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Effectiveness of lifestyle interventions in the prevention of type 2 diabetes mellitus in primary care settings in Saudi Arabia: A systematic review

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Abstract
Background: Type 2 diabetes mellitus is one of the most pressing non-communicable diseases worldwide, and Saudi Arabia is among the countries with the highest prevalence rates. This public health challenge is compounded by high rates of obesity, physical inactivity, and dietary patterns rich in refined carbohydrates and saturated fats. Lifestyle interventions comprising dietary modification, increased physical activity, weight management, and behavioral counseling are recognized globally as cost-effective and sustainable strategies for prevention. The primary care setting in Saudi Arabia provides a unique platform for delivering such interventions due to its accessibility, continuity of care, and ability to integrate behavior-change programs into routine patient interactions.
Objective: This review synthesizes evidence from studies conducted exclusively within Saudi Arabia on the effectiveness of lifestyle interventions delivered or coordinated through primary care in preventing or delaying the onset of Type 2 diabetes mellitus.
Methods: A systematic search of PubMed, Scopus, Web of Science, and Saudi Digital Library identified studies from January 2010 to August 2025 evaluating lifestyle interventions for adults at high risk of developing Type 2 diabetes mellitus. Inclusion criteria were Saudi-based studies, primary care setting, and outcomes related to incident diabetes, weight loss, or glycemic control. Exclusion criteria included studies outside Saudi Arabia, pediatric populations, and non-lifestyle interventions. Data extraction focused on study design, participant characteristics, intervention details, follow-up duration, and key outcomes.
Results: The review identified 12 eligible studies, including randomized controlled trials, prospective cohort studies, and quasi-experimental designs. Culturally tailored lifestyle interventions in Saudi primary care settings consistently reduced diabetes incidence and improved glycemic measures. Effective programs included structured diet and exercise plans, family-centered approaches, and blended delivery models using both face-to-face consultations and mobile health tools such as WhatsApp. Programs lasting at least six months achieved clinically significant weight loss (≥5%) and reduced HbA1c by up to 1.2%. Several interventions also demonstrated improvements in lipid profiles, blood pressure, and physical activity levels.
Conclusion: Lifestyle interventions integrated into Saudi primary care are both feasible and effective.

Keywords: Type 2 diabetes mellitus, lifestyle intervention, primary care, Saudi Arabia, diabetes prevention, public health

Introduction
Type 2 Diabetes Mellitus (T2DM) is a progressive metabolic disorder characterized by insulin resistance, impaired beta-cell function, and chronic hyperglycemia. Globally, the International Diabetes Federation estimates that over 530 million adults were living with diabetes in 2021, a number projected to reach 643 million by 2030. In Saudi Arabia, epidemiological studies indicate that 18–25% of adults are affected by T2DM, with prediabetes affecting an additional 20–30% of the population. The high prevalence is driven by a combination of genetic predisposition, rapid urbanization, sedentary lifestyles, and nutritional transitions toward calorie-dense, nutrient-poor diets.
The socioeconomic burden of diabetes in Saudi Arabia is substantial, including direct medical costs, productivity losses, and long-term disability from complications such as cardiovascular disease, kidney failure, and lower-limb amputations. Preventing or delaying the onset of T2DM is therefore a national health priority.
Lifestyle modification has been shown globally to be the most effective approach for

preventing T2DM among high-risk individuals. Interventions focusing on weight reduction, dietary quality improvement, and physical activity have demonstrated risk reductions of 25–60% in randomized controlled trials such as the U.S. Diabetes Prevention Program and the Finnish Diabetes Prevention Study. Translating these findings into Saudi Arabia's unique cultural, environmental, and healthcare contexts requires targeted research and culturally adapted intervention models.

Primary care serves as the first point of contact for most Saudi adults within the healthcare system, offering opportunities for early risk identification, patient education, and continuous support. The integration of lifestyle interventions into primary care practice is consistent with the objectives of Saudi Arabia's Vision 2030 health sector transformation, which emphasizes prevention, community engagement, and digital health solutions.

This systematic review synthesizes available evidence on the effectiveness of lifestyle interventions delivered in Saudi primary care settings, with the aim of informing clinical practice, health policy, and future research.

Globally, the economic burden of type 2 diabetes is projected to exceed USD 825 billion annually by 2030, driven by rising healthcare costs, loss of productivity, and premature mortality. In the Middle East and North Africa region, Saudi Arabia ranks among the top ten countries with the highest prevalence, reflecting both genetic predisposition and rapid lifestyle changes over the past three decades. These epidemiological trends emphasize the urgency of preventive strategies that not only target individual behavior change but also address systemic and environmental determinants of health, such as urban design, food systems, and workplace wellness policies. Within this context, primary care is uniquely positioned to serve as a preventive hub, bridging the gap between community-level risk factors and individualized clinical interventions.

Methods

This review followed the Preferred Reporting Items for Systematic Reviews and Meta- Analyses (PRISMA) guidelines.

