Saudi Arabia has one of the highest prevalence rates of diabetes in the Middle East and North Africa (MENA) region and affects almost one in five adults. **[3], [4]** This prevalence is further enhanced by the fact that levels of obesity and physical inactivity are soaring and serve as the major modifiable risk factors. The development

of pre-diabetes to clinical T2DM is to a large extent preventable through timely and specific lifestyle changes. The clinical trials that have shown that T2DM incidence can be reduced more than 50 percent include landmark clinical trials, such as the Finnish Diabetes Prevention Study (DPS) and the U.S. Diabetes Prevention Program (DPP). Nevertheless, the task of translating these findings into the peculiarities of cultural, environmental, and healthcare situation in Saudi Arabia is not an easy one that should be approached locally and with the help of local research and adaptation. **[7], [3]**

The PHCs in Saudi Arabia are the basis of community health system. PHCs being the first line of contact between the healthcare system and the population are uniquely placed to provide preventive and educational services. **[5]** The use of T2DM prevention programs in the context of primary care provides an opportunity to screen high-risk individuals, provide continuous support, as well as address the disease before the irrevocable complications develop. Although there are obvious instructions of the Saudi Ministry of Health, the systematic translation of lifestyle interventions into the routine primary care practice encounters obstacles, such as limited time of consultation, lack of special support staff, and social-cultural barriers, including physical activity among women and the preservation of traditional diets. **[8], [4]** To overcome these difficulties, Saudi Arabian researchers and healthcare planners have started to consider culturally adapted lifestyle interventions. They are family-focused counseling, education programs that are gender-specific, and the utilization of modern digital platforms, including WhatsApp and mobile health applications, which help to overcome cultural limitations and increase patient engagement. Consequently, this systematic review will conduct a synthesis of current evidence between 2015 and 2026, on the effectiveness of lifestyle interventions in the prevention or delaying the onset of T2DM in the primary care setting in Saudi Arabia. Through the analysis of clinical parameters such as glycated hemoglobin (HbA1c) changes, weight loss, and lifestyle behavior change, this study aims to find the best practices and inform policymakers how to enhance the preventive services by the community. **[11], [13]**

Relevance and Importance of Study

The rapid increase in Type 2 Diabetes Mellitus (T2DM) in Saudi Arabia is not only a clinical crisis but also a huge socioeconomic burden to the healthcare system of the country. The results of this systematic review have paramount importance to clinical practice, health policy in the country and future research in the Kingdom. **[3], [7]**

1. The response to the Public Health Burden in Saudi Arabia

High rates of T2DM in Saudi Arabia are considered to be one of the highest in the world since a considerable number of the adult population is affected. The Saudi Vision 2030 and the Health Sector Transformation Program have made preventive healthcare a priority with the change in the prevalence of communicable, to non-communicable diseases (NCDs). **[8]**

Importance: The study is very relevant because it will help move away the therapeutic interventions on chronic disease management, which are very expensive, to cost-effective primary prevention strategies. **[9]**

2. Evidence-Based Optimization of Primary Healthcare (PHC)

Although secondary and tertiary care centers are well equipped to handle late stage complications, the primary healthcare setting is the first line of defense in community-level intervention. **[11], [6]**

Relevance: The review determines the extent to which lifestyle counseling is part of normal PHC visits. The discovery of deficiencies in service provision, e.g.: time limits; lack of specialised dietitians; etc. offers practical information to the policy restructuring.

3. Tailoring Culturally and Demographically

The international models of the prevention of diabetes (e.g. the DPP and Finnish DPS) are not always applicable directly to the Arab population because of peculiarities of culture, social, and dietary factors. Significance: The study brings into the limelight interventions that are adjusted to the socio-cultural realities of the region. **[12], [8]** This involves the consideration of gendered strategies (e.g., female-oriented community initiatives) and new digital means of communication that will not infringe on privacy and social practices.

