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Role of diet on type 2 diabetes mellitus

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Abstract
Globally, type 2 diabetes mellitus (T2DM) is considered as one of the most common diseases. The etiology of T2DM is complex and is associated with irreversible risk factors such as age, genetic, race, and ethnicity and reversible factors such as diet, physical activity and smoking. The objectives of this review are to examine various studies to explore relationship of T2DM with different dietary habits/patterns and practices and its complications. Dietary habits and sedentary lifestyle are the major factors for rapidly rising incidence of DM among developing countries. In type 2 diabetics, recently, elevated HbA1c level has also been considered as one of the leading risk factors for developing microvascular and macrovascular complications. Lifestyle and medical nutrition therapy are considered the keystones of type 2 diabetes prevention and treatment, but there is no definite consensus on how to treat this disease with these therapies. The American Diabetes Association has made several recommendations regarding the medical nutrition therapy of diabetes; these emphasize the importance of minimizing macrovascular and microvascular complications in people with diabetes. Four types of diets were reviewed for their effects on diabetes: the Mediterranean diet, a low-carbohydrate/high-protein diet, a vegan diet and a vegetarian diet. Each of the four types of diet has been shown to improve metabolic conditions, but the degree of improvement varies from patient to patient. Therefore, it is necessary to evaluate a patient's pathophysiological characteristics in order to determine the diet that will achieve metabolic improvement in each individual. Many dietary regimens are available for patients with type 2 diabetes to choose from, according to personal taste and cultural tradition. It is important to provide a tailor-made diet wherever possible in order to maximize the efficacy of the diet on reducing diabetes symptoms and to encourage patient adherence. Additional randomized studies, both short term (to analyse physiological responses) and long term, could help reduce the multitude of diets currently recommended and focus on a shorter list of useful regimens.

Keywords: diabetes complication; diets; type 2 diabetes

Introduction
Diabetes mellitus (DM) was first recognized as a disease around 3000 years ago by the ancient Egyptians and Indians, illustrating some clinical features very similar to what we now know as diabetes. DM is a combination of two words, “diabetes” Greek word derivative, means siphon - to pass through and the Latin word “mellitus” means honeyed or sweet. In 1776, excess sugar in blood and urine was first confirmed in Great Britain. With the passage of time, a widespread knowledge of diabetes along with detailed etiology and pathogenesis has been achieved. DM is defined as “a metabolic disorder characterized by hyperglycaemia resulting from either the deficiency in insulin secretion or the action of insulin.” The poorly controlled DM can lead to damage various organs, especially the eyes, kidney, nerves, and cardiovascular system.4 DM can be of three major types, based on etiology and clinical features. These are DM type 1 (T1DM), DM type 2 (T2DM), and gestational DM (GDM). In T1DM, there is absolute insulin deficiency due to the destruction of β cells in the pancreas by a cellular mediated autoimmune process. In T2DM, there is insulin resistance and relative insulin deficiency. GDM is any degree of glucose intolerance that is recognized during pregnancy. DM can arise from other diseases or due to drugs such as genetic syndromes, surgery, malnutrition, infections, and corticosteroids intake. T2DM factors which can be irreversible such as age, genetic, race, and ethnicity or revisable such as diet, physical activity and smoking.

Epidemiology
Globally, T2DM is at present one of the most common diseases and its levels are progressively on the rise. It has been evaluated that around 366 million people worldwide or 8.3% in the age group of 20-79 years had T2DM in 2011. This figure is expected to rise to 552 million (9.9%) by 2030. This disease is associated with severe complications which affect patient’s health, productivity, and quality of life. More than 50% of people with diabetes die of cardiovascular disease (CVD) (primarily heart disease and stroke) and is a sole cause of end stage renal disease which requires either dialysis or kidney transplantation. It is also a major cause of blindness due to retinal damage in adult age group referred to as diabetic retinopathy (DR). People with T2DM have an increased risk of lower limb amputation that may be 25 times greater than those without the disease. This disease caused around 4.6 million deaths in the age-group of 20-79 years in 2011.

