



Systematic Review Article

EFFECTIVENESS OF LIFESTYLE INTERVENTIONS ON HBA1C REDUCTION AMONG ADULTS WITH TYPE 2 DIABETES IN PRIMARY CARE: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a major public health challenge worldwide. Maintaining optimal glycemic control, commonly assessed using HbA1c levels, is essential to prevent diabetes-related complications. Lifestyle interventions such as dietary modification, physical activity, weight management, and diabetes self-management education are widely recommended in primary care settings. However, evidence regarding their effectiveness in reducing HbA1c remains varied. This systematic review aims to synthesize existing evidence on the impact of lifestyle interventions on HbA1c among adults with T2DM in primary care. **Aim:** To evaluate the effectiveness of lifestyle interventions on HbA1c reduction among adults with Type 2 diabetes in primary care through a systematic review. **Objectives:** This systematic review aims to assess the effect of lifestyle interventions on HbA1c levels in adults with Type 2 diabetes, identify the most effective intervention strategies, and compare outcomes across different intervention, types and durations.

Materials and Methods: This systematic review followed the PRISMA guidelines. A comprehensive literature search was conducted using PubMed/MEDLINE, Scopus, Web of Science, Cochrane Library, and Google Scholar. Relevant keywords and search terms included "Type 2 Diabetes Mellitus," "Lifestyle Interventions," "HbA1c," "Glycemic Control," "Primary Care," and "Diabetes Management." Studies reporting the effectiveness of lifestyle interventions on HbA1c reduction among adults with type 2 diabetes were considered for inclusion. Eligible study designs included original studies, observational studies, randomized controlled trials, cohort studies, comparative studies. Study selection involved title and abstract screening followed by full-text assessment, and the process was documented using a PRISMA flow diagram. Data were extracted using a standardized data extraction form, and the findings were synthesized narratively.

Results: Lifestyle interventions and structured diabetes self-management education improved HbA1c, body weight, physical activity, self-management behaviors, diabetes knowledge, self-efficacy, lipid profiles and quality of life. Several studies also reported improvements in blood pressure, cardiovascular risk factors, and reduced medication requirements. Group-based, culturally tailored and Chronic Care Model interventions generally produced greater benefits than usual care, although the sustainability of glycemic improvements varied across studies.

Conclusion: Lifestyle interventions and structured diabetes self-management education consistently improved glycemic control, self-management behaviors, cardiovascular risk factors, and quality of life among adults with

type 2 diabetes. However, the long-term sustainability of these benefits varied across studies, highlighting the need for larger, high-quality multi-centre trials to optimize and implement effective interventions in primary care.

Keywords: Type 2 Diabetes Mellitus, Lifestyle Interventions, HbA1c, Glycemic Control, Primary Care, Diabetes Management.

INTRODUCTION

Diabetes continues to be a major global health concern, with approximately 537 million adults affected in 2021, a number expected to rise to 643 million by 2030 and 783 million by 2045. Millions of people also have impaired glucose tolerance, increasing their risk of developing diabetes. The disease contributes to significant mortality, healthcare expenditure, and complications, including hyperglycaemia during pregnancy and childhood diabetes. With nearly half of diabetes cases remaining undiagnosed, there is an urgent need for early detection, effective management, and timely interventions to reduce the growing global burden of diabetes (Dianna J. Magliano et al., 2021).^[1]

The American Diabetes Association (ADA) Standards of Care provides updated evidence-based recommendations for diabetes management, including treatment goals, care strategies, and quality assessment guidelines.^[2]

In patients with type 2 diabetes, prolonged hyperglycaemia is strongly linked to an increased risk of diabetic complications. Improving HbA1c levels can reduce this risk, with better outcomes observed among individuals achieving near-normal glycaemic control (Stratton IM et al., 2000).^[3]

