

Review Article

Diabetes prevention in primary care: a review of lifestyle interventions, screening, and risk reduction

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ABSTRACT

Diabetes mellitus, a global health crisis, necessitates effective prevention strategies. The prevalence of diabetes is on a relentless rise, leading to severe complications and imposing a substantial societal burden. Diabetes prevention has taken center stage in the public health arena. The imperative to develop effective strategies for preventing diabetes, particularly type 2 diabetes, has never been more apparent. The primary goal of diabetes screening is to identify individuals at risk of developing the disease, particularly type 2 diabetes. This paper explores the multifaceted landscape of diabetes prevention, emphasizing the role of lifestyle modifications, screening, and risk reduction. Lifestyle modifications encompass dietary changes, physical activity, and behavioral adjustments, forming the foundational approach. Screening, with various methods and risk assessment tools, identifies at-risk individuals, allowing for timely interventions. Risk reduction strategies target modifiable factors and are essential for both preventing diabetes onset and mitigating complications. These approaches empower individuals, healthcare professionals, and policymakers to combat diabetes's increasing prevalence and its associated health and economic consequences.

Keywords: Diabetes mellitus, Prevention, Lifestyle modifications, Screening, Risk reduction, Dietary interventions, Physical activity

INTRODUCTION

Diabetes mellitus, a group of metabolic disorders characterized by hyperglycemia, has emerged as one of the most pressing global health concerns of the 21st century. As of 2021, an estimated 537 million people worldwide

were living with diabetes, with this number projected to rise to 643 million by 2030, highlighting the escalating magnitude of this epidemic.¹ Beyond sheer prevalence, diabetes exacts a heavy toll on individuals, families, healthcare systems, and economies, contributing to a multitude of complications, including cardiovascular

disease, neuropathy, retinopathy, nephropathy, and lower limb amputations.²

In this context, diabetes prevention has taken center stage in the public health arena. The imperative to develop effective strategies for preventing diabetes, particularly type 2 diabetes, has never been more apparent. Addressing this challenge is not merely a matter of mitigating individual suffering but also of averting the immense healthcare costs and societal burdens associated with diabetes-related complications.³ This comprehensive review aims to delve into the multifaceted domain of diabetes prevention, offering an in-depth exploration of diverse strategies ranging from lifestyle modifications to pharmacological interventions and public health initiatives. By synthesizing current evidence and examining the nuances of each approach, this paper seeks to provide a holistic perspective on diabetes prevention. Such insights can serve as a valuable resource for healthcare professionals, policymakers, and researchers alike, facilitating informed decision-making and guiding future endeavors aimed at curbing the global diabetes epidemic.⁴

As we embark on this exploration of diabetes prevention strategies, it becomes evident that a multi-pronged approach is essential. The complexity of diabetes etiology, influenced by genetic, environmental, and behavioral factors, necessitates a tailored and interdisciplinary response.⁵ This review will traverse the terrain of dietary interventions, physical activity, pharmacological interventions, awareness campaigns, and policy initiatives, offering a comprehensive analysis of each facet and its contribution to diabetes prevention. Through collective efforts, we can aspire to bend the curve of diabetes incidence, alleviate suffering, and promote healthier societies, ultimately ensuring a brighter and healthier future for generations to come.

METHODOLOGY

This study is based on a comprehensive literature search conducted on 16 October 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed diabetes prevention in primary care with a focus on lifestyle interventions, screening, and risk reduction. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

Dietary modifications represent a cornerstone in the realm of diabetes prevention.⁶ The significance of dietary choices cannot be overstated, given the direct impact of food

consumption on blood glucose levels and insulin sensitivity. Several dietary strategies have emerged as effective means of reducing the risk of diabetes. One of the primary dietary approaches for diabetes prevention is the adoption of a balanced and nutritious diet.⁷ This entails an emphasis on whole foods, including fruits, vegetables, whole grains, lean proteins, and healthy fats. Such a diet not only helps to regulate blood sugar levels but also provides essential nutrients and fibers that support overall health. Indeed, a wealth of research indicates that diets rich in plant-based foods and low in processed or red meats are associated with a lower risk of type 2 diabetes.⁸

The impact of carbohydrates on diabetes risk has been a focal point of dietary discussions. Low-carbohydrate diets, often characterized by reduced intake of high-glycemic-index foods and sugars, have shown promise in diabetes prevention.⁹ However, it is important to differentiate between the quality of carbohydrates. While refined carbohydrates, such as those found in sugary snacks and beverages, are linked to an increased risk of diabetes, complex carbohydrates from whole grains and legumes offer a protective effect.¹⁰