Physical Activity and Lifestyle
A large number of cross-sectional as well as prospective and

retrospective studies have found significant association between physical inactivity and T2DM. A prospective study was carried out among more than thousand nondiabetic individuals from the high-risk population of Pima Indians (North American Indian). During an average follow-up period of 6-year, it was found that the diabetes incidence rate remained higher in less active men and women from all BMI groups. The existing evidence suggests a number of possible biological pathways for the protective effect of physical activity on the development of T2DM. First, it has been suggested that physical activity increases sensitivity to insulin. In a comprehensive report published by Health and Human Services, USA, 2015 reported that physical activity enormously improved abnormal glucose tolerance when caused by insulin resistance primarily than when it was caused by deficient amounts of circulating insulin. Second, physical activity is likely to be most beneficial in preventing the progression of T2DM during the initial stages, before insulin therapy is required. The protective mechanism of physical activity appears to have a synergistic effect with insulin. During a single prolonged session of physical activity, contracting skeletal muscle enhances glucose uptake into the cells. This effect increases blood flow in the muscle and enhances glucose transport into the muscle cell. Third, physical activity has also been found to reduce intra-abdominal fat, which is a known risk factor for insulin resistance. In certain other studies, physical activity has been inversely associated with intra-abdominal fat distribution and can reduce body fat stores. Lifestyle and environmental factors are reported to be the main causes of extreme increase in the incidence of T2DM.

Patient's Knowledge Regarding DM

Among the patients, diabetes awareness and management are still the major challenges faced by stakeholders worldwide. Poor knowledge related to diabetes is reported in many studies from the developing countries. Some studies have suggested that the occurrence of diabetes is different in various ethnic groups. Knowledge is a requirement to achieve better compliance with medical therapy. According to a study conducted by Mohammadi patient's knowledge and self-care management regarding DM was not sufficient. Low awareness of DM affects the outcome of diabetes. Another study conducted in Slovakia by Magurová compared two groups of patients (those who received diabetes education and those who did not). The results indicated that receiving diabetes education significantly increased awareness about the disease in patients ($p < 0.001$). The study further concluded that having diabetes knowledge can notably improve patient's quality of life and lessen the burden on their family. Dussa conducted a cross-sectional study on assessment of diabetes awareness in India. The study concluded that level of diabetes awareness among patients and general population was low. Another study conducted in India by Shah reported that 63% of T2DM patients did not know what DM is and the majority were also unaware about its complications.

According to the study conducted by Bani in Saudi Arabia, majority of the patients 97.3% males and 93.1% females were unaware about the importance of monitoring diabetes, with no significant gender difference. Diabetes knowledge, attitude, and practice were also studied in Qatari type 2 diabetics. The patients' knowledge regarding diabetes was very poor, and their knowledge regarding the effect of diabetes on feet was also not appreciable. Results from a study conducted in Najran, Saudi Arabia reported that almost half of the patients did not have adequate knowledge regarding diabetes disease. Males in this study had more knowledge regarding diabetes than female patients. Diabetes knowledge among self-reported diabetic female teachers was studied in Al-Khobar, Saudi Arabia. The study concluded that diabetes knowledge among diabetic female teachers was very poor. It was further suggested that awareness and education about diabetes should be urgently given to sample patients. The knowledge of diabetes provides the information about eating attitude, workout, weight monitoring, blood glucose levels, and use of medication, eye care, foot care, and control of diabetes complications.

