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Type 2 diabetes mellitus: Link between diet, HbA1c and complications

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REVIEW

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ABSTRACT

Background
Diabetes mellitus is now globally considered as a leading cause of morbidity and mortality. It is associated with high rates of microvascular and macrovascular complications. Regular consumption of high caloric food, poor dietary habits and adoption of sedentary life style has been linked with the development of type 2 diabetes mellitus.

Aims
The purpose of this review is; to highlight the influence of diet on HbA1c in type 2 diabetics, to explore association between HbA1c and diabetes complications and to propose a dietary consultation model for more effective diabetes care.

Methods
The literature was reviewed intensively from January – March 2016 through PubMed central, Medscape, Google Scholar and other databases. The keywords and MeSH terms used in this search were “diabetes mellitus”, “glycated haemoglobin”, “type 2 diabetes mellitus”, “diet and type 2 diabetes mellitus” and “diabetes complications”.

Results
Dietary management is a superior option for glycaemic control in type 2 diabetes mellitus. It is important to keep the HbA1c level in acceptable range to delay the onset and progression of diabetes complications. In this review, various food groups that can have beneficial and adverse effects on HbA1c have been identified. Moreover, Diabetic Retinopathy (DR) stood out as the most prevalent complication of poorly managed diabetes mellitus in Saudi Arabia.

Conclusion
The dimensions of the proposed dietary consultation model are based on the assessment of diabetics’ diabetes mellitus knowledge, dietary knowledge, dietary attitude and dietary practices. This assessment if carried out at the initial stage of Diabetes mellitus can be helpful in delaying the early onset and progression of microvascular and macrovascular diabetes complications.

Key Words
Glycaemic control, diabetes complications, diet, type 2 diabetes mellitus

What this review adds:

Dietary management is considered as a corner stone in the management of type 2 diabetes mellitus. Therefore, in this review, link between diet, HbA1c and diabetic complications have been presented. The review concludes by proposing a dietary consultation model for more effective diabetes care. The consultation model if used at an initial stage of Diabetes mellitus can be useful in delaying the early onset and progression of diabetes complications

1. What is known about this subject?

Globally, Diabetes mellitus is one of the leading causes of morbidity and mortality and is associated with high rates of vascular complications.

2. What new information is offered in this review?

A relatively new dietary consultation model has been proposed in this review for more effective diabetes care.

3. What are the implications for research, policy, or practice?

Improvement in management of type 2 diabetes can be achieved if special emphasis is given on diabetics', diabetes mellitus & dietary knowledge, dietary attitude and dietary practices.

Introduction

Globally, Diabetes mellitus (DM) is now considered as a leading cause of morbidity and mortality. Diabetes mellitus is associated with high rates of microvascular and macrovascular complications. Throughout the world, Diabetes mellitus is rated as one of the most common non-communicable diseases.[1] In the last few decades, especially in the developing world, diabetes is the fourth leading cause of deaths.[2] Currently, worldwide Diabetes mellitus has affected approximately 240 million people and by 2025 this number is expected to reach 380 million.[3] Increase in the incidence of Diabetes mellitus at this pace is creating an alarming situation that can have serious long term consequences and presents as a challenge for healthcare stakeholders. Six Arab speaking countries namely; Saudi Arabia, Kuwait, Qatar, Lebanon, Bahrain and United Arab Emirates are among the world's top countries with the highest prevalence of type 2 Diabetes mellitus (T2DM) affecting 32.8 million people in 2011, which is expected to increase to 60 million by 2030. Diabetes affects almost every organ of the body and causes serious complications like stroke, heart attack, kidney disease, gangrene, blindness and renal failure.[4] Many risk factors have been associated with diabetes and its complications such as diet, sedentary life-style, age, obesity and genetic profile of a person.[5–7] Moreover, ill effects of intensive therapy on microvascular complications of diabetes is suggestive of choosing some way to control hyperglycaemia by moderate treatment with both diet and medication.[8]

The principal step in the management of Diabetes mellitus is to train the patients in self-management care to prevent the early onset of diabetes complications. Dietary management is considered as a corner stone in the management of type 2 Diabetes mellitus; therefore, in this review, we have tried to highlight the impact of diet on HbA1c in type 2 diabetics, including association between HbA1c and diabetes complications, and conclude by proposing a dietary consultation model for more effective diabetes care.

