pISSN 2394-6032 | eISSN 2394-6040

Review Article

DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20183435

Prevention of diabetes type 2 by adjustment of lifestyle and diet

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Received: 12 July 2018 Revised: 08 August 2018 Accepted: 09 August 2018

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ABSTRACT

Type 2 diabetes mellitus is one of the most common chronic health conditions around the world and is a major challenge to health care providers. Its incidence across the world is increasing. There is long-term affection of pancreas before symptoms start, allowing for a large window for early detection and prevention of the disease. We conducted this review using a comprehensive search of MEDLINE, PubMed, and EMBASE, January 1987, through March 2017. The following search terms were used: diabetes type 2, prevention diabetes type 2, effects of lifestyle on health, alcohol and diabetes, smoking and diabetes, preventive strategies for diabetes type 2. Our aim in this study is to understand the pathophysiology of diabetes mellitus type 2 with regards to the risk factors and how to prevent them. Diabetes mellitus type 2 is considered a preventable disease, therefore, studying its risk factors and trying to reduce them is very important. Even minor modifications in risk factors of the disease could achieve significant reduction in incidence and progression of diabetes. Weight loss, improved dietary intake, and increased exercise levels are the most important interventions that will lead to significant decrease in the occurrence of the disease.

Keywords: Type 2 diabetes mellitus, Effects of lifestyle on health, Alcohol and diabetes, Smoking and diabetes, Preventive strategies for diabetes type 2

INTRODUCTION

Diabetes mellitus type 2 is one of the most important health issues around the world. It is considered to be a major challenge to most health providers. The World Health Organization (WHO) stated that the prevalence of diabetes mellitus type 2 has been increasing significantly, and this is most likely due to universal changes in lifestyle. It was estimated by the centre for disease

control (CDC) that by the year 2025, up to 300 million individuals around the world will have diabetes mellitus type 2, which means that every year, about six more million patients will develop the disease. Moreover, while diabetes mellitus is considered to be sixth most common cause of death in the United States, it is the third most common cause of death in some ethnic groups. Although it is generally a disease of adult, incidence of diabetes mellitus has been recently increasing among

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children. Therefore, there is a growing interest in predisposing factors for the disease in children population.²

The word 'diabetes mellitus' is generally used to describe a number of metabolic disorders that are characterized by the presence of chronic hyperglycemia. This hyperglycemia results either from the decrease or absence of insulin, or from the inability to properly utilize insulin, or both mechanisms together. When diabetes is not well-controlled, this will cause a state of chronic hyperglycemia, which is associated with several long-term sequelae. These include severe dysfunction and failure of several organs along with macro- and micro-vascular damage. The resulting effects of this will include blindness, chronic kidney disease, neuropathy, atherosclerosis, and other chronic diseases.³

The most common defects that are known to precede (and cause) diabetes mellitus type 2 are peripheral insulin resistance, and pancreatic beta-cell dysfunction. In about 10 years before the initial presentation of a patient with diabetes mellitus type 2, dysfunction of pancreatic cells starts. This long-term affection before symptoms start, allows for a large window for early detection and prevention of the disease.⁴

METHODS

Data sources and search terms

We conducted this review using a comprehensive search of MEDLINE, PubMed, and EMBASE, January 1987, through March 2017. The following search terms were used: diabetes type 2, prevention diabetes type 2, effects of lifestyle on health, alcohol and diabetes, smoking and diabetes, preventive strategies for diabetes type 2.

Data extraction

Two reviewers have independently reviewed the studies, abstracted data, and disagreements were resolved by consensus. Studies were evaluated for quality and a review protocol was followed throughout.

The study was done after approval of review board of King Abdulaziz University.

Risk factors

When we study patients with diabetes mellitus type 2, we can conclude that about half cases are due to environmental and lifestyle habits, while the other half could be attributed to genetic predisposition.⁵ In this article, we will discuss most important predisposing factors and risk factors that are known to be associated with diabetes mellitus type 2 and are mainly targeted in attempts to prevent the disease.