Relation Between Diet and Type 2 DM

The role of diet in the etiology of T2DM was proposed by Indians as mentioned earlier, who observed that the disease was almost confined to rich people who consumed oil, flour, and sugar in excessive amounts. During the First and Second World Wars, declines in the diabetes mortality rates were documented due to food shortage and famines in the involved countries such as Germany and other European countries. In Berlin, diabetes mortality rate declined from 23.1/100,000 in 1914 to 10.9 in 1919. In contrast, there was no change in diabetes mortality rate in other countries with no shortage of food at the same time period such as Japan and North American countries. Whereas few studies have found strong association of T2DM with high intake of carbohydrates and fats. Many studies have reported a positive association between high intake of sugars and development of T2DM. In a study, Ludwig investigated more than 500 ethnically diverse schoolchildren for 19 months. It was found that for each additional serving of carbonated drinks consumed, frequency of obesity increased, after adjusting for different parameters such as dietary, demographic, anthropometric, and lifestyle.

A study was conducted which included the diabetic patients with differing degrees of glycaemic control. There were no differences in the mean daily plasma glucose levels or diurnal glucose profiles. As with carbohydrates, the association between dietary fats and T2DM was also inconsistent. Many of prospective studies have found relations between fat intake and subsequent risk of developing T2DM. In a diabetes study, conducted at San Louis Valley, a more than thousand subjects without a prior diagnosis of diabetes were prospectively investigated for 4 years. In that study, the researchers found an association between fat intake, T2DM and impaired glucose tolerance. Another study observed the relationship of the various diet components among two groups of women, including fat, fibre plus sucrose, and the risk of T2DM. After adjustment, no associations were found between intakes of fat, sucrose, carbohydrate or fibre and risk of diabetes in both groups.

Recently, evidence suggested a link between the intake of soft drinks with obesity and diabetes, resulting from large amounts of high fructose corn syrup used in the manufacturing of soft drinks, which raises blood glucose levels and BMI to the dangerous levels. It was also stated by Assy that diet soft drinks contain glycated chemicals that markedly augment insulin resistance. Food intake has been strongly linked with obesity, not only related to the volume

of food but also in terms of the composition and quality of diet. High intake of red meat, sweets and fried foods, contribute to the increased the risk of insulin resistance and T2DM. In contrast, an inverse correlation was observed between intake of vegetables and T2DM. Consumption of fruits and vegetables may protect the development of T2DM, as they are rich in nutrients, fibre and antioxidants which are considered as protective barrier against the diseases. Recently, in Japanese women, a report revealed that elevated intake of white rice was associated with an increased risk of T2DM. This demands an urgent need for changing lifestyle among general population and further increase the awareness of healthy diet patterns in all groups.

Dietary Knowledge of Type 2 Diabetics

American Diabetes Association has defined self-dietary management as the key step in providing the diabetics, the knowledge and skill in relation with treatment, nutritional aspects, medications and complications. A study showed that the dietary knowledge of the targeted group who were at high risk of developing T2DM was poor. Red meat and fried food were consumed more by males as compared to females. The percent of males to females in daily rice consumption was significantly high.

In recent times in Saudi Arabia, food choices, size of portions and sedentary lifestyle have increased dramatically that resulted in high risk of obesity. Unfortunately, many Saudis are becoming more obese because of the convenience of fast foods, and this adds to the scary diabetes statistics. On the other hand, Saudis drink too many high-sugar drinks. In addition, Backman reported dietary knowledge to be a significant factor that influences dietary behaviours. In another study conducted by Savoca and Miller stated that patients' food selection and dietary behaviours may be influenced by the strong knowledge about diabetic diet recommendations. Significant positive relationship was observed between knowledge regarding diabetic diet and the amount of calorie needs ($r = 0.27$, $p < 0.05$). The study concluded that knowledge regarding diabetic diet is essential and is needed to achieve better dietary behaviours. Results of study conducted in Saudi Arabia reported that more than half of the diabetic patients denied modifying their dietary pattern, reduction in weight and perform exercise.

National Centre for Health Statistics reported that socioeconomic status plays an important role in the development of T2DM; where it was known as a disease of the rich. On the contrary, the same reference reported that T2DM was more prevalent in lower income level and in those with less education. The differences may be due to the type of food consumed. Nutritionists advised that nutrition is very important in managing diabetes, not only type but also quantity of food which influences blood sugar. Meals should be consumed at regular times with low fat and high fibre contents including a limited amount of carbohydrates. It was observed that daily consumption of protein, fat and energy intake by Saudi residents were higher than what is recommended by the International Nutritional Organization.

