

ORIGINAL RESEARCH

# Preventing Type II Diabetes Mellitus through Self-Monitoring of Blood Glucose And Nutritional Education – A Pilot Study

Adam Maestas, B.S.<sup>1</sup> , Jasmine Rodriguez, MPH<sup>2</sup>, Robert Wood, DrPH<sup>2</sup>, Barbara Kierrsz, D.O., Fozia Ali, M.D.<sup>2</sup>

<sup>1</sup> The University of Texas Health Science Center at San Antonio, <sup>2</sup> Family and Community Medicine, The University of Texas Health Science Center at San Antonio

Keywords: pre-diabetes, type II diabetes, community health intervention, nutrition education, blood glucose self-monitoring, HbA1c reduction, socioeconomic disparities, diabetes prevention

---

## Texas Family Medicine Research Journal

Vol. 1, Issue 1, 2025

---

### Introduction

Over 720 million individuals are estimated to have pre-diabetes worldwide. Experts expect this number to continue increasing with no immediate end in sight. Socioeconomic barriers and limited healthcare access have a significant impact on the diagnosis and clinical management of pre-diabetes. Studies show that blood glucose monitoring can improve HbA1C in patients with poorly controlled type II diabetes. However, researchers have not explored this as a possible intervention in patients with pre-diabetes. The purpose of this study is to demonstrate that blood glucose self-monitoring and nutritional education can limit progression toward type II diabetes mellitus in patients with pre-diabetes.

### Materials and Methods

This pilot study occurred at a South Texas family medicine clinic serving an economically disadvantaged, under-resourced, predominantly Hispanic community. Twenty-five adult patients (ages 38-69) with pre-diabetes were enrolled. The intervention consisted of a 30-minute nutritional session, followed by a 10-minute session where patients were given a glucometer and educated on self-monitoring. HbA1C (%) and BMI (kg/m<sup>2</sup>) were measured at baseline and 12 months post-intervention.

### Results

Mean HbA1C and BMI measures pre-intervention were 5.94% and 36.2 kg/m<sup>2</sup>, respectively. Wilcoxon matched-pairs signed-ranks tests of the pre- and post-intervention measures indicated an overall HbA1c decrease of 0.183% (P=0.001) and a BMI decrease of 1.35 kg/m<sup>2</sup> (P=0.054). Nonzero confidence intervals provide supporting evidence of a meaningful reduction in both measures. Importantly, none of the patients who completed the study progressed toward type II diabetes. Furthermore, 39% (n=9) of patients experienced an HbA1c decrease below the pre-diabetes threshold of 5.7%. The remaining patients (n=14) remained within a pre-diabetes range based on HbA1c measures.

## Conclusions

This study revealed the significant role of blood glucose self-monitoring and nutritional education in limiting the progression toward type II diabetes. Providing glucometers and dietary/lifestyle education to patients with pre-diabetes shows substantial potential for mitigating preexisting barriers that challenge a healthy lifestyle and diabetic control.

## INTRODUCTION

Diabetes accounts for an estimated 6.7 million deaths per year and represents a significant burden in healthcare.<sup>1</sup> According to the International Diabetes Federation (IDF), an estimated 537 million people are living with diabetes globally. Furthermore, this number is predicted to surpass 700 million by 2045. In North America, diabetes affected 51 million people, accounted for approximately 913,000 deaths, and resulted in 415 billion dollars of healthcare expenditure in 2021 alone. The prevalence of diabetes in North America is expected to increase by 24% over the next 20 years. In the United States specifically, the 2021 National Diabetes Statistics Report estimated that 38.4 million Americans were living with diabetes.<sup>2</sup> At the time of the report, this number represented 11.6% of the U.S. population.