The Look AHEAD (Action for Health in Diabetes) trial (2010) evaluated the impact of intensive lifestyle intervention (ILI) compared with diabetes support and education (DSE) among overweight or obese adults with type 2 diabetes. Over four years, ILI resulted in greater weight reduction, improved physical fitness, better HbA1c control, reduced blood pressure, and improved lipid profiles compared with DSE. The study demonstrated that structured lifestyle interventions can provide sustained improvements in glycemic control and cardiovascular risk factors in individuals with type 2 diabetes.^[4]

The Look AHEAD (Action for Health in Diabetes) trial (2016) was a multi-centre randomized study involving 5,145 overweight or obese adults with type 2 diabetes. It compared intensive lifestyle intervention with diabetes support and education, evaluating the association of weight loss and fitness improvement with cardiovascular outcomes. The study assessed major cardiovascular events while adjusting for baseline characteristics and risk factors.^[5]

Given the growing burden of T2DM and the increasing emphasis on non-pharmacological approaches to disease management, a comprehensive synthesis of current evidence is

warranted. Therefore, this systematic review aims to evaluate the effectiveness of lifestyle interventions on HbA1c reduction among adults with type 2 diabetes managed in primary care settings. By examining the available evidence, this review seeks to identify the most effective intervention strategies and provide guidance for healthcare professionals, policymakers, and researchers involved in diabetes care.

Objectives

This systematic review aimed to evaluate the impact of lifestyle interventions on HbA1c levels among adults with Type 2 diabetes, determine the most effective intervention approaches, and compare outcomes across various types and durations of interventions.

MATERIALS AND METHODS

This systematic review followed PRISMA guidelines and searched PubMed/MEDLINE, Scopus, Web of Science, Cochrane Library, and Google Scholar using relevant keywords such as Type 2 Diabetes Mellitus, Lifestyle Interventions, HbA1c, Glycemic Control, Primary Care, Diabetes Management. Eligible study designs included original studies, randomized controlled trials, cohort studies, comparative observational studies, case-control studies, and other original research articles evaluating the effectiveness of lifestyle interventions on HbA1c reduction among adults with Type 2 diabetes. Only studies published from 2000 were included in the review. Studies that lacked sufficient data for extraction, provided unclear outcome measures, or conference abstracts, editorials, letters were excluded. Titles, abstracts, and full-text articles were independently screened by two reviewers, with disagreements resolved through discussion. Data extraction and quality assessment were conducted independently using standardized tools appropriate to the study design. Data were extracted using a standardized format, and the findings were synthesized narratively.