Furthermore, dietary patterns such as the Mediterranean diet and the dietary approaches to stop hypertension (DASH) diet have garnered attention for their potential to reduce diabetes risk.¹¹ The Mediterranean diet, rich in fruits, vegetables, whole grains, olive oil, and moderate consumption of fish and poultry, is associated with improved insulin sensitivity and a decreased risk of type 2 diabetes.¹² The DASH diet, which focuses on reducing sodium intake and emphasizing nutrient-dense foods, has demonstrated similar benefits.¹³

In addition to food choices, meal timing and portion control play vital roles in diabetes prevention. Eating regular, balanced meals and avoiding large, sporadic meals can help stabilize blood sugar levels.¹⁴ Moreover, portion control helps in managing calorie intake and preventing excessive weight gain, a major risk factor for type 2 diabetes.

Regular physical activity is another pillar of diabetes prevention that complements dietary modifications. Exercise has a profound impact on insulin sensitivity, glucose metabolism, and overall cardiovascular health.¹⁵ For individuals at risk of diabetes, incorporating physical activity into their daily routines can be transformative. Aerobic exercises, such as brisk walking, swimming, cycling, and jogging, are particularly effective in improving insulin sensitivity.¹⁶ These activities not only burn calories but also enhance the body's ability to utilize glucose efficiently. The American Diabetes Association recommends at least 150 minutes of moderate-intensity aerobic activity per week for adults to reduce their risk of developing diabetes.¹⁷ Resistance training, involving activities like weightlifting, can also contribute to diabetes prevention. It helps build muscle mass, which is metabolically active and aids in glucose uptake.¹⁸

A combination of aerobic and resistance exercises often yields the best results in terms of diabetes risk reduction. Moreover, promoting an active lifestyle beyond structured exercise is crucial. Encouraging individuals to incorporate physical activity into their daily routines, such as taking the stairs instead of the elevator or walking to nearby destinations, can be highly effective in preventing diabetes.¹⁹ It is important to recognize that the benefits of physical activity extend beyond diabetes prevention, encompassing cardiovascular health, weight management, and overall well-being.

The primary goal of diabetes screening is to identify individuals at risk of developing the disease, particularly type 2 diabetes, in its early stages or during the prediabetic phase.²⁰ Timely identification allows healthcare professionals to intervene with preventive measures such as lifestyle modifications, dietary changes, and, when necessary, pharmacological interventions. Identifying at-risk individuals is essential, as many individuals with diabetes remain asymptomatic for an extended period, leading to delayed diagnosis and increased disease-related complications.²¹ Screening also plays a pivotal role in preventing diabetes-related complications. Early detection and intervention can help individuals maintain better blood glucose control, reducing the risk of cardiovascular disease, neuropathy, retinopathy, nephropathy, and other associated complications.²⁰ Thus, effective screening not only prevents the onset of diabetes but also mitigates the severity of its consequences.

The fasting plasma glucose (FPG) test is one of the most commonly used methods for diabetes screening.²² It

measures the fasting blood glucose level after an overnight fast. A fasting glucose level of 126 mg/dl (7.0 mmol/l) or higher is indicative of diabetes, while levels between 100 and 125 mg/dl (5.6 to 6.9 mmol/l) suggest prediabetes. The oral glucose tolerance test (OGTT) involves fasting overnight and then drinking a glucose solution, followed by blood glucose measurements at specific intervals.²³ A 2-hour glucose level of 200 mg/dl (11.1 mmol/l) or higher is diagnostic of diabetes, while values between 140 and 199 mg/dl (7.8 to 11.0 mmol/l) indicate prediabetes. The HbA1c (hemoglobin A1c) test measures the average blood glucose level over the past 2-3 months. An HbA1c level of 6.5% or higher is diagnostic of diabetes, while values between 5.7% and 6.4% suggest prediabetes.²⁴

In addition to traditional screening methods, risk assessment tools and questionnaires are valuable in identifying individuals at risk. The American Diabetes Association's diabetes risk test and the Finnish diabetes risk score are examples of such tools.^{25,26} They consider various risk factors, including age, family history, physical activity, and body mass index, to estimate an individual's likelihood of developing diabetes. While diabetes screening holds significant promise, it also faces challenges such as accessibility, adherence, and the potential for over diagnosis.