The increasing incidence of diabetes seen globally is highly associated with type II diabetes (T2DM), which accounts for 90-95% of all diabetes cases.<sup>3</sup> T2DM is a metabolic disorder characterized by impaired insulin sensitivity due to persistently elevated blood glucose levels.<sup>4</sup> However, unlike type I diabetes, type II is largely preventable. Primary risk factors include obesity, physical inactivity, smoking, alcohol, as well as genetic predisposition.<sup>5</sup> T2DM is associated with several complications, with areas affected including the heart, kidneys, eyes, and nervous system.<sup>6</sup> Chronic complications include coronary artery disease, peripheral vascular disease, neuropathy, and end-stage organ damage.<sup>7</sup> These complications are due to prolonged exposure to elevated blood glucose levels that induce nonenzymatic glycation (NEG), leading to sclerosis and occlusion of vessels supplying vital tissues.<sup>8</sup> Chronic exposure can additionally precipitate acute complications such as heart attacks, the leading cause of death in diabetes, or hyperosmolar hyperglycemia nonketotic states, leading to coma.<sup>9</sup> Furthermore, T2DM profoundly affects emotional and psychological well-being, with many patients experiencing frustration, fear, and anxiety as they navigate the challenges of managing the disease.<sup>10</sup> Feelings of isolation and a perceived lack of understanding from others further exacerbate this distress. Socioeconomic factors also play a crucial role in diabetes-related stress. Rising healthcare costs and limited access to resources make it increasingly difficult for patients to adhere to recommended dietary and medication regimens, adding another layer of hardship to disease management.

The gold standard for T2DM diagnosis is elevated hemoglobin A1c (HbA1c), which measures the NEG of red blood cells as a proxy for the average blood glucose concentration in the previous three months (capturing the typical cell lifespan).<sup>11</sup> An HbA1c of 6.5% or greater is diagnostic of T2DM. An HbA1c percent below this value, specifically from 5.7 to 6.4%, represents prediabetes, a precursor to T2DM. Prediabetes is similarly characterized by impaired fasting glucose and glucose tolerance but without the advanced vascular and systemic damage seen in T2DM.<sup>12</sup> Studies indicate that without intervention, approximately 5-10% of people with prediabetes will progress to T2DM annually, and the lifetime risk can be as high as 70%.<sup>13</sup> However, the risk of progressing towards T2DM decreases by 16% for every 1% of body weight lost.<sup>14</sup> Furthermore, other studies have shown that even mild decreases in HbA1c have significant benefits, with a 0.1% decrease in HbA1c corresponding to a 5-10% decrease in future complications.<sup>15</sup> These trends highlight the importance of prediabetes as a critical window of opportunity to intervene and prevent the onset of T2DM.

The transition from prediabetes to T2DM is not inevitable; however, without timely dietary and lifestyle modifications, the risk is substantial. This study aims to determine the efficacy of combining self-monitoring of blood glucose (SMBG) with nutritional education in preventing the progression from prediabetes to T2DM. Current guidelines do not suggest providing glucose meters to pre-diabetic patients.<sup>16</sup> However, research on this population of patients may be limited. It is hypothesized that patients with prediabetes who receive nutritional education and are more self-aware of their blood glucose levels can significantly reduce the risk of progressing toward T2DM based on HbA1c and BMI measures. Ideally, this also would prevent microvascular and macrovascular damage that begins during prediabetes, which is associated with an increased risk of cardiovascular and renal diseases.<sup>17</sup> The result of this study will be valuable to family medicine, internal medicine, and endocrinology practitioners, as well as patients, in developing a better practice for preventing the advancement of prediabetes to T2DM. By focusing on the early stages of glucose dysregulation, this study aims to contribute to the growing body of evidence supporting patient-centered approaches to diabetes prevention.

## **METHODS**

This pilot cohort study was conducted at a large family medicine clinic affiliated with the University of Texas Health System. With more than 300,000 outpatient visits a year, it is one of South Texas's busiest in its category. The clinic is a family medicine residency training clinic serving urban, underserved, and a predominantly Hispanic population in South Texas. Participants recruited for this study included males and females with prediabetes below 70 years old, fluent in English or Spanish, and BMIs

from 24.9 to 49.9 kg/m<sup>2</sup>. Patients were excluded if they had been previously diagnosed with T2DM or cardiovascular disease managed with anticoagulants. A total of 25 patients were enrolled.