Dietary Practices of Type 2 Diabetics

Diabetic's dietary practices are mainly influenced by cultural backgrounds. Concerning each of the dimensions of dietary practices, there were significant positive relationships between knowledge regarding diabetic diet and dietary practices. Knowledge was a salient factor related to dietary behaviours control. Moreover, patients' knowledge on a recommended diet indicates their understanding of dietary guidelines which influenced their food selection and eating patterns. The association between dietary knowledge and dietary practices among T2DM patients in the previous studies were inconsistent. Another study revealed that there was no relationship between dietary knowledge and compliance of dietary practices. On the other hand, the same study found that a high dietary knowledge score was associated with following dietary recommendations and knowledgeable patients performed self-management activities in a better way. Dietary knowledge significantly influences dietary practices. In Indonesia, a study was conducted to measure dietary practices among diabetic patients, which elaborated that the Indonesian people, preferred to consume high-fat foods which lead to an increased risk of CVD. The trend of skipping breakfast has dramatically increased over the past 10 years in children, adolescents, and adults. There is increasing evidence that skipping breakfast is related with overweight and other health issues. In addition, frequent eating or snacking may also increase the body weight and risk of metabolic diseases. Rimm demarcated western and prudent dietary patterns. The prudent dietary pattern was characterized by increased consumption of fish, poultry, various vegetables and fruits whereas; the western dietary pattern was characterized by an increased consumption of processed and red meat, chips, dairy products, refined grains, and sweets and desserts. These patterns were previously associated with T2DM risk. The glycaemic index is an indicator of the postprandial blood glucose response to food per gram of carbohydrate compared with a reference food such as white bread or glucose. Hence, the glycaemic load represents both the quality and quantity of the carbohydrates consumed. Another study conducted in Lebanon demonstrated direct correlation of the refined grains and desserts and fast food patterns with T2DM, however, in the same study an inverse correlation was observed between the traditional food pattern and T2DM among Lebanese adults.

Type 2 Dibetes Complications

DM is the fourth among the leading causes of global deaths due to complications. Annually, more than three million people die because of diabetes or its complications. Worldwide, this disease weighs down on health systems and also on patients and their families who have to face too much financial, social and emotional strains. Diabetic patients have an increased risk of developing complications such as stroke, myocardial infarction, and coronary artery disease. However, complications such as retinopathy, nephropathy, and neuropathy can have a distressing impact on patient's quality of life and a significant increase in financial burden. The prevalence reported from studies conducted worldwide on the complications of T2DM showed varying rates. The prevalence of cataracts was 26-62%, retinopathy 17-50%, blindness 3%, nephropathy 17-28%, cardiovascular complications 10-22.5%, stroke 6-12%, neuropathy 19-42%, and foot problems 5-23%. Mortality from all causes was reported between 14% and 40%. In a study, researchers found that 15.8% incidence of DR is in the developing countries. The prevalence of DR reported from Saudi Arabia, Sri Lanka, and Brazil was 30%, 31.3%, and 35.4%, respectively; while in Kashmir it was 27% and

in South Africa it was 40%. The prevalence of DR 26.1% was observed among 3000 diabetic patients from Pakistan; it was significantly higher than that what was reported in India (18%) and in Malaysia (14.9%). Studies conducted on diabetes complications in Saudi Arabia are very few and restricted. A 1992 study from Saudi Arabia showed that in T2DM patients; occurrence rate of cataract was 42.7%, neuropathy in 35.9% patients, retinopathy in 31.5% patients, hypertension in 25% patients, nephropathy in 17.8% patients, ischemic heart disease in 41.3% patients, stroke in 9.4% patients, and foot infections in 10.4% of the patients. However, this study reported complications for both types of diabetes.