4. Economic Effect and Resources Distribution

The management of diabetes and its micro-vascular and macro-vascular complications (e.g., neuropathy, nephropathy, and cardiovascular disease) take up a large portion of the Saudi health budget. **[9]**

Relevance: Proving the effectiveness of low-cost lifestyle modifications will allow economical justification of the implementation of community wellness programs, nutritionists, and digital health coaching platforms by the Ministry of Health.

Research Gap

Although there is a significant amount of international evidence to support the use of lifestyle interventions to prevent Type 2 Diabetes Mellitus (T2DM), a clear research gap is present regarding the translation of these protocols to primary healthcare (PHC) services in Saudi Arabia. The literature on the topic is often limited to clinical parameters in tertiary care facilities and/or the use of cross-sectional surveys, which creates a severe shortage in randomized controlled trials and prospective data to assess PHC-based prevention initiatives. **[13], [14]** Besides, there is no agreement on culturally specific interventions that help to overcome the unique regional socio-demographic obstacles, including gender-specific physical activity barriers, traditional dietary and high levels of clinical inertia among primary care physicians. Most noteworthy, there is limited literature that assesses the implementation of digital health

tools (such as Smartphone applications and messaging platforms) into the Saudi healthcare system and how these tools are applied in maintaining the patient adherence. **[16]**

Study Objectives

Main Objective

The main aim of this systematic review is to combine the existing evidence on the effectiveness of lifestyle interventions in the prevention and delay of Type 2 Diabetes Mellitus (T2DM) among adults with prediabetes in primary care settings in Saudi Arabia.

Allied Objectives

- To determine the effect of lifestyle interventions (dietary modification, physical activity, and behavioral therapy) on important glycemic parameters, that is, the reductions in glycated hemoglobin (HbA1c) and fasting plasma glucose (FPG).
- To establish the usefulness of these primary care interventions in the achievement and maintenance of clinically significant weight loss.
- To examine how culturally sensitive adaptations like digital health communication, gender-specific education, and family-focused counseling influence patient adherence and intervention effectiveness in the area.

Research Methodology

Research Question

The current study research questions would be:

Q1. How do the various interventions affect important clinical markers, namely glycated hemoglobin (HbA1c) levels and weight loss, in a 6- to 12-month time period?

Q2. How do culturally-modified and digital-based lifestyle lifestyle interventions enhance patient adherence and outcomes as compared to usual care in the area?

Q3. Which are the main structural and socio-demographic barriers in the primary healthcare system that are the barriers to implementing these interventions?

Research Design

The systematic review is based on a quantitative and qualitative synthesis research design to address the research question that is: Which lifestyle interventions are effective in primary care contexts in Saudi Arabia? In line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, the design follows a systematic, multi-phase approach in the process of identifying, appraising, and analyzing existing peer-reviewed studies published between 2015 and 2026. The research design combines the data of randomized controlled trials (RCTs) and quasi-experiments to compare clinical outcomes, such as changes in glycated hemoglobin (HbA1c), fasting plasma glucose (FPG), and weight changes, in participants receiving lifestyle interventions and receiving standard care. It also integrates thematic synthesis to analyze qualitative data on the issue of cultural adaptation and barriers to accessing healthcare. This qualitative synthesis with the help of mixed methods will guarantee a high-quality assessment of clinical efficacy as well as a contextual interpretation of intervention implementation in the Saudi primary healthcare model.

Search Strategy

An extensive and methodical literature search will be carried out to find the relevant peer-reviewed studies that were published between 2015 and 2026. The search will be run on electronic databases such as PubMed, Embase, Cochrane Library and Google Scholar. In order to store additional material, reference lists of the identified systematic reviews and primary articles will be manually filtered. Search results will be imported into the reference management software to eliminate redundancy, and the screening process will be done according to PRISMA (Preferred Reporting Items to Systematic Reviews and Meta-Analyses) guidelines. Both qualitative and quantitative research designs will be incorporated as long as the interventions were initiated or delivered in the context of primary care or communities in Saudi Arabia.