Impact of carbohydrate intake on HbA1c

A randomized controlled trial carried out by Foster[9] stated that diabetics consuming a low carbohydrate diet had a significant weight loss as compared to diabetics who were on a conventional diet. A study conducted in women reported that carbohydrates like rice and barley had harmful effects on HbA1c.[10] Another study conducted on type 2 Diabetes mellitus patients revealed that low carbohydrate and low fat hypo-caloric diets led to an improvement in HbA1c level.[11] Shadman[12] suggested that type 2 diabetics on low carbohydrate & low saturated fat diet had better glycaemic control. Hajime[13] reported that restricting carbohydrate diet to 45 per cent led to a greater reduction in HbA1c as compared to diets high in carbohydrates. Study conducted by Arora[14] concluded that during 5 weeks dietary intervention HbA1c decreased significantly on limiting the carbohydrates consumption between 40–55 per cent.

Impact of protein (meat & fish) intake on HbA1c

A systematic review of 12 cohort studies stated that consuming red meat more than three times a week significantly increases the risk of type 2 Diabetes mellitus.[15] A longitudinal study conducted in men by Van Dam[16] reported that increased consumption of processed meat was related with a higher risk for type 2 Diabetes mellitus (relative risk=1.46, for more than five times a week vs. less than once per month, $p<0.0001$). Gross[17] suggested that limiting the amount of red meat as compared to chicken had a significant effect on HbA1c, fasting blood glucose (FBG), low density lipoprotein – cholesterol (LDL-C), and high density lipoprotein – cholesterol (HDL-C). In women with, type 2 Diabetes mellitus, frequent intake of red meat as compared to chicken was related with high risk of coronary heart disease (CHD) ($p<0.001$).[18] From previous studies, it has been reported that the eating of fish, especially long chain omega 3 fatty acids have several beneficial metabolic effects in diabetics. Wallin[19] concluded from his study conducted on type 2 Diabetes mellitus patients that consuming fish had positive effects on their glycaemic control, glucose tolerance and microalbuminuria. Another study conducted on type 2 Diabetes mellitus patients reported that regular consumption of fish improved HbA1c level.[20]

Impact of fatty acids on HbA1c

In comparison to dietary macronutrients distribution recommendation, intake of carbohydrates, total and saturated fat was found to be high in Saudi Arabia and other Gulf Cooperation Council (GCC) countries.[21] This composition of the diet was also compared to an Iranian study that showed Iranian patients had high calorie intake and also consumed foods high in fat. Otherwise stated, increase in calorie intake was associated with the intake of foods high in fat (butter, margarine, cheese etc.) and greasy foods (polyunsaturated fatty acids).[22] Many studies have documented a valuable effect of high monounsaturated fatty acids (MUFA) diets in prevention and management of Diabetes mellitus.[23–25] A meta-analysis compared the effect of high MUFA versus low MUFA diet (less than 12 per cent vs. more than 12 per cent) on HbA1c level in participants with elevated glucose reported that a high MUFA diet was more effective in reducing HbA1c level as compared to a low MUFA diet.[26]

Improved HbA1c through high fibre intake

Various studies have reported that high intake of fibre has a positive effect on HbA1c. Fujii[27] conducted a study in Japanese type 2 diabetics stated that diabetics should be encouraged to consume diets high in fibre on a daily basis because of their beneficial effect on HbA1c and it also lowers the risk of CHD. Another study conducted by Chandalia[28] in type 2 diabetics concluded that consumption of soluble dietary fibre, as recommended by the American Diabetes Association (ADA), improves glycaemic control, and decreases hyperinsulinemia. Mcintosh[29] conducted a study in a group of type 2 diabetic patients and reported that decline in HbA1c values and lipid profile was observed in patients on a high fibre diet. Patients on high fibre diets also had a significantly lower risk of cardiovascular diseases (CVD), microvascular and macrovascular complication of Diabetes mellitus. Allick[30] stated in his study conducted on type 2 diabetic patients that a high fibre diet was associated with low concentrations of HbA1c as compared to low and saturated fat diet.