Relation between Dietary Practices and Diabetes Complications

Interventional studies showed that high carbohydrate and high monounsaturated fat diets improve insulin sensitivity, whereas glucose disposal dietary measures comprise the first line intervention for control of dyslipidaemia in diabetic patients. Several dietary interventional studies recommended nutrition therapy and lifestyle changes as the initial treatment for dyslipidaemia. Metabolic control can be considered as the cornerstone in diabetes management and its complications. Acquiring HbA1c target minimizes the risk for developing microvascular complications and may also protect CVD, particularly in newly diagnosed patients. Carbohydrate intake has a direct effect on postprandial glucose levels in people with diabetes and is the principal macronutrient of worry in glycaemic management. In addition, an individual's food choices and energy balance have an effect on body weight, blood pressure, and lipid levels directly. Through the mutual efforts, health-care professionals can help their patients in achieving health goals by individualizing their nutrition interventions and continuing the support for changes. A study suggested that intake of virgin olive oil diet in the Mediterranean area has a beneficial effect on the reduction of progression of T2DM retinopathy. Dietary habits are essential elements of individual cardiovascular and metabolic risk. Numerous health benefits have been observed to the Mediterranean diet over the last decades, which contains abundant intake of fruit and vegetables. The beneficial effects of using fish and olive oil have been reported to be associated with improved glucose metabolism and decreased risk of T2DM, obesity and CVD.

Conclusions

The review of various studies suggests that T2DM patients require reinforcement of DM education including dietary management through stakeholders (health-care providers, health facilities, etc.) to encourage them to understand the disease management better, for more appropriate self-care and better quality of life. The overall purpose of treating T2DM is to help the patients from developing early end-organ complications which can be achieved through proper dietary management. The success of dietary management requires that the health professionals should have an orientation about the cultural beliefs, thoughts, family, and communal networks of the patients. As diabetes is a disease which continues for the lifetime, proper therapy methods with special emphasis on diet should be given by the healthcare providers in a way to control the disease, reduce the symptoms and prevent the appearance of the complications. The patients should also have good knowledge about the disease and diet, for this purpose, the health-care providers must inform the patients to make changes in their nutritional habits and food preparations. Active and effective dietary education may prevent the onset of diabetes and its complications.

References

1. Frank LL. Diabetes mellitus in the texts of old Hindu medicine (Charaka, Susruta, Vagbhata) Am J Gastroenterol,1957:27:76-95.
2. Ahmed AM. History of diabetes mellitus. Saudi Med J,2002:23:373-8.
3. Reece EA, Homko CJ. Diabetes mellitus in pregnancy. What are the best treatment options? Drug Saf,1998:18:209-20.
4. Alberti K, Davidson MB, DeFronzo RA, Drash A, Genuth S, Harris MI *et al*. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care,1998:21:S5.
5. Narayan KV, Zhang P, Kanaya AM, Williams DE, Engelgau MM, Imperatore G *et al*. Diabetes: The Pandemic and Potential Solutions. Washington, DC: World Bank, 2006.
6. Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB *et al*. Diabetes: The Pandemic and P 1. Frank LL. Diabetes mellitus in the texts of old Hindu medicine (Charaka, Susruta, Vagbhata) Am J Gastroenterol,1957:27:76-95.
7. 2. Ahmed AM. History of diabetes mellitus. Saudi Med J,2002:23:373-8.
8. Reece EA, Homko CJ. Diabetes mellitus in pregnancy. What are the best treatment options? Drug Saf,1998:18:209-20.
9. Alberti K, Davidson MB, DeFronzo RA, Drash A, Genuth S, Harris MI *et al*. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care,1998:21:S5.
10. Narayan KV, Zhang P, Kanaya AM, Williams DE, Engelgau MM, Imperatore G *et al*. Diabetes: The Pandemic and Potential Solutions. Washington, DC: World Bank, 2006.
11. Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB *et al*. Diabetes: The Pandemic and Potential Solutions. Washington, DC: World Bank, 2006.
12. Whiting DR, Guariguata L, Weil C, Shaw J. IDF diabetes atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract,2011:94:311–21.
13. Organization WH. Obesity: Preventing and Managing the Global Epidemic. Geneva, Switzerland: World Health Organization, 2000.
14. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res Clin Pract,2010:87:4-14.
15. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care,2004:27:1047-53.
16. Rizkalla SW. Glycaemic index: Is it a predictor of metabolic and vascular disorders? Curr Opin Clin Nutr Metab Care,2014:17:373-8.
17. Weinstein MC, Toy EL, Sandberg EA, Neumann PJ, Evans JS, Kuntz KM *et al*. Modeling for health care