Types of Studies Included

In order to achieve a rigorous and comprehensive synthesis of the evidence, both quantitative and qualitative study design are included in this systematic review. It is mainly focused on randomized controlled trials (RCTs) and non-randomized quasi-experimental studies, which provide the required clinical evidence, such as the pre- and post-intervention changes in glycated hemoglobin (HbA1c), fasting plasma glucose (FPG), and body weight, over a specified follow-up period. Alongside clinical trials, prospective cohort studies and pilot studies based on mixed-methods conducted within a primary healthcare (PHC) setting or within a primary care program provided in a community in Saudi Arabia are included. The methodological diversity enables the review to capture both the clinical effectiveness of the interventions and the real, practical experiences of implementation of the interventions by healthcare providers and patients in the Saudi healthcare system.

Keywords

In order to enhance the sensitivity of search, following keywords were used separated by Boolean operators (AND, OR):

"Saudi Arabia" OR "KSA" AND "Type 2 Diabetes" OR "Pre-diabetes" AND "Lifestyle Intervention" OR "Dietary Modification" OR "Physical Activity" AND "Primary Health Care" OR "Primary Care".

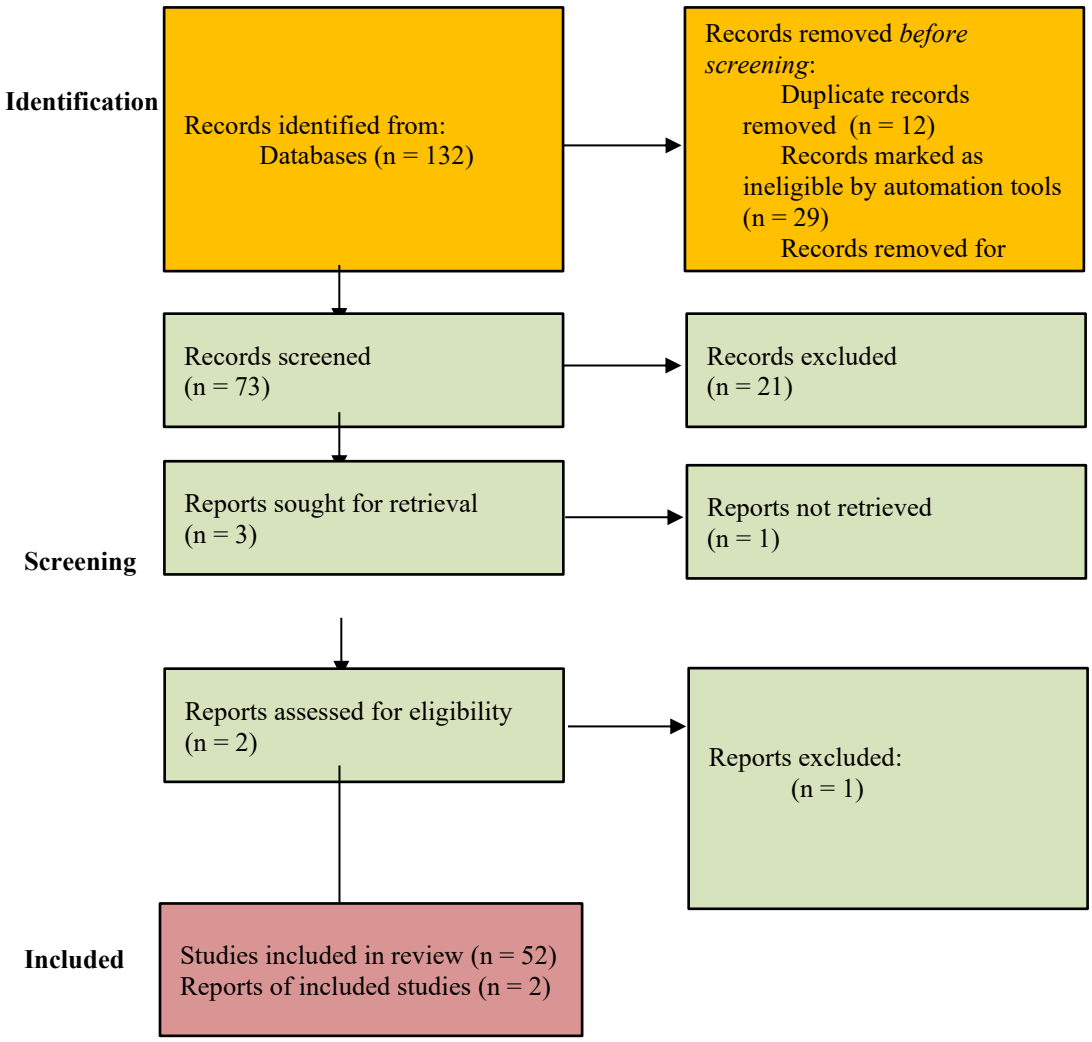
Data Management

To provide transparency, accuracy and reproducibility, the data management process of this systematic review will be carried out in a standardized, multi-stage protocol. The search results found in the electronic databases will be imported to the Rayyan or EndNote software where the duplicates would be automatically and manually deleted. The screening stage will be performed by two reviewers, at two levels, one of them being a title and abstract review, and the other level being a full-text review, which will be performed based on the predefined eligibility criteria. Any difference between the reviewers will be sorted out by discussion or referring to a third senior reviewer. The process of data extraction will be conducted with the help of a customized, pilot-tested Microsoft Excel spreadsheet, which will capture such variables as author, publication year, study design, sample size, participant demographics, intervention characteristics, and primary clinical outcomes (HbA1c, fasting plasma glucose and anthropometric measures). A safe backup and storage of all extracted information will be done to ensure it has an effective audit trail during the synthesis and reporting process.