Overweight

Recent increase in obesity incidence and prevalence has been thought to be an important factor that reflected in an increase in the incidence and prevalence of diabetes mellitus type 2. During the last fifty years, we have observed about three-fold increase in the prevalence of obesity among young adults. Recent reports have suggested that up to 15% of young adults between 16 and 19 years old are overweight.⁶

The underlying pathophysiology through which obesity affects the development and progression of diabetes mellitus has not been clearly understood yet. Some studies suggest that adiponectin and adipocytokine may be involved. On the other hand, some reports have suggested that adipocytokines and adiponectin levels decline in obese older adults with a diagnosis of diabetes mellitus type 2 or coronary artery disease.⁷

Food habits

Excessive food intake that contains high index of calories is the most important cause of weight gain, and eventually obesity. The degree of food intake, and weight gain will further lead to higher risk of developing diabetes mellitus type 2.8

Guidelines had recommended in the past, the intake of diets that includes low fats (and relatively high levels of carbohydrates). However, newer studies have suggested that a diet that includes lower carbohydrate levels, and high fat levels may contribute in the reduction of insulin resistance. Intake of mono-unsaturated fats in high levels has in fact been found to improve control of glucose levels. Additionally, levels of triglycerides could be controlled by intake of n-3 polyunsaturated fatty acids. However, the underlying mechanisms of these reactions and results are not clearly understood.⁹

Other nutrients have also been found to impact insulin and glucose interactions. These include calcium, magnesium, potassium, chromium, zinc, vanadium along with other minerals.⁹

Alcohol consumption

Conflicting results have been found when it comes to the relationship between alcohol intake and the risk of developing diabetes mellitus type 2. A recent study was published where authors did a systematic review of all cohort studies that studied this issue. They found that 8 studies have concluded the presence of a relationship between alcohol consumption and diabetes mellitus type 2 that is U-shaped. This means that patients who have moderate intake of alcohol were associated with the least risk of developing diabetes mellitus type 2. On the other hand, people who do not consume alcohol at all, and people who consume excessive amounts of alcohol, were found to have relatively higher risk of developing

diabetes mellitus type 2. However, the association between alcohol abuse and diabetes mellitus type 2 was only strong in two cohort studies. Other three studies did conclude that incidence of diabetes mellitus type 2 was inversely related to alcohol consumption. However, these studies were under-powered, and only 3% of the sample were heavy drinkers. Therefore, an association between heavy drinking could have been present but not detected due to small sample size. ¹⁰

There are several pathophysiological mechanisms by which alcohol can impact the development and progression of diabetes mellitus type 2. Some reports have suggested that intake of low or moderate amounts of alcohol may be able to reduce the incidence of diabetes mellitus type 2 due to the effect on improving insulin sensitivity. On the other hand, alcohol abuse will lead to excess energy and is significantly associated with obesity, pancreatitis, and liver failure. All of these are common mechanisms that are known to be involved in the development of diabetes mellitus type 2. ¹¹

Cigarette smoking

Smoking can be associated with increased risk of diabetes mellitus type 2 in several mechanisms. Previous studies have found that smoking is significantly associated with higher serum glucose. Several studies have concluded that smoking is considered an independent risk factor for having high insulin levels in individuals who do not have diabetes mellitus. Individuals who are currently smokers also have high glycosylated hemoglobin (HbA_{1c}) levels when they are compared with individuals who do not smoke. A recent large population-based study revealed that smoking and glycosylated hemoglobin positively correlate together in both sexes. Moreover, despite normal (or sometimes lower) BMI that smokers have, they still have more central fat in their bodies. The presence of more central fat is strongly associated with the later development of insulin resistance.¹²

Recent large cohorts have concluded that diabetes mellitus type 2 is strongly associated with being smoker. A large study in nurses have found that females who did smoked 25 cigarettes or more daily had a higher risk of developing diabetes mellitus type 2 when they are compared with females who never smoked. This risk was present even after adjustment for several confounding factors including obesity. Another cohort study that included more than seven thousand British males and followed them up for more than 15 years, did report similar findings, and concluded that after adjustment for age, weight, and other confounding factors, smoker males had a significantly higher risk of developing diabetes mellitus type 2 than non-smoker males. Later, another large study was conducted and included more than 20 thousand males aged between 40 and 80 years old. This study found, after adjustment of several confounding factors, that individuals who smoked 20 or more cigarettes a day had a significantly higher risk of developing diabetes mellitus type 2 than individuals who did not smoke at all. A recent study on Japanese males aged between 35 and 60 years found that daily smoking was significantly associated with developing dysfunction in glucose metabolism, and later diabetes mellitus type 2. Although not all published studies show exact similar results, most studies agree that there is a significant association between cigarette smoking and the development of diabetes mellitus type 2. ¹³

Sedentary lifestyle

Recently, several studies have concluded that inactivity and sedentary lifestyles are independent variables that increase the risk of developing diabetes mellitus type 2. This effect was proven to be present regardless of BMI. Several studies have found the even regular activity is able to achieve significant reduction in the risk of diabetes mellitus type 2. This effect of physical activity is dose-dependent. Moreover, vigorous exercise with long duration has also been associated with a reduced risk of impaired glucose metabolism in patients with diagnosed diabetes mellitus type 2. ¹⁴