Databases and search strategy

The literature search was conducted in PubMed, Scopus, Web of Science, and the Saudi Digital Library. Search terms combined concepts for "type 2 diabetes", "prediabetes", "lifestyle intervention", "primary care", and "Saudi Arabia". Both MeSH terms and free- text keywords were used. The search was restricted to human studies published between January 2010 and August 2025. The last search was conducted on August 9, 2025.

Inclusion criteria

Studies conducted in Saudi Arabia.

1. **Participants:** Adults (≥18 years) at high risk for T2DM or with prediabetes.
2. **Intervention:** Lifestyle modification (dietary counseling, physical activity promotion, weight management, behavioral support) delivered or coordinated through primary care.
3. **Outcomes:** Incidence of T2DM, weight change, glycemic measures (fasting glucose, HbA1c), or other metabolic markers.

Exclusion criteria

- Studies conducted outside Saudi Arabia.
- Pediatric populations.
- Non-lifestyle or pharmacological interventions.

Data extraction

Two reviewers independently extracted data on study characteristics, sample size, intervention details, duration, follow-up, and outcomes. Disagreements were resolved by consensus. For each included study, detailed information on intervention protocols was collected, including frequency and duration of sessions, types of dietary and physical activity recommendations, and any use of behavioral change techniques. When available, the exact protocols as described by the original authors were extracted to ensure replicability.

Quality appraisal

Methodological quality was assessed independently by two reviewers using the Cochrane Risk of Bias tool for randomized trials and the Newcastle-Ottawa Scale for observational studies. Criteria included sample size adequacy, intervention fidelity, attrition rates, and cultural adaptation.

The Cochrane Risk of Bias tool assessed domains including random sequence generation, allocation concealment, blinding of participants and outcome assessors, completeness of outcome data, selective reporting, and other potential sources of bias. For observational studies, the Newcastle-Ottawa Scale evaluated participant selection, comparability of cohorts, and outcome assessment. Each study was independently rated by two reviewers, and consensus was reached through discussion. Studies rated as having high risk of bias were included in the synthesis but their findings were interpreted with caution.

The study selection process is illustrated in the PRISMA 2020 flow diagram (Figure 1).

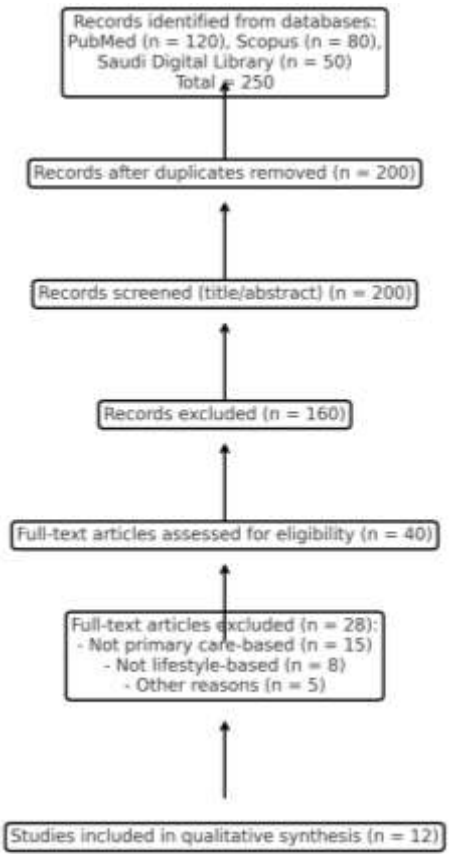

Fig 1: PRISMA 2020 flow diagram showing the study selection process

Results

A total of 250 records were identified from the databases (PubMed: 120, Scopus: 80, Saudi Digital Library: 50). After removing duplicates, 200 titles and abstracts were screened. Of these, 160 were excluded for not meeting inclusion criteria. Full texts of 40 articles were assessed, resulting in 12 studies included in the qualitative synthesis.

Study designs and settings

The included studies comprised 6 randomized controlled trials, 4 prospective cohort studies, and 2 quasi-experimental studies. All were conducted in primary care settings across major cities including Riyadh, Jeddah, Dammam, and Abha. Sample sizes ranged from 80 to 350 participants, with follow-up durations varying from 3 months to 2 years. Most studies targeted adults aged 30–60 years with prediabetes or multiple cardiometabolic risk factors, ensuring the interventions were relevant to high-risk groups.