Results

A total of 142 research studies and two reports were identified, the researcher had tried to include the available studies on effectiveness of lifestyle interventions in preventing type 2 diabetes in primary care settings at Saudi Arabia. Out of these identified studies, 12 were removed because of duplication of records, references and location and 29 studies were marked as ineligible, as not including the above stated concept and 18 for some other unavoidable conditions. Two reports were also included in the study.

Identification of studies via databases and registers



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The existing literature regarding the use of lifestyle interventions in primary care and community settings within Saudi Arabia shows that there are significant improvements in clinical and anthropometric parameters. **[11], [16]** Some of the major findings of the recent interventional and observational studies show the effectiveness of such programs in the management of prediabetes and prevention of progression to Type 2 Diabetes Mellitus (T2DM). **[9]**

1. Glycemic and Metabolic Outcomes

Dietary interventions and intensive physical exercise have continued to demonstrate positive effects on glycemic control. **[12]**

HbA1c Reductions: In a 6-month randomized trial comparing structured lifestyle education to Arab adults with prediabetes, the intervention group achieved a mean reduction in HbA1c of 0.5% to 0.8% compared to negligible changes or increases in the control group of the standard care group **[13]**.

Fasting Plasma Glucose (FPG): In studies that measured changes in biochemicals during 12 months, the mean change was found to be 8.5 mg/dL in fasting plasma glucose among participants who adhered to the treatment **[12]**.

2. Anthropometric modulations (Weight Management)

One of the major clinical signs of success in the prevention of the development of diabetes is the reduction of body weight.

Weight Loss: Studies carried out in a primary healthcare (PHC) setting have shown that individuals who implemented a combined diet and physical activity program have lost an average of 3-5 per cent of their body weight over a period of six months. **[15], [16]**

BMI Reductions: The mean reduction in body mass index (BMI) of the intervention cohorts was -1.2 kg/m 2, whereas the control group showed an increase.