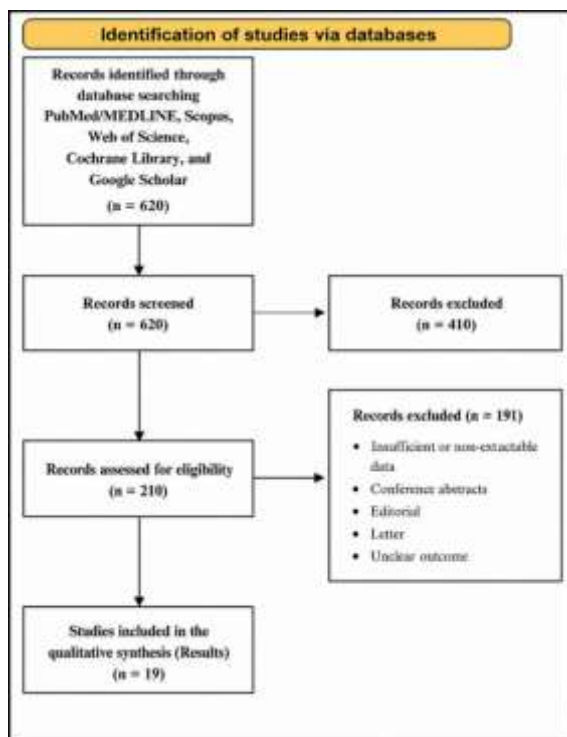


Figure 1: PRISMA Flow chart of Study Selection Process

RESULTS

Vanroy J et al., (2017) evaluated the effects of a six-week need-supportive physical activity intervention in patients with type 2 diabetes. Forty-eight participants were randomized to an intervention or control group, receiving individualized activity plans, coaching, and group sessions. Although no significant differences were observed between groups, the intervention was associated with short-term HbA1c reduction and improvements in physical activity and fitness over time, suggesting potential benefits of regular expert-guided support.^[6] A randomized controlled trial among 221 Marshallese adults with type 2 diabetes compared standard diabetes self-management education (DSME) with a culturally adapted, family-based DSME program. The adapted DSME group showed greater HbA1c reductions immediately after the intervention (-0.61%; 95% CI {Confidence Interval} -1.19 to -0.03; $P = 0.038$) and at 12 months (-0.77%; 95% CI -1.38 to -0.17; $P = 0.013$) compared with standard DSME. Within the adapted DSME group, HbA1c decreased significantly from baseline immediately after the intervention (-1.18%; 95% CI -1.55 to -0.81), at 6 months (-0.67%; 95% CI -1.06 to -0.28), and at 12 months (-0.87%; 95% CI -1.28 to -0.46) ($P < 0.001$). These findings suggest that culturally tailored, family-supported DSME may be more effective in improving glycemic control than standard DSME (McElfish PA et al., 2019).^[7] In the Look AHEAD randomized clinical trial (2010) involving 5,145 overweight or obese adults with type 2 diabetes, participants receiving an intensive lifestyle intervention (ILI) demonstrated

significantly greater improvements over four years compared with those receiving diabetes support and education (DSE). Average weight loss was substantially higher in the ILI group (-6.15% vs. -0.88%), accompanied by greater gains in physical fitness and better glycemic control (HbA1c -0.36% vs. +0.09%). The ILI group also showed more favorable reductions in systolic and diastolic blood pressure, increased HDL-cholesterol levels, and lower triglyceride concentrations. Although the greatest benefits were observed during the first year, significant improvements in weight, fitness, HbA1c, systolic blood pressure, and HDL-cholesterol were maintained at four years, indicating sustained cardiovascular and metabolic benefits of intensive lifestyle modification.^[4]

Andrews et al. (2011) conducted a randomized trial involving 593 adults recently diagnosed with type 2 diabetes and found that intensive dietary intervention significantly improved glycemic control compared with usual care, but adding a physical activity program provided no additional benefit over diet alone. At 6 months, HbA1c decreased by 0.28% in the diet group ($p=0.005$) and by 0.33% in the diet-plus-activity group ($p<0.001$), while glycemic control worsened in the control group. These improvements persisted at 12 months and were accompanied by reductions in body weight and insulin resistance, although blood pressure remained unchanged across groups.^[8]

Piatt et al. (2010) reported that participants receiving a chronic care model intervention maintained significant improvements in glycemic control (HbA1c reduction of 0.5%), blood pressure (-4.8 mmHg), and self-monitoring of blood glucose (86.7% to 100%) over a 3-year follow-up period. Additional benefits included improved non-HDL cholesterol levels and quality-of-well-being scores, demonstrating the long-term effectiveness of multifaceted diabetes care interventions.^[9]

Trento et al. (2004) demonstrated that group-based diabetes education over five years significantly improved diabetes knowledge, problem-solving ability, and quality of life compared with individual care ($P<0.001$). HbA1c remained stable in the group-care participants (+0.1%, 95% CI -0.5 to 0.4) but increased in the individual-care group (+1.7%, 95% CI 1.1–2.2). Group care was also associated with a reduction in Body Mass Index (BMI) (-1.4, 95% CI -2.0 to -0.7) and an increase in HDL cholesterol (+0.14 mmol/L, 95% CI 0.07–0.22), indicating sustained clinical and psychosocial benefits.^[10]

Davies et al. (2008) evaluated a structured group education program for adults with newly diagnosed type 2 diabetes and found significant improvements in weight loss, smoking cessation, and psychosocial outcomes at 12 months. Participants in the intervention group achieved greater weight loss (-2.98 kg vs. -1.86 kg; $P=0.027$) and had higher odds of smoking cessation (Odds ratio [OR] 3.56, 95% CI 1.11–11.45; $P=0.033$) than those receiving

usual care. Although HbA1c levels decreased in both groups (−1.49% vs. −1.21%), the between-group difference was not significant (0.05%, 95% CI −0.10 to 0.20). The intervention group also demonstrated improved illness perceptions ($P=0.001$) and lower depression scores (mean difference −0.50, 95% CI −0.96 to −0.04; $P=0.032$).^[11]