and other policy decisions: Uses, roles, and validity. Value Health,2001:4:348-61.
18. Davies R, Roderick P, Raftery J. The evaluation of disease prevention and treatment using simulation models. Eur J Oper Res,2003:150:53-66.
19. Charokopou M, Sabater F, Townsend R, Roudaut M, McEwan P, Verheggen B. Methods applied in cost-effectiveness models for treatment strategies in Type 2 diabetes mellitus and their use in health technology assessments: A systematic review of the literature from 2008 to 2013. Curr Med Res Opin,2015:32:1-12.
20. Tucker DM, Palmer AJ. The cost-effectiveness of interventions in diabetes: A review of published economic evaluations in the UK setting, with an eye on the future. Prim Care Diabetes,2011:5:9-17.
21. Cole G, Leonard B, Hammond S, Fridinger F. Using stages of behavioral change constructs to measure the short-term effects of a worksite-based intervention to increase moderate physical activity. Psychol Rep,1998:82:615-8.
22. Danaei G, Finucane MM, Lu Y, Singh GM, Cowan MJ, Paciorek CJ *et al*. National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: Systematic analysis of health examination surveys and epidemiological studies with 370 country-years and 2·7 million participants. Lancet,2011:378:31-40.
23. Bassuk SS, Manson JE. Epidemiological evidence for the role of physical activity in reducing risk of Type 2 diabetes and cardiovascular disease. J Appl Physiol,2005:99:1193-204.
24. Jakicic JM, Otto AD. Physical activity considerations for the treatment and prevention of obesity. Am J Clin Nutr,2005:82(1 Suppl):226S-9.
25. Kriska AM, Saremi A, Hanson RL, Bennett PH, Kobes S, Williams DE *et al*. Physical activity, obesity, and the incidence of Type 2 diabetes in a high-risk population. Am J Epidemiol,2003:158:669-75.
26. Mohammadi S, Karim NA, Talib RA, Amani R. Knowledge, attitude and practices on diabetes among Type 2 diabetic patients in Iran: A cross-sectional study. Science,2015:3:520-4.
27. Magurová D, Majerníková Ľ, Hloch S, Tozan H, Goztepe K. Knowledge of diabetes in patients with Type 2 diabetes on insulin therapy from Eastern Slovakia. Diabetol Croat,2012:41:95-102.
28. Parimalakrishnan S, Dussa K, Sahay R. Assessment of diabetes knowledge using diabetes knowledge questionnaire among people with Type 2 diabetes mellitus. Asian J Pharm Clin Res,2015:8(2):254-6.
29. Shah VN, Kamdar PK, Shah N. Assessing the knowledge, attitudes and practice of Type 2 diabetes among patients of Saurashtra region, Gujarat. Int J Diabetes Dev Ctries,2009:29:118-22.
30. Bani IA. Prevalence, knowledge, attitude and practices of diabetes mellitus among Jazan population, Kingdom of Saudi Arabia (KSA) Int J Diabetes Mellitus,2015:5:115.
31. Kheir N, Greer W, Yousif A, Al Geed H, Al Okkah R. Knowledge, attitude and practices of Qatari patients with Type 2 diabetes mellitus. Int J Pharm Pract,2011:19:185-91.
32. Khan LA, Khan SA. Level of knowledge and self-care in diabetics in a community hospital in Najran. Ann Saudi Med,2000:20:300-1.