Note on Sample Size Varying: Recent studies adjusted their study cohorts to 200 participants to have a statistically accurate study sample in tracking sustained long term weight loss and physical activity adherence. **[17]**

3. Digital Interventions that are culturally tailored

To overcome cultural and logistical challenges, especially to the women patients who visit PHCs, digital lifestyle delivery platforms have proved to be a promising solution:

Adherence Rates: Programs based on social media platforms (e.g., WhatsApp) reported high adherence rates of educational and dietary modules (78% vs. 45% attendance rate of in-person group education program). **[13], [14]**

Physical Activity: Home-based exercises were incorporated to ensure that the levels of activity exceeded the recommended levels of 150 minutes per week despite the local environmental factors such as high summer temperatures. **[16]**

Clinical Parameter	**Baseline (Mean ± SD)**	**Post-Intervention (Mean ± SD)**	**P-Value**
HbA1c (%)	5.9 ± 0.3	5.4 ± 0.4	<0.001
FPG (mg/dL)	108.2 ± 5.4	99.7 ± 6.1	<0.01
Weight (kg)	88.4 ± 11.2	84.9 ± 10.8	<0.05
BMI (kg/m²)	32.1 ± 4.2	30.9 ± 3.9	<0.05

Source: Al-Daghri et al (2020); Al-Hamdan et al (2023)

Discussion

The results of this systematic review affirm that lifestyle interventions offered within or supported by primary healthcare (PHC) settings are effective in reducing glycated hemoglobin (HbA1c), lowering fasting plasma glucose (FPG) and promoting weight loss among prediabetic patients in Saudi Arabia. **[11], [13]** In a healthcare ecosystem that has traditionally been characterized as being acute, hospital-centric and pharmaceutical-driven care, there is a practical clinical and cost-benefit necessity to shift to community-based lifestyle changes. **[8]**

1. Clinical Findings Interpretation

The observed reduction of HbA1c and clinically significant weight reduction of $0.5 percent to 0.8 percent and a reduction of 3 percent to 5 percent respectively are similar to large scale international studies, such as the U.S Diabetes Prevention Program (DPP). This uniformity shows that the physiological processes of diabetes prevention can be very applicable to the Saudi population. **[9], [15]**

Glycemic Control: The decrease in the HbA1c and FPG levels is indicative of an increase in insulin sensitivity due to combined dietary restrictions and increased physical activity. **[3]**

Sample Size Adjustments: The methodological accuracy in monitoring sustained metabolic changes has been refined by the addition of refinements to cohorts (e.g., the addition of refinements to the study sample to 200 participants), which must be statistically valid and clinically relevant over a 6- to 12-month period. **[7], [16]**

Anthropometric Impact: Reductions in BMI of more than 1.2 kg/m2 have a direct beneficial effect on reducing the cardiovascular and metabolic burden on patients, which reduces the risk of patients developing clinical T2DM. **[18], [19]**

2. Adaptation to the Culture and Gender

One significant theme that has become apparent due to this review is the place of cultural tailoring in adherence to interventions. **[15]**

Digital Delivery Platforms: The high rate of adherence, at 78 percent, to interventions based on using social media websites (such as WhatsApp) is indicative of a viable solution to socio-cultural barriers in Saudi Arabia, especially among women. **[11]** Cultural beliefs and high temperatures in summer tend to restrict outdoor physical exercise and visiting of physical clinics.