The study participants attended a 30-minute in-house diabetic educational session led by a family medicine physician and registered dietitian, emphasizing lifestyle modifications, including daily 30-minute brisk physical activity at least five times a week. The diabetic teaching included fast and budget-friendly recipes. A nutritional guide was provided to all participants, highlighting which types of food should be limited, along with an exercise guide to promote easy and doable exercise regimens. Furthermore, participants received a teaching session to provide an overview of T2DM, the consequences of the disease, and why lifestyle modifications are paramount in preventing the progression of this disease. All participants received a glucometer, a 12-month supply of test strips, lancets, a logbook, and 10-15 minutes of instruction on how to use the glucometer. They were instructed to check their blood glucose level two hours after one of their primary meals three times a week. Participants were also asked to record their meal content and estimate portion sizes to increase self-awareness of how meal contents affect glucose levels. Nutritional education sessions emphasized that high content of carbohydrates and fats can increase blood glucose levels. Follow-ups were scheduled for 6 and 12 months, with a phone call scheduled at 3 months to address any participant questions.

Twenty-three of the 25 enrolled patients completed the study. One patient was lost to follow-up, and the other was excluded due to cardiovascular disease complications. The pre vs. post-HbA1C and BMI measures were compared statistically using Wilcoxon matched-pairs signed-ranks tests. The Wilcoxon non-parametric procedure is most appropriate for small samples. Pre vs. post HbA1C and BMI measures were compared overall and within demographic strata. Descriptive statistics were used to construct tables and charts, but all p values were derived from Wilcoxon tests.

## RESULTS

The effects of SMBG and nutritional education on HbA1c (%) and BMI (kg/m<sup>2</sup>) were analyzed across different demographic and clinical groups using the Wilcoxon Rank Sum test ([Table 1](#)). The mean HbA1c and BMI were 5.95% and 35.2 kg/m<sup>2</sup> pre-intervention, compared to 5.77% and 33.9 kg/m<sup>2</sup> post-intervention (n=23). This represented a mean HbA1c reduction of 0.183% (95% CI -0.278 to -0.087, P=0.001) and a mean BMI reduction of 1.35 kg/m<sup>2</sup> (95% CI -2.51 to -0.182, P=0.054). Although modest in terms of absolute values, the decrease observed in HbA1c was statistically and clinically significant. While not statistically significant, the decrease in BMI indicated overall weight loss or improved body composition among the participants. Notably, none of the patients who completed the study progressed to T2DM, and 43% (n=10) of participants reduced their HbA1c

Table 1. Statistical analysis of Pre vs. Post HbA1c and BMI

	Sample	HbA1c (%)			BMI (kg/m <sup>2</sup> )		
		Mean Change	95% CI	P value	Mean Change	95% CI	P value
<b>Total</b>	23	-0.183	-0.278, -0.087	0.001	-1.35	-2.51, -0.182	0.054
<b>Age (years)</b>							
35-51	10	-0.200	-0.362, -0.038	0.021	-1.90	-3.76, 0.337	0.041
52-70	13	-0.169	-0.305, -0.033	0.020	-0.923	-2.61, 0.762	0.646
<b>Gender</b>							
Male	8	-0.238	-0.410, -0.065	0.020	-2.34	-2.34, 0.092	0.043
Female	15	-0.153	-0.281, -0.026	0.024	-0.820	-2.21, 0.575	0.506
<b>Ethnicity</b>							
Hispanic	14	-0.154	-0.281, -0.027	0.022	-1.27	-1.27, 0.391	0.195
Non-Hispanic	9	-0.220	-0.391, -0.049	0.024	-1.45	-3.43, 0.533	0.161
<b>Pre-HbA1c (%)</b>							
5.7-5.9	11	-0.109	-0.261, 0.042	0.136	-1.18	-3.32, 0.953	0.859
6.0-6.4	12	-0.250	-0.379, -0.122	0.005	-1.50	-2.96, -0.037	0.036
<b>Pre-BMI (kg/m<sup>2</sup>)</b>							
25-29.9	6	-0.133	-0.388, 0.121	0.223	-0.33	-0.761, 1.43	0.500
30-39.9	12	-0.200	-0.365, -0.035	0.029	-0.525	-1.43, 0.384	0.358
40+	5	-0.200	-0.288, -0.112	0.039	-5.34	-8.58, -2.10	0.043

levels below the prediabetes threshold of 5.7%. These findings suggest that the intervention may have played a significant role in preventing the progression of T2DM among the participants.