Impact of polyunsaturated fats intake on HbA1c and type 2 Diabetes mellitus

Various studies conducted on type 2 diabetics have reported association between nuts consumption and their beneficial effect on HbA1c. Nuts improve insulin homeostasis and serum glucose concentration; they are well known to be rich in unsaturated oils. A study conducted by Jiang[31] in type 2 diabetics stated that increased intake of nuts and peanut butter had numerous positive effects on glycaemic control. The study further concluded that nuts consumption was significantly associated with lower risk of CHD. The findings of a cohort study reported that participants who consumed nuts more than four times per week or more had 26 per cent less chances of developing diabetes as compared to those who rarely or never consumed nuts.[32] A systematic review and meta-analysis was conducted by Viguiliouk[33] to study the effect of tree nuts on glycaemic control of type 2 diabetics. Pooled analysis results revealed that consuming nuts had significantly improved HbA1c level of type 2 diabetics. According to another study, an increased intake of polyunsaturated fats was associated with a lower risk of type 2 Diabetes mellitus.[34]

Impact of dairy products on HbA1c

Studies have reported that intake of dairy products leads to positive effects on weight, glycemic control and CVD.[35,36] However, there is a scarcity of literature relating frequency of dairy intake and control of diabetes. A study conducted by Mizoue[37] found that low fat dairy products had beneficial effect on glycemic control. Calcium and Vitamin D deficiency have harmful effect on glycaemia, whereas the combined effect of these supplementations is beneficial in enhancing glucose metabolism.[38] According to Liu[39] men and women who consume low fat dairy products have a lower risk of developing type 2 Diabetes mellitus. A meta-analysis conducted on dairy products and the risk of type 2 diabetes showed that there was a significant inverse relationship between intake of low fat dairy products, and cheese with the risk of type 2 Diabetes mellitus.[40]

Impact of fruits and vegetables on HbA1c

Various studies have reported that consuming fruits and vegetables are helpful in decreasing the risk of Diabetes mellitus. Moreover in type 2 Diabetes mellitus, fruits and vegetables are also beneficial in maintaining good glycaemic control.[41–43] Study conducted by Franz[44] reported that increased intake of vegetables and fruits significantly decreased HbA1c level. However, the same study also reported that vegetable intake significantly decreased Triglyceride (TG) levels (p<0.001). A systematic review and meta-analysis conducted by Carter[45] concluded that consuming vegetables and fruits in an increased amount had a significant effect on body mass index (BMI), TG and HbA1c. In Japan, for the treatment of Diabetes mellitus, it was recommended that consuming at least 300g of vegetables daily can lead to significant decrease in HbA1c levels.[46] A study done by Hamer[47] on diabetic patients reported a significant effect of a semi-vegetarian and full vegetarian diet on glycaemic control. Patients on a semi-vegetarian diet had lower fasting plasma glucose levels; whereas, patients on a full vegetarian diet had significant lower HbA1c levels. More studies that

investigated the association between vegetables and fruits intake and Diabetes mellitus concluded that the onset of diabetes can be prevented by increasing the intake of vegetables and fruits.[48,49]

Impact of legumes on HbA1c

Low glycemic index (LGI) foods (beans, lentils and chickpeas) have been shown to improve glycemic control in patients with type 2 Diabetes mellitus. Legumes have also been included in the International Diabetes Guidelines, 2013. Legumes comprise of various nutrients including dietary fiber, oligosaccharides, vegetable protein, complex carbohydrates and minerals. A randomized controlled trial reported that incorporation of legumes in the diet of type 2 diabetics had a significant beneficial effect on HbA1c.[50] Shoff[51] stated that foods with LGI such as legumes are beneficial for diabetic patients. Another study by Wolever[52] also reported a beneficial effect of a LGI diet on HbA1c in treatment of T2DM.

Impact of drinks on HbA1c and type 2 Diabetes mellitus

Consumption of sweetened beverages (soft drinks, fruit drinks, iced drinks, energy drinks and vitamin water drinks) has risen across the