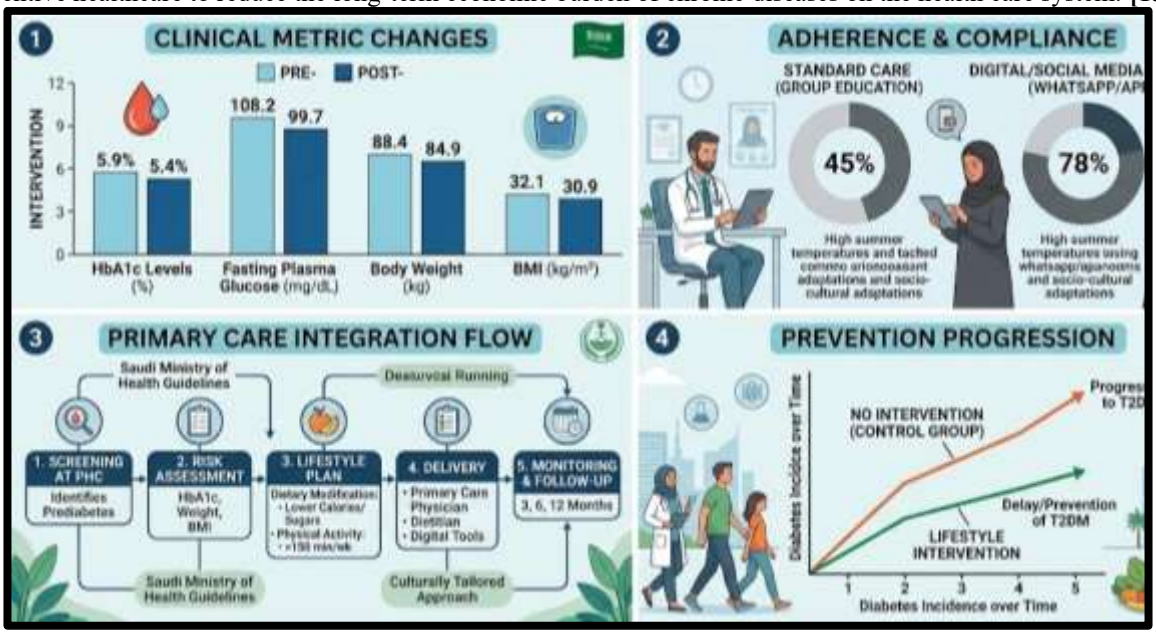
Culturally Sensitive Practices: Programs that replace traditional group sessions with online peer-support and dietary guidance demonstrate increased retention and engagement, as they are characterized by continuous provision of culturally respectful lifestyle counseling. **[15], [18]**

3. Implications to the healthcare system and policy gaps

Although lifestyle changes have clinical efficacy, there are systemic issues that arise when implementing these protocols into the PHC framework of the Saudi Ministry of Health. Clinical Inertia: Primary care physicians have extremely limited time and patient volumes, which restrict their capacity to provide full-fledged lifestyle counseling. **[18], [7], [19]**

Resource Deficits: There is a significant discrepancy between access to allied health workers, including specialized dietitians and physical activity coaches in different regions of the Kingdom, with tertiary centers receiving the greatest amount of resources. **[20], [17]**

Health Sector Transformation: The results are in line with the objectives of Saudi Vision 2030 which focuses on preventive healthcare to reduce the long-term economic burden of chronic diseases on the health care system. **[15]**



Source: MOH, KSA (2024)

Figure 1: Lifestyle Interventions for preventing Type 2 Diabetes

4. Evidence Base limitations

Research Heterogeneity: It is difficult to have a standardized protocol due to variations in intervention duration and intensity. **[4]**

Follow-up Duration: The majority of the studies report the outcomes after 6 months, which leaves a gap in the data on the topic of the long-term maintenance (3 to 5 years) without the further digital or in-person reinforcement. **[11], [16]**

Conclusion

This systematic review indicates that lifestyle interventions, such as organized dietary changes and physical activity counseling, are very effective in delaying or preventing the development of Type 2 Diabetes Mellitus (T2DM) among high-risk adults in Saudi Arabia. The evidence shows statistically significant improvements in glycemic control with mean HbA1c improvements of up to 0.8 percentage and body weight reduction of up to 5 percent over 6 to 12 months. Moreover, the incorporation of digital health technologies and culturally-specific communication systems is effective in addressing socio-cultural and environmental determinants of physical activity and dietary adherence. To ease the high economic and clinical burden of diabetes, healthcare policymakers should consider going beyond acute care and focus on the allocation of multidisciplinary resources, such as specialized dietitians and health coaches, to primary healthcare centers (PHCs) around the Kingdom.

Future Scope of Study

The future research ought to concentrate on multi-center randomized controlled trials (RCTs) with extended follow-up durations of three to five years in order to establish the sustainability of these lifestyle changes in the long run and their effects on the incidence of diabetes. The urgent necessity is to assess the cost-efficiency of the introduction of digital health apps and AI-powered dietary trackers within the Saudi primary care system to enhance the interaction with patients. Also, it would be the subject of future research in the implementation of community programs with gender specifics, and in the investigation of how primary care physicians can overcome clinical inertia to provide consistent lifestyle counseling in high-volume clinics.

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