Deakin et al. (2006) evaluated the X-PERT self-management education program in adults with type 2 diabetes and found significant improvements at 14 months compared with usual care. Participants in the X-PERT group achieved a greater reduction in HbA1c (−0.6% vs. +0.1%; $P<0.001$), with a number needed to treat of 4 (95% CI 3–7) to prevent medication escalation and 7 (95% CI 5–11) to reduce diabetes medication use. Significant benefits were also observed in body weight, Body Mass Index (BMI), waist circumference, total cholesterol, diabetes knowledge, self-empowerment, physical activity, dietary habits, self-management behaviors, and treatment satisfaction.^[12]

Jakicic et al. (2013) reported that overweight or obese adults with type 2 diabetes who participated in an intensive lifestyle intervention achieved greater improvements in fitness (3.70% vs. 0.94%; $P<0.01$) and physical activity (+348 vs. +105 kcal/week; $P<0.01$) over 4 years compared with diabetes support and education. Increased fitness was significantly associated with improved HbA1c levels ($P<0.01$), whereas changes in physical activity alone were not related to glycemic control.^[13]

In a randomized controlled trial of 77 adults with type 2 diabetes, a pharmacist-led, experience-based group education program was evaluated over 24 months. The intervention significantly reduced HbA1c by 0.4% at 24 months and improved participants' ability to regulate their diabetes through increased physical activity and better prediction of blood glucose levels. Initial HbA1c, satisfaction with diabetes-related knowledge, and treatment were significant predictors of glycemic outcomes. Although the early improvement in HbA1c diminished after 12 months, a significant reduction reappeared at 24 months, indicating sustained long-term benefits of structured diabetes education and the importance of extended follow-up to capture delayed effects (Sarkadi A & Rosenqvist U, 2004).^[14]

In a randomized trial of 170 adults with type 2 diabetes, both group ($n=87$) and individual ($n=83$) diabetes education significantly improved knowledge, self-management, BMI, quality of life, and glycemic control over six months. Mean HbA1c decreased from $8.5 \pm 1.8\%$ to $6.5 \pm 0.8\%$ ($P<0.01$). HbA1c reduction was $2.5 \pm 1.8\%$ in the group education arm versus $1.7 \pm 1.9\%$ in the individual education arm (both $P<0.01$), with a marginally greater improvement in the group setting ($P=0.05$) (Rickheim PL et al., 2002).^[15]

In a randomized trial of 252 adults with type 2 diabetes, a culturally tailored diabetes education program significantly reduced HbA1c at 4 months (−0.88 vs. −0.35%; $P<0.01$), but the difference was not sustained at 12 months (−0.46 vs. −0.20%; $P=0.293$). At 12 months, significant improvements were observed in diabetes knowledge ($P=0.001$), self-efficacy ($P=0.001$), blood glucose self-monitoring ($P=0.02$), dietary quality ($P=0.01$), caloric intake ($P<0.001$), total fat ($P=0.003$), and saturated fat intake ($P=0.04$), all of which were associated with improved HbA1c (Rosal MC et al., 2011).^[16]

In a cohort study of 77 African-American adults with type 2 diabetes, an empowerment-based diabetes self-management support program significantly improved HbA1c ($P<0.001$), weight ($P<0.05$), BMI ($P<0.05$), and LDL cholesterol ($P<0.001$). Compared with the control period, the intervention achieved a significantly greater reduction in HbA1c ($P<0.01$), while the control period improved diastolic blood pressure ($P<0.05$), serum cholesterol ($P<0.001$), healthy diet adherence ($P<0.01$), and blood glucose monitoring ($P<0.01$) (Tang TS et al., 2010).^[17]