Additionally, there is a need for greater standardization of screening criteria and guidelines. Future research should focus on refining risk assessment tools, improving screening accuracy, and exploring novel approaches, such as digital health technologies, to enhance diabetes screening and prevention efforts.

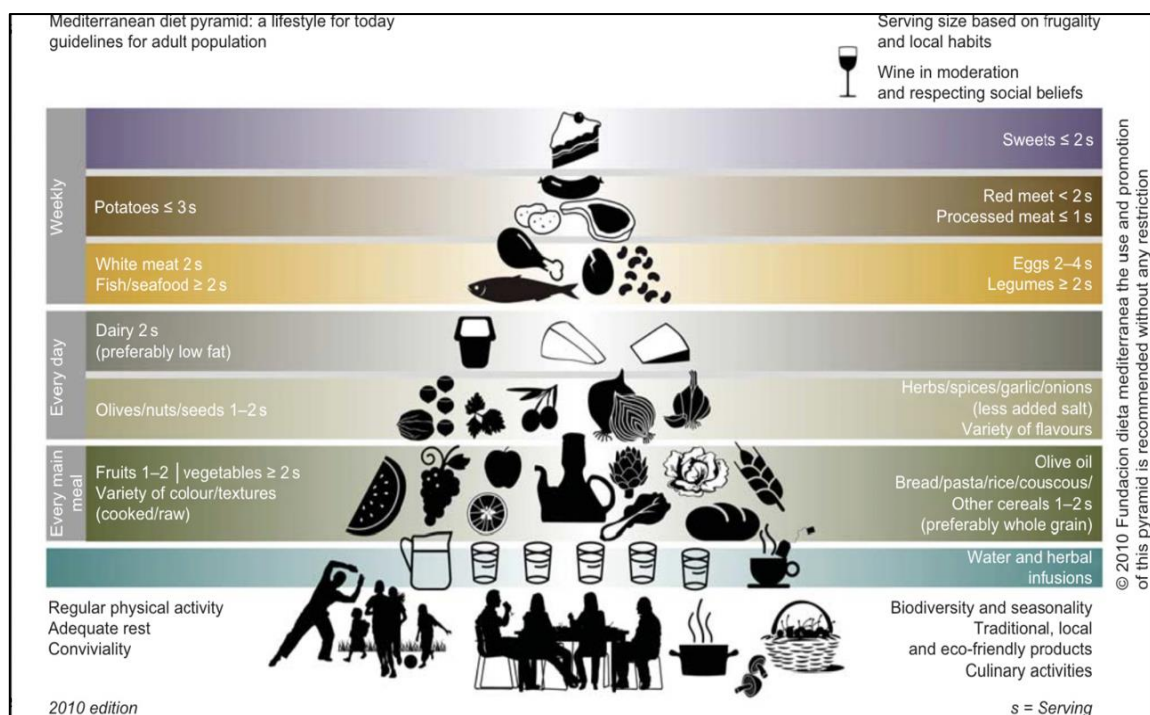


Figure 1: The Mediterranean diet pyramid.

Table 1: Screening tests for diabetes mellitus.

Test	Purpose	Procedure	Results indicative of
Fasting plasma glucose (FPG)	Diabetes diagnosis and screening	After an overnight fast, a blood sample is taken	Normal: less than 100 mg/dl (5.6 mmol/l), prediabetes: 100-125 mg/dl (5.6-6.9 mmol/l), diabetes: 126 mg/dl (7.0 mmol/l) or higher
Oral glucose tolerance test (OGTT)	Diabetes diagnosis and gestational diabetes screening	After an overnight fast, the individual drinks a glucose solution, and blood samples are taken at specific intervals	Normal: less than 140 mg/dl (7.8 mmol/l) at 2 hours, prediabetes: 140-199 mg/dl (7.8-11.0 mmol/l) at 2 hours, diabetes: 200 mg/dl (11.1 mmol/l) or higher at 2 hours
Glycated hemoglobin (HbA1c)	Long-term blood sugar control assessment	A blood sample is collected at any time, with no fasting required	Normal: less than 5.7%, prediabetes: 5.7%-6.4%, diabetes: 6.5% or higher
Random plasma glucose	Quick assessment of blood sugar levels	A blood sample is taken at any time, regardless of fasting	Diabetes: 200 mg/dl (11.1 mmol/l) or higher (with symptoms)
Risk assessment tools	Diabetes risk assessment	Individuals answer a set of questions about their age, family history, physical activity, and other factors to estimate their risk	Risk level for developing diabetes, which may prompt further testing or preventive measures