Demographic factors were utilized for a subgroup analysis, which revealed minor variations in the observed HbA1c and BMI reductions. Participants aged 35-51 years demonstrated the largest reduction in HbA1c levels (-0.200%, P=0.021), while those aged 52-70 also saw significant, though slightly smaller, decreases (-0.169%, P=0.020) (Fig. 1). The differences in HbA1c reduction between the two age groups could indicate that the intervention was more effective in the younger population or that age played a metabolic role in the magnitude of the decrease. Similarly, gender differences were observed, with males experiencing a more pronounced reduction in HbA1c (-0.238%, P=0.020) compared to females (-0.153%, P=0.024). These findings highlight potential demographic factors that could influence the effectiveness of self-monitoring and nutritional education. When considering BMI, participants with higher pre-intervention BMI ( $\geq 40$  kg/m<sup>2</sup>) showed the

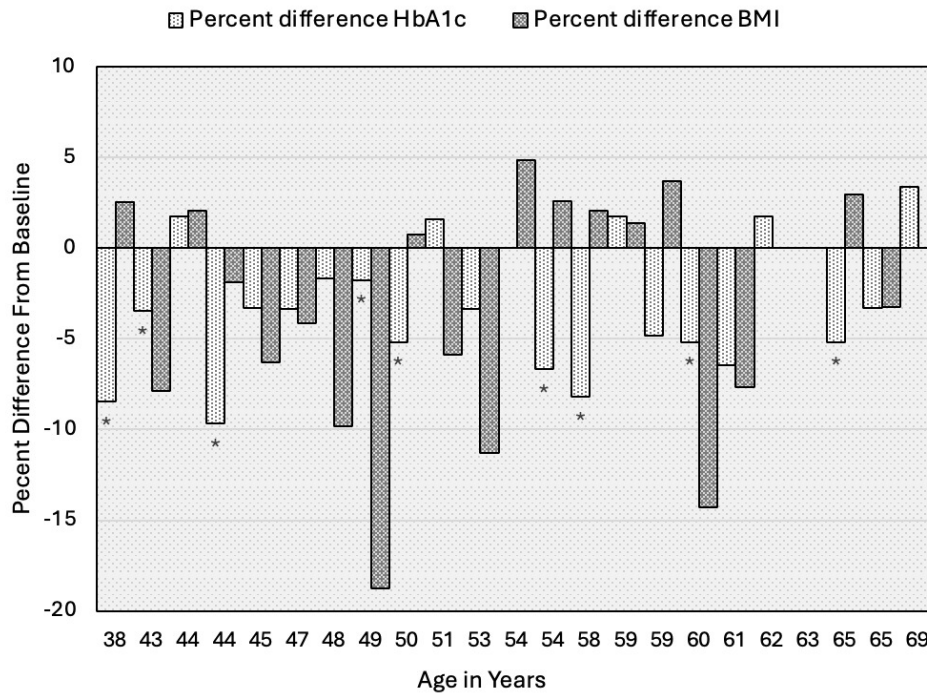


Figure 1. HbA1c and BMI percent difference from baseline. Data is organized in order of increasing age and linked to the corresponding patient. Asterisks indicate patients whose HbA1c decreased below the pre-diabetic threshold of 5.7% (n=9) and blank values indicate 0% change.

most notable improvements, with a mean reduction of  $5.34 \text{ kg/m}^2$  ( $P=0.043$ ). This reduction was substantially greater than those observed in participants with lower baseline BMI, indicating that individuals with more significant obesity may benefit more from the intervention. Although BMI changes were not statistically significant across all groups, the findings suggest a positive trend toward improved body composition, particularly for higher-risk individuals.