In a randomized trial of 345 adults with type 2 diabetes, a community-based, peer-led diabetes self-management program did not significantly reduce HbA1c but significantly improved depression, hypoglycemia symptoms, physician communication, healthy eating, food-label reading, patient activation, and self-efficacy ($P<0.01$). Improvements in depression, physician communication, healthy eating, patient activation, and self-efficacy were maintained at 12 months (Lorig K et al., 2009).^[18]

In a cluster randomized trial involving 119 patients with type 2 diabetes, a community-based Chronic Care Model (CCM) intervention significantly reduced HbA1c (−0.6%; $P=0.008$), increased HDL cholesterol (+5.5 mg/dL; $P=0.0004$), improved empowerment scores (+2; $P=0.02$), and increased self-monitoring of blood glucose (+22.2%; $P<0.0001$). The CCM group also showed greater improvements in non-HDL cholesterol ($P=0.05$) and self-monitoring of blood glucose ($P=0.03$) compared with the control groups, demonstrating the effectiveness of community-based chronic care management (Piatt GA et al., 2006).^[19]

In a randomized trial of 245 adults with type 2 diabetes, the Diabetes Conversation Map™ program produced greater HbA1c reductions than usual care at 3 months (−0.59%) and 6 months (−1.13%; $P<0.01$). Although differences were not significant at 9 and 12 months in the intention-to-treat analysis (−0.43% and −0.49%), the per-protocol analysis showed a sustained reduction at 12 months (−0.67%). The intervention also significantly improved self-care behaviors, including physical activity, problem-solving, risk reduction, and healthy coping (Yang YS et al., 2015).^[20]

In a randomized controlled trial of 112 adults with type 2 diabetes followed for approximately 51 months, group-based diabetes education prevented the rise in HbA1c observed in the control group ($P < 0.001$), reduced BMI ($P < 0.001$), increased HDL cholesterol ($P < 0.001$), improved quality of life, diabetes knowledge, and health behaviors (all $P < 0.001$), lowered hypoglycemic medication requirements ($P < 0.001$), and slowed retinopathy progression ($P < 0.009$). Both groups showed reductions in diastolic blood pressure ($P < 0.001$) and cardiovascular risk ($P < 0.05$). Despite slightly higher costs, group education was a cost-effective strategy for maintaining metabolic control and quality of life (Trento M et al., 2002).^[21]

In a randomized trial of 38 adults with poorly controlled type 2 diabetes, lifestyle intervention achieved HbA1c reductions comparable to lifestyle

plus insulin and insulin alone (-1.2% , -1.0% , and -1.5% , respectively; $P = 0.74$) while improving lipid profiles. Weight changed significantly between groups ($P < 0.01$), with a 3.0 kg loss in the lifestyle group versus gains of 3.5 kg and 4.9 kg in the lifestyle plus insulin and insulin groups, respectively (Aas AM et al., 2005).^[22]

In a randomized trial involving 201 African American adults with type 2 diabetes from 24 churches, a culturally tailored church-based intervention significantly reduced mean HbA1c at 8 months (7.4% vs. 7.8%; difference 0.4%, 95% CI 0.1–0.6; $P = 0.009$), with an adjusted difference of 0.5% (95% CI 0.2–0.7; $P < 0.001$). The intervention also significantly improved diabetes knowledge and diabetes-related quality of life. However, the HbA1c difference was not maintained at 12 months (Samuel-Hodge CD et al., 2009).^[23]