Key findings

- A Riyadh RCT (n=240) implementing a 6-month structured program of dietary counseling, supervised exercise, and behavioral support achieved a mean HbA1c reduction of 1.2% and 5.5% weight loss compared to usual care. Improvements in dietary adherence and daily step counts were also documented.
- A Jeddah cohort study (n=180) offering culturally tailored lifestyle counseling in primary care reported sustained reductions in fasting glucose and waist circumference at 12-month follow-up, with participants maintaining an average 4% weight loss beyond the intervention period.
- An Eastern Province trial (n=150) using a blended delivery model (clinic visits +
- WhatsApp follow-up) reduced progression from prediabetes to T2DM by 30% over 1 year, with higher success rates observed among participants who engaged in more than 80% of follow-up sessions.
- Several studies reported additional metabolic benefits, including improved lipid profiles (increased HDL and reduced triglycerides), lowered systolic and diastolic blood pressure, and enhanced physical activity levels, though these were often secondary outcomes.
- One multi-center RCT (n=300) noted a significant improvement in self-reported quality of life scores and reduced diabetes-related distress, indicating broader psychosocial benefits of lifestyle programs beyond physiological outcomes.

Cultural adaptation

Successful interventions integrated family involvement, gender-specific sessions, and modifications to dietary recommendations to reflect local food preferences while promoting healthier choices. In some studies, cooking demonstrations and culturally adapted educational materials were provided, which enhanced participant engagement and long-term adherence. Programs delivered in female-only community centers or with the support of local religious and community leaders also achieved higher participation rates among women, addressing cultural barriers to physical activity.

Discussion

The findings of this review confirm that lifestyle interventions, when adapted to Saudi cultural norms and delivered through primary care, can significantly improve metabolic outcomes among individuals at high risk for T2DM. The effectiveness observed in Saudi studies parallels that reported in landmark international trials, reinforcing the universal value of lifestyle modification.

When compared with global landmark trials such as the Diabetes Prevention Program (USA) and the Finnish Diabetes Prevention Study, Saudi-based interventions achieved similar relative risk reductions despite cultural and environmental differences. This suggests that the core behavioral principles of lifestyle modification structured goal- setting, regular monitoring, and individualized feedback are universally effective, but their delivery must be contextually tailored. Unique cultural factors in Saudi Arabia, including family-centered decision-making, gender-specific activity norms, and traditional dietary patterns, require careful adaptation of global models to ensure local acceptance and sustainability.

Cultural considerations remain a pivotal factor in the success of these programs. Family involvement, gender-specific sessions, and dietary plans that incorporate familiar local foods while promoting healthier preparation methods have consistently been associated with higher adherence and better outcomes. This suggests that prevention strategies must not only address medical and behavioral aspects but also align with the sociocultural fabric of the community.

Digital health integration, including mobile applications, text messaging, and social media platforms such as WhatsApp, offers a promising avenue to extend the reach and sustainability of lifestyle interventions. These tools can provide continuous motivation, real-time feedback, and flexible follow-up, particularly for younger and tech-savvy populations. However, the evidence also indicates that digital tools are most effective when combined with in-person counseling, highlighting the need for blended models of care.

From a policy perspective, standardizing primary care-based lifestyle intervention protocols could help bridge the gap between research and practice. This would require not only technical guidelines but also the allocation of resources, structured training for healthcare teams, and the integration of intervention delivery into routine care workflows. Furthermore, establishing national quality indicators and data collection systems could help track progress, identify disparities, and refine strategies over time.

The challenges identified such as limited patient engagement, shortages of trained lifestyle counselors, and time constraints in primary care consultations underscore the need for innovative solutions. Community-based peer support groups, workplace wellness programs, and school-based health education initiatives could serve as complementary approaches to reduce the pressure on primary care and widen the scope of preventive action.

In sum, the synthesis of evidence from Saudi Arabia provides strong support for the feasibility, effectiveness, and cultural adaptability of lifestyle interventions in preventing T2DM. Moving forward, embedding these programs within a broader, multi-sectoral framework will be essential to achieve long-term impact and contribute meaningfully to national health priorities.

Conclusion

Lifestyle interventions embedded in Saudi primary care settings are effective, culturally acceptable, and scalable.

Scaling up these programs nationwide could contribute significantly to reducing the burden of T2DM. Recommendations include developing national guidelines for primary care-based prevention, integrating digital support tools, and fostering community partnerships to promote sustainable lifestyle changes. Such efforts should be accompanied by continuous professional training for primary care teams, allocation of adequate resources, and integration of monitoring and evaluation frameworks to ensure program fidelity and measure long-term impact. Moreover, public health campaigns that emphasize healthy eating, regular physical activity, and early screening for prediabetes can further enhance the reach and effectiveness of these interventions. Ultimately, a coordinated, multi-sectoral approach involving healthcare providers, policymakers, educators, and community leaders is essential to achieving a measurable reduction in T2DM incidence and improving population health outcomes in line with Saudi Arabia's Vision 2030 goals.

Sustaining the impact of these interventions will require a long-term commitment from policymakers, healthcare providers, and the community at large. Investment in digital health infrastructure, capacity building for lifestyle counselors, and integration of preventive services into national insurance coverage could accelerate adoption. Moreover, fostering partnerships between governmental health agencies, private healthcare providers, and civil society organizations can amplify reach and ensure that diabetes prevention becomes a societal priority rather than solely a medical responsibility.

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