Ethnic subgroup analysis also revealed differences in response to the intervention. Hispanic participants showed a mean HbA1c reduction of  $-0.154\%$  ( $P=0.022$ ), while non-Hispanic participants achieved a slightly greater reduction of  $-0.220\%$  ( $P=0.024$ ). Although the non-Hispanic group experienced a greater mean HbA1c decrease, the similar P values indicate a nearly equal significance. Furthermore, overlapping confidence intervals ( $-0.391$  to  $-0.049$  for non-Hispanics, and  $-0.281$  to  $-0.027$  for Hispanics) suggest that there is no distinguishable difference in the intervention's efficacy between the two groups. Both groups showed comparable trends in BMI reduction, with no statistically significant differences between them. The intervention's effects appeared to vary by baseline HbA1c levels. Participants with pre-intervention HbA1c levels of 6.0-6.5% exhibited the largest reductions ( $-0.250\%$ ,  $P=0.005$ ) compared to those with lower initial levels of 5.7-5.9%, who experienced non-significant changes ( $-0.109\%$ ,  $P=0.136$ ). These findings suggest that individuals with higher initial HbA1c levels may derive greater glycemic benefits from targeted interventions such as self-

monitoring and nutritional education. Collectively, these results underscore the importance of tailoring interventions to individual baseline characteristics to maximize effectiveness in preventing T2DM progression.

## DISCUSSION

Several studies have shown that early detection and treatment of pre-diabetes is an effective strategy in the prevention of T2DM.<sup>18-20</sup> However, most patients with pre-diabetes are not identified and multiple barriers to treatment exist. Patient-dependent barriers include limited economic resources and a lack of sustained motivation, while provider-dependent barriers involve insufficient time for patient education and inadequate resources.<sup>21</sup> Lifestyle modifications, particularly those involving dietary changes and physical activity, are effective in delaying or preventing the transition from pre-diabetes to T2DM.<sup>22</sup> However, implementation and adherence to dietary and lifestyle modifications remain a challenge to both clinicians and patients.<sup>23</sup> SMBG has traditionally been relied upon for T2DM control; however, it has not been previously explored in patients with pre-diabetes.<sup>24</sup> SMBG is a powerful tool in diabetes management because it provides real-time data on blood glucose levels [25]. When combined with nutritional education, patients are equipped with greater knowledge to make healthier food choices, understand portion sizes, and identify foods contributing to their elevated blood glucose. The immediate feedback provided by SMBG allows patients to have a better understanding of how their lifestyle and dietary choices can affect their blood sugar. Providing patients with resources for self-monitoring with nutritional education may motivate patients to maintain healthier habits and promote better outcomes. Of note, certain groups within this study demonstrated markedly greater reductions. This included greater reductions in HbA1c and BMI in male participants and male or female participants 35-51 years old. Furthermore, greater reductions in HbA1c in participants with initial values  $\geq 6.0\%$  and BMI with initial values  $\geq 40 \text{ kg/m}^2$  were observed. It is useful to consider this when applying to clinical practice, (i.e. a younger male patient with an elevated BMI and borderline T2DM HbA1c may benefit from SMBG and nutritional education as a first-line approach). However, further research with a larger sample is required.

Existing research on preventing T2DM in individuals with pre-diabetes remains limited, especially within the Hispanic population. Hispanics are a particular population at risk due to genetic predisposition and disadvantaged socioeconomic status. Further research with a larger and more diverse sample size is warranted for several reasons. 1.) A larger study could determine the external validity and allow for potential public health interventions on a much larger scale. 2.) A study that focuses on long-term prevention could provide deeper insights into potential benefits or unseen challenges. 3.) Social determinants of health exist that could be additionally assessed, including

but not limited to acculturation, lifestyle, built environment, and healthcare access. Furthermore, simple changes in insurance policies could greatly benefit disease prevention. For example, insurance policies may limit patients to once-yearly lab work that delays screening or may not cover potential disease-preventing resources such as glucometers. However, these changes must be made on the insurance company side. Insurance represents a significant financial burden that results in many patients being unable to switch policies or without insurance entirely. Because of this, advocacy is the most crucial resource. By highlighting a need and potential area for intervention, change is possible. This study, while limited by a small sample size, highlights the positive impact SMBG and nutritional education can have in mitigating progression towards T2DM.

In summary, introducing glucometer management with dietary and lifestyle education for pre-diabetic patients presents a promising method of addressing the management of a healthy lifestyle and effective diabetes management. This study demonstrated that the intervention significantly reduced HbA1c and BMI, two critical health metrics for diabetes prevention and management. By equipping patients with essential tools and knowledge, this strategy could reduce T2DM risk and serve as a practical, sustainable preventive measure. This general approach could be successfully adopted across diverse populations, making it a valuable tool in public health strategies for combating metabolic diseases. These findings highlight the importance of future research to explore the lasting impact of such interventions on patient health.