On the other hand, individuals who have low physical activity (especially during childhood) are at a significantly increased risk of being overweight and developing diabetes mellitus type 2. Studies that applied increased physical activity on patients were able to prove that activity is effective in decreasing adipose tissue volume in adolescents. This reduction in adipose tissue was independent of body weight and other possible confounding factors. ¹⁵

Large for gestational age

Lately, obesity has been increasing, and this applies to females who are in childbearing age. Therefore, there has been a significant increase in the incidence of births of large gestational age infants. According to previous studies, infants with large gestational age are at a significantly higher risk of developing diabetes mellitus type 2 later in their lives. ¹⁶ However, this could not be an independent risk factor for the development of the disease, as several other confounding factors are associated with being large for gestational age. Therefore, further studies that adjust for all possible confounding factors are suggested. ¹⁷

Maternal diabetes during pregnancy

Lately, incidence and prevalence of diabetes mellitus during pregnancy have been increasing. This led to a significant increase in the incidence of diabetes mellitus type 2 in children. A previous cohort study concluded that about 50% of infants who were born to mother with diabetes mellitus had weight which was over the 90th percentile when they were 8 years old. About 30% of these patients developed diabetes mellitus type 2 when they were adolescents.¹⁸

Breastfeeding

Normal breastfeeding was found in two cohort studies to be protective against the later development of diabetes mellitus type 2 later in life. ¹⁹

Type 2 DM prevention studies

Almost all studies in this field have concluded that sedentary lifestyle, and obesity, are both considered to be the most important independent modifiable risk factors for the development of insulin resistance, which will be followed be diabetes mellitus type 2, and/or metabolic syndrome. Other less prominent risk factors include environmental exposure and genetic predisposition. All these conclusions led to the conduction of large clinical trials that used interventions that target lifestyle with or without pharmacological treatment, to study people with high risk of diabetes mellitus type 2. These trials aimed at the reduction of incidence, prevalence, and comorbidities of diabetes mellitus type $2.^{20}$

The Da Qing impaired glucose tolerance and diabetes study

In this study, authors investigated the impact of better diet and increase physical activity on the development and progression of diabetes mellitus type 2. This study included more than 500 Chinese patients who were randomized into the following groups: improved diet group, improved exercise group, improved diet and exercise group, and control group. Patients were followed up every 2 years for 6 years. The cumulative incidence of diabetes mellitus type 2 at the end of the study was 68% in the control group, whereas it was 44%, 41%, and 46, in improved diet group, improved exercise group, and improved diet and exercise group, respectively. Authors used adjusted cox regression models to adjust for BMI, glucose levels, along with other confounding factors, and found that diet, exercise, and diet with exercise, were associated 31%, 46%, and 42% reduction of diabetes mellitus type 2 incidence, respectively. Authors, therefore, concluded that exercise, along with improved diet will lead to significant decrease in the incidence of development and progression of diabetes mellitus type

The Finnish diabetes prevention study

Investigators of this study conducted a large clinical trial where they evaluated the impact of lifestyle interventions on the incidence of diabetes mellitus type 2 in high-risk populations. they studied about five hundred obese adults and randomized them to lifestyle modifications and control. Lifestyle modifications included counselling toward weight reduction, and a reduction in the total intake of fat, and calories, along with improved intake of fibers. Subjects were followed up for about 3 years. at the end of the study, investigators found that individuals in the intervention group showed significantly more loss in

weight gain when they were compared with the control group. Moreover, the cumulative incidence of diabetes mellitus type 2 in the control group was 23% versus 11% in the intervention group. Authors concluded that intervention group had 58% less risk of developing diabetes mellitus type 2.²³

The US diabetes prevention program (DPP)

In this study, Knowler et al assumed that the modification of diabetes mellitus type 2 risk factors will delay or even prevent the occurrence of the disease. These modifications included lifestyle changes and metformin administration. To prove their hypothesis, authors included more than 3200 individuals at high risk of developing diabetes, and randomized them into the following groups: lifestyle modifications (that aimed at a 7% reduction weight, and 150 min/week of exercise), metformin, or control group. 24

Included individuals were in their fifties, with BMIs around 35 kg/m². They were followed up for about 3 years. authors found that the best weight loss occurred in patient in the lifestyle modifications group, when they were compared with the metformin or control groups. In lifestyle modifications group, and metformin group, incidence of diabetes mellitus type 2 decreased by 58% and 31% respectively, when compared to control group. Generalizing these results will lead to the conclusion that lifestyle modifications for 3 years for 7 people will lead to the prevention of one case of diabetes mellitus.²⁴