Table 1: Summary of Key Findings of the Included Studies

Author (Year)	Key findings
Vanroy J et al. (2017)	Short-term HbA1c reduction with improved physical activity and fitness over time; no significant difference between groups.
McElfish PA et al. (2019)	Culturally adapted family-based DSME produced greater and sustained HbA1c reductions than standard DSME.
Look AHEAD Research Group (2010)	Intensive lifestyle intervention improved weight loss, HbA1c, fitness, blood pressure, HDL cholesterol, and triglycerides at 4 years.
Andrews et al. (2011)	Adding physical activity to diet provides no extra HbA1c reduction in newly diagnosed type 2 diabetes.
Piatt et al. (2010)	Chronic Care Model improved HbA1c, blood pressure, self-monitoring, non-HDL cholesterol, and quality of well-being.
Trento et al. (2004)	Group education maintained HbA1c, reduced BMI, increased HDL cholesterol, and improved knowledge and quality of life.
Davies et al. (2008)	Structured education improved weight loss, smoking cessation, illness perception, and depression, but not HbA1c than those receiving usual care.
Deakin et al. (2006)	X-PERT education improved HbA1c, weight, total cholesterol, diabetes knowledge, self-management, and treatment satisfaction.
Jakicic et al. (2013)	Intensive lifestyle intervention improved fitness and physical activity; improved fitness was associated with improved HbA1c.
Sarkadi A & Rosenqvist U (2004)	Experience-based group education reduced HbA1c and improved physical activity and glucose self-management.
Rickheim PL et al. (2002)	Both group and individual education improved glycemic control; group education showed greater HbA1c reduction.
Rosal MC et al. (2011)	Culturally tailored education improved HbA1c, diabetes knowledge, self-efficacy, diet, and self-monitoring.
Tang TS et al. (2010)	Empowerment-based self-management support improved HbA1c, weight, BMI, LDL cholesterol.
Lorig K et al. (2009)	Peer-led self-management improved depression, hypoglycemia symptoms, physician communication and patient activation without significant HbA1c reduction.
Piatt GA et al. (2006)	Community-based CCM improved HbA1c, HDL cholesterol, empowerment, and blood glucose self-monitoring.
Yang YS et al. (2015)	Diabetes Conversation Map™ improved HbA1c and self-care behaviors, with sustained benefit in per-protocol analysis.
Trento M et al. (2002)	Long-term group education preserved HbA1c, improved BMI, HDL cholesterol, quality of life, and reduced retinopathy progression.
Aas AM et al. (2005)	Lifestyle intervention achieved HbA1c reduction comparable to insulin while promoting weight loss.
Samuel-Hodge CD et al. (2009)	Church-based culturally tailored intervention improved short-term HbA1c, diabetes knowledge, and quality of life.

CONCLUSION

Lorig et al. (2009) concluded that although the community-based, peer-led diabetes self-management program did not significantly improve HbA1c, it produced sustained improvements in self-management behaviors, psychosocial well-being, and patient activation, supporting its value as an effective educational intervention for people with type 2 diabetes.^[18]

Uusitupa et al. (2009) concluded that although intensive lifestyle intervention did not significantly reduce cardiovascular events or total mortality compared with the control group, the lower mortality observed relative to the general population suggests that sustained lifestyle modification and regular follow-up may provide important long-term health benefits.^[24]

Esposito et al. (2009) concluded that a Mediterranean-style low-carbohydrate diet provided superior long-term glycemic control, reduced the

need for antihyperglycemic medication, and improved cardiovascular risk factors compared with a low-fat diet in adults with newly diagnosed type 2 diabetes.^[25]

Piatt et al. (2010) concluded that chronic care model-based diabetes management provides sustained long-term improvements in glycemic control, cardiovascular risk factors, and self-management behaviors, supporting its effectiveness as a comprehensive approach to diabetes care.^[9]

Yang et al. (2015) concluded that structured, interactive diabetes education can improve short-term glycemic control and self-care behaviors, although ongoing reinforcement may be needed to sustain long-term benefits.^[20]

Trento et al. (2002) concluded that long-term group-based diabetes education is a practical and cost-effective approach for maintaining metabolic control, improving quality of life, and reducing diabetes-related complications in individuals with type 2 diabetes.^[21]

Overall, the evidence suggests that lifestyle interventions and structured diabetes education improve glycemic control, self-management, cardiovascular risk factors, and quality of life in people with type 2 diabetes. However, the durability of these benefits varies across studies. Future large-scale, multi-centre randomized controlled trials are warranted to strengthen the current evidence base, identify the most effective intervention strategies, and evaluate their long-term applicability in diverse primary care settings.

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