Submitted: May 08, 2025 CDT. Accepted: June 06, 2025 CDT. Published: August 29, 2025 CDT.

## REFERENCES

1. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Diabetes Res Clin Pract.* 2022;183:109119. doi:[10.1016/j.diabres.2023.110945](https://doi.org/10.1016/j.diabres.2023.110945)
2. CDC. National Diabetes Statistics Report. Diabetes. 2024. Accessed October 8, 2024. <https://www.cdc.gov/diabetes/php/data-research/index.html>
3. Deshpande AD, Harris-Hayes M, Schootman M. Epidemiology of Diabetes and Diabetes-Related Complications. *Phys Ther.* 2008;88(11):1254-1264. doi:[10.2522/ptj.20080020](https://doi.org/10.2522/ptj.20080020). PMID:18801858
4. Solis-Herrera C, Triplitt C, Cersosimo E, DeFronzo RA, et al. Pathogenesis of Diabetes Mellitus. In: Feingold KR, Anawalt B, Blackman MR, Boyce A, Chrousos G, Corpas E, et al., eds. *Endotext [Internet]*. MDText.com, Inc.; 2000. Accessed October 8, 2024. <http://www.ncbi.nlm.nih.gov/books/NBK279115/>
5. Hu FB. Globalization of diabetes: the role of diet, lifestyle, and genes. *Diabetes Care.* 2011;34(6):1249-1257. doi:[10.2337/dc11-0442](https://doi.org/10.2337/dc11-0442). PMID:21617109
6. Eid S, Sas KM, Abcouwer SF, Feldman EL, Gardner TW, Pennathur S, et al. New insights into the mechanisms of diabetic complications: role of lipids and lipid metabolism. *Diabetologia.* 2019;62(9):1539-1549. doi:[10.1007/s00125-019-4959-1](https://doi.org/10.1007/s00125-019-4959-1). PMID:31346658
7. Mauricio D, Alonso N, Gratacòs M. Chronic Diabetes Complications: The Need to Move beyond Classical Concepts. *Trends in Endocrinology & Metabolism.* 2020;31(4):287-295. doi:[10.1016/j.tem.2020.01.007](https://doi.org/10.1016/j.tem.2020.01.007)
8. Singh VP, Bali A, Singh N, Jaggi AS. Advanced Glycation End Products and Diabetic Complications. *Korean J Physiol Pharmacol.* 2014;18(1):1-14. doi:[10.4196/kjpp.2014.18.1.1](https://doi.org/10.4196/kjpp.2014.18.1.1). PMID:24634591
9. Gosmanov AR, Gosmanova EO, Kitabchi AE, et al. Hyperglycemic Crises: Diabetic Ketoacidosis and Hyperglycemic Hyperosmolar State. In: Feingold KR, Anawalt B, Blackman MR, Boyce A, Chrousos G, Corpas E, et al., eds. *Endotext [Internet]*. MDText.com, Inc.; 2000. Accessed October 8, 2024. <http://www.ncbi.nlm.nih.gov/books/NBK279052/>
10. Hernandez L, Leutwyler H, Cataldo J, Kanaya A, Swislocki A, Chesla C. The Lived Experience of Older Adults With Type 2 Diabetes Mellitus and Diabetes-Related Distress. *J Gerontol Nurs.* 2020;46(3):37-44. doi:[10.3928/00989134-20200129-05](https://doi.org/10.3928/00989134-20200129-05)
11. Sherwani SI, Khan HA, Ekhzaimy A, Masood A, Sakharkar MK. Significance of HbA1c Test in Diagnosis and Prognosis of Diabetic Patients. *Biomark Insights.* 2016;11:95-104. doi:[10.4137/BMI.S38440](https://doi.org/10.4137/BMI.S38440). PMID:27398023
12. Brannick B, Dagogo-Jack S. Prediabetes and Cardiovascular Disease: Pathophysiology and Interventions for Prevention and Risk Reduction. *Endocrinol Metab Clin North Am.* 2018;47(1):33-50. doi:[10.1016/j.ecl.2017.10.001](https://doi.org/10.1016/j.ecl.2017.10.001). PMID:29407055
13. Bennasar-Veny M, Fresneda S, López-González A, Busquets-Cortés C, Aguiló A, Yañez AM. Lifestyle and Progression to Type 2 Diabetes in a Cohort of Workers with Prediabetes. *Nutrients.* 2020;12(5):1538. doi:[10.3390/nu12051538](https://doi.org/10.3390/nu12051538). PMID:32466178
14. Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med.* 2002;346(6):393-403. doi:[10.1056/NEJMoa012512](https://doi.org/10.1056/NEJMoa012512)
15. American Diabetes Association. Standards of Care in Diabetes—2023 Abridged for Primary Care Providers. *Clinical Diabetes.* 2022;41(1):4-31. doi:[10.2337/cd23-as01](https://doi.org/10.2337/cd23-as01)