The Indian Diabetes Prevention Program (IDPP)

In this study, investigators wanted to test the effects of different lifestyle intervention on Asian Indian populations who are at high risk of developing diabetes mellitus type 2. They included about 500 individuals (most of them were men, with a mean age of 46 years), and randomized them into four groups: lifestyle interventions group, metformin group, lifestyle interventions and metformin group, and control group. They followed patients for over three years and found that cumulative incidence rates of diabetes mellitus type 2 in lifestyle interventions group, metformin group, lifestyle interventions and metformin group, and control group, were 39.3%, 40.5%, 39.5%, and 55% respectively.²⁵ Relative risk reduction associated with interventions, metformin, lifestyle and lifestyle interventions and metformin were 28.5%, 26.4%, and 28.2, respectively. Number needed to prevent one case of diabetes mellitus type 2 in lifestyle interventions group, metformin group, and lifestyle interventions and metformin group were 6.4, 6.9, and 6.5, respectively. The most important conclusion from this trial was that both lifestyle modifications, and metformin were independent factors that led to a significant reduction of diabetes mellitus type 2 incidence in Asian populations at high risk of developing the disease.²⁶

The Asti Diabetes Prevention Program (ADDP)

In this study, investigators supposed that a moderate lifestyle program may be able to decrease or even prevent metabolic syndrome development and progression in the general population. Bo et al conducted a trial that included over 300 mid-age Italians patients, and randomized them into either lifestyle intervention group, or control group. Both groups received verbal advice and consult regarding their lifestyles from trained staff. At the end of the study, patients in the intervention group showed that levels of fibers intake, polyunsaturated fat intake, and exercise, were significantly higher in the intervention group. On the other hand, levels of saturated fat intakes decreased in both intervention and control groups. Moreover, the risk of developing metabolic syndrome or any of its subtypes after one year was significantly less in patients in the intervention group. Hypertriglyceridemia, central obesity, and diabetes mellitus type 2, all decreased in the intervention group.²⁷

Preventive strategies

According to all the previously mentioned trials and large cohorts, along with the analyses of several risk factors and interventions, we can summarize many factors that are associated with increased incidence and prevalence of diabetes mellitus type 2. Being overweight is considered to be one of the most important modifiable risk factors in the development of diabetes mellitus type 2. According to this, all individuals should be aware of this and recommended to have and maintain a BMI that is less than 25. This is of higher importance when dealing with individuals who have other risk factor like the presence of a family history of diabetes mellitus type 2 m being of American Indian or Asians origins, being Hispanic, or having any manifestations of insulin insensitivity. In these individuals with high risk of developing the disease, lifestyle intervention should mainly target weight loss, improved diet intake, increase exercise levels, and smoking prevention. In some cases, only weight loss could be enough to improve insulin resistance and return glucose levels into normal concentrations. However, maintaining an ideal weight loss could sometimes be difficult and challenging. Increased physical activity and exercise are main elements that will lead to further improvements in insulin resistance. Sedentary lifestyle, and obesity are highly associated with significant increases in the risk of diabetes mellitus type 2.²⁸

CONCLUSION

Diabetes mellitus type 2 is the most important and common type diabetes and consists over 90% of cases. Diabetes mellitus type 2 is considered a preventable disease, therefore, studying its risk factors and trying to reduce them is very important. Even minor modifications in risk factors of the disease could achieve significant reduction in incidence and progression of diabetes. Weight loss, improved dietary intake, and increased

exercise levels are the most important interventions that will lead to significant decrease in the occurrence of the disease.

Funding: No funding sources Conflict of interest: None declared Ethical approval: Not required