Identifying and addressing modifiable risk factors is a cornerstone of effective diabetes risk reduction strategies. These risk factors encompass various aspects of lifestyle and health that, when recognized, enable proactive measures to mitigate the risk of developing diabetes.²⁷ Firstly, unhealthy dietary choices, characterized by diets high in refined sugars and saturated fats, contribute to weight gain, insulin resistance, and impaired glucose metabolism.²⁸ Secondly, sedentary lifestyles and physical inactivity reduce insulin sensitivity and increase body fat, elevating diabetes risk. Moreover, obesity, as an independent risk factor, is strongly associated with type 2 diabetes, necessitating interventions promoting weight loss through dietary changes and increased physical activity.²⁹ Prediabetes, a critical stage characterized by impaired glucose tolerance, represents another vital aspect of risk identification, as it provides an opportunity for early intervention through lifestyle modifications and pharmacological approaches.³⁰ Additionally, the presence of metabolic syndrome, characterized by multiple risk factors including central obesity and high blood pressure, significantly heightens diabetes risk. Family history, genetics, gestational diabetes history, smoking, excessive alcohol consumption, and poor stress management all contribute to modifiable risk factors. Recognizing these factors empowers individuals and healthcare professionals to craft personalized prevention plans, ultimately working toward reducing the global diabetes burden.³¹ The importance of diabetes risk reduction strategies goes beyond the prevention of diabetes itself; they play a vital role in averting the severe complications associated with the disease. Early detection and effective risk reduction measures can significantly mitigate the development and progression of these complications, ultimately enhancing the overall well-being of individuals at risk. Cardiovascular disease, a major concern for those with diabetes, is reduced through risk reduction measures as

they lower the risk of heart attacks, strokes, and peripheral artery disease.³² Diabetes-related retinopathy, a leading cause of vision impairment, can be delayed or prevented with early risk reduction efforts to maintain stable blood glucose levels.³³ Diabetic neuropathy, characterized by nerve damage, can also be prevented or delayed by maintaining optimal blood glucose control. Diabetic nephropathy, which can lead to kidney failure, can be slowed through risk reduction strategies targeting blood pressure control and blood glucose management.³⁴ Furthermore, comprehensive risk reduction efforts encompassing foot care education can prevent or delay foot-related complications, including the need for lower limb amputations. By addressing these modifiable risk factors and preserving individuals' health, risk reduction strategies contribute to not only enhancing their quality of life but also reducing the broader healthcare and societal burden imposed by diabetes-related complications. Diabetes risk reduction, thus, serves as a comprehensive strategy that extends far beyond diabetes prevention, encompassing the preservation of health and the prevention of devastating complications. As mentioned earlier, lifestyle modifications constitute the foundational approach to risk reduction in diabetes prevention. Dietary interventions, such as adopting balanced diets rich in whole foods and reducing sugar-sweetened beverage consumption, are effective in preventing diabetes.³⁵ Physical activity, encompassing aerobic exercises and resistance training, enhances insulin sensitivity and glucose metabolism. Behavioral changes that promote healthier eating patterns, weight management, and regular exercise are fundamental elements of lifestyle modification.⁵ For individuals at high risk or with prediabetes, pharmacological interventions can be valuable adjuncts to lifestyle modifications. Medications like metformin, thiazolidinediones, alpha-glucosidase inhibitors, and glucagon-like peptide-1 (GLP-1) receptor agonists can improve insulin sensitivity and glycemic

control.³⁶ However, these interventions must be carefully considered, with benefits weighed against potential side effects and individual needs. Public health initiatives offer a population-level approach to risk reduction. Awareness campaigns that educate individuals about diabetes risk factors and the importance of early detection can foster preventive behaviors. Policy interventions, such as sugar taxation, food labeling regulations, and school-based nutrition programs, create environments conducive to healthier choices.³⁷ These initiatives have the potential to address systemic factors contributing to diabetes risk.

CONCLUSION

Diabetes prevention is paramount to addressing the burgeoning global diabetes epidemic. Lifestyle modifications, including dietary improvements and increased physical activity, play a central role in reducing diabetes risk. Screening, with its diverse methods and risk assessment tools, facilitates the early identification of at-risk individuals. Risk reduction strategies targeting modifiable factors not only prevent diabetes but also avert complications. Recognizing the significance of prevention is vital for mitigating individual suffering and curbing healthcare costs. Collective efforts, informed by this comprehensive approach, can bend the curve of diabetes incidence, alleviate suffering, and promote healthier societies, ensuring a brighter and healthier future for all.

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