16. Horton WB, Barrett EJ. Microvascular Dysfunction in Diabetes Mellitus and Cardiometabolic Disease. *Endocr Rev.* 2020;42(1):29-55. doi:[10.1210/endo/bnaa025](https://doi.org/10.1210/endo/bnaa025). PMID:33125468
17. Bell K, Shaw JE, Maple-Brown L, Ferris W, Gray S, Muflet G, et al. A position statement on screening and management of prediabetes in adults in primary care in Australia. *Diabetes Research and Clinical Practice.* 2020;164:108188. doi:[10.1016/j.diabres.2020.108188](https://doi.org/10.1016/j.diabres.2020.108188)
18. Herman WH, Ye W, Griffin SJ, Simmons RK, Davies MJ, Khunti K, et al. Early Detection and Treatment of Type 2 Diabetes Reduce Cardiovascular Morbidity and Mortality: A Simulation of the Results of the Anglo-Danish-Dutch Study of Intensive Treatment in People With Screen-Detected Diabetes in Primary Care (ADDITION-Europe). *Diabetes Care.* 2015;38(8):1449-1455. doi:[10.2337/dc14-2459](https://doi.org/10.2337/dc14-2459). PMID:25986661
19. US Preventive Services Task Force. Screening for Prediabetes and Type 2 Diabetes: US Preventive Services Task Force Recommendation Statement. *JAMA.* 2021;326(8):736-743. doi:[10.1001/jama.2021.12531](https://doi.org/10.1001/jama.2021.12531)
20. Zhang J, Zhang Z, Zhang K, Ge X, Sun R, Zhai X. Early detection of type 2 diabetes risk: limitations of current diagnostic criteria. *Front Endocrinol (Lausanne).* 2023;14:1260623. doi:[10.3389/fendo.2023.1260623](https://doi.org/10.3389/fendo.2023.1260623). PMID:38027114
21. Uusitupa M, Khan TA, Viguiliouk E, Kahleova H, Rivellese AA, Hermansen K, et al. Prevention of Type 2 Diabetes by Lifestyle Changes: A Systematic Review and Meta-Analysis. *Nutrients.* 2019;11(11):2611. doi:[10.3390/nu11112611](https://doi.org/10.3390/nu11112611). PMID:31683759
22. Andualem A, Gelaye H, Damtie Y. Adherence to Lifestyle Modifications and Associated Factors Among Adult Hypertensive Patients Attending Chronic Follow-Up Units of Dessie Referral Hospital, North East Ethiopia, 2020. *Integr Blood Press Control.* 2020;13:145-156. doi:[10.2147/IBPC.S275575](https://doi.org/10.2147/IBPC.S275575). PMID:33122940
23. Weinstock RS, Aleppo G, Bailey TS, Bergenstal RM, Fisher WA, Greenwood DA, et al. The Role of Blood Glucose Monitoring in Diabetes Management. American Diabetes Association. doi:[10.2337/db2020-31](https://doi.org/10.2337/db2020-31)
24. Reddy N, Verma N, Dungan K, et al. Monitoring Technologies- Continuous Glucose Monitoring, Mobile Technology, Biomarkers of Glycemic Control. In: Feingold KR, Anawalt B, Blackman MR, Boyce A, Chrousos G, Corpas E, et al., eds. *Endotext [Internet]*. MDText.com, Inc.; 2000. Accessed October 8, 2024. <http://www.ncbi.nlm.nih.gov/books/NBK279046/>