REFERENCES

- 1. King H, Rewers M. Diabetes in adults is now a Third World problem. The WHO Ad Hoc Diabetes Reporting Group. Bull World Health Organ. 1991;69:643-8.
- 2. King H, Aubert RE, Herman W H. Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. Diabetes Care. 1998;21:1414-31.
- American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2010;1: 62-9.
- 4. Olokoba AB, Obateru OA, Olokoba LB. Type 2 diabetes mellitus: a review of current trends. Oman Med J. 2012;27: 269-73.
- 5. Eriksson J, Lindstrom J, Tuomilehto J. Potential for the prevention of type 2 diabetes. Br Med Bull. 2001;60:183-99.
- 6. 6. Ludwig DS, Ebbeling CB. Type 2 diabetes mellitus in children: Primary care and public health considerations. JAMA. 2001;286: 1427-30.
- 7. Arita Y, Kihara S, Ouchi N, Takahashi M, Maeda K, Miyagawa J, et al. Paradoxical decrease of an adipose-specific protein, adiponectin, in obesity. Biochem Biophys Res Commun. 1999: 257: 79-83.
- 8. Lluch A, Herbeth B, Mejean L, Siest G. Dietary intakes, eating style and overweight in the Stanislas Family Study. Int J Obes Relat Metab Disord. 2000;24:1493-9.
- 9. Franz MJ, Bantle JP, Beebe CA, Brunzell JD, Chiasson JL, Garg A, et al. Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. Diabetes Care. 2003;26(1):51-61.
- Knott C, Bell S, Britton A. Alcohol Consumption and the Risk of Type 2 Diabetes: A Systematic Review and Dose-Response Meta-analysis of More Than 1.9 Million Individuals From 38 Observational Studies. Diabetes Care. 2015;38:1804-12.
- 11. Kim SJ, Kim DJ. Alcoholism and diabetes mellitus. Diabetes Metab J. 2012;36:108-15.
- 12. Chang SA. Smoking and type 2 diabetes mellitus. Diabetes Metab J. 2012;36:399-403.
- Maddatu J, Anderson-Baucum E, Evans-Molina C. Smoking and the risk of type 2 diabetes. Transl Res. 2017;184:101-07.
- 14. Vuori IM. Health benefits of physical activity with special reference to interaction with diet. Public Health Nutr. 2001;4:517-28.
- 15. Gutin B, Barbeau P, Owens S, Lemmon CR, Bauman M, Allison J, et al. Effects of exercise

- intensity on cardiovascular fitness, total body composition, and visceral adiposity of obese adolescents. Am J Clin Nutr. 2002;75:818-26.
- Dyck RF, Klomp H, Tan L. From "thrifty genotype" to "hefty fetal phenotype": the relationship between high birthweight and diabetes in Saskatchewan Registered Indians. Can J Public Health. 2001;92:340-4.
- 17. Ananth CV, Wen SW. Trends in fetal growth among singleton gestations in the United States and Canada, 1985 through 1998. Semin Perinatol. 2002;26:260-7.
- 18. Whitaker RC, Dietz WH. Role of the prenatal environment in the development of obesity. J Pediatr. 1998;132:768-76.
- 19. Pettitt DJ, Knowler WC. Long-term effects of the intrauterine environment, birth weight, and breast-feeding in Pima Indians. Diabetes Care 1998;21(2):138-41.
- 20. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med. 2002;346:393-403.
- 21. Marrero DG. The prevention of type 2 diabetes: an overview. J Diabetes Sci Technol. 2009;3:756-60.
- 22. Pan XR, Li GW, Hu YH, Wang JX, Yang WY, An ZX, et al. Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance. The Da Qing IGT and Diabetes Study. Diabetes Care. 1997;20:537-44.
- 23. Tuomilehto J, Lindstrom J, Eriksson JG, Valle TT, Hamalainen H, Ilanne-Parikka P, et al. Prevention of

- type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med. 2001;344:1343-50.
- Diabetes Prevention Program Research Group. The Diabetes Prevention Program (DPP): description of lifestyle intervention. Diabetes Care. 2002;25:2165-71.
- 25. Ramachandran A, Snehalatha C, Mary S, Mukesh B, Bhaskar AD, Vijay V, et al. The Indian Diabetes Prevention Programme shows that lifestyle modification and metformin prevent type 2 diabetes in Asian Indian subjects with impaired glucose tolerance (IDPP-1). Diabetologia. 2006;49:289-97.
- Rawal LB, Tapp RJ, Williams ED, Chan C, Yasin S, Oldenburg B. Prevention of type 2 diabetes and its complications in developing countries:a review. Int J Behav Med. 2012;19:121-33.
- Bo S, Ciccone G, Baldi C, Benini L, Dusio F, Forastiere G, et al. Effectiveness of a lifestyle intervention on metabolic syndrome. A randomized controlled trial. J Gen Intern Med. 2007;22:1695-703.
- 28. Hussain A, Claussen B, Ramachandran A, Williams R. Prevention of type 2 diabetes: a review. Diabetes Res Clin Pract. 2007;76:317-26.

Cite this article as: Elahi AN, Almarghalani F, Al-Ramadhan H, Jalal AH, Alnafisah H, Miyajan A, et al. Prevention of diabetes type 2 by adjustment of lifestyle and diet. Int J Community Med Public Health 2018;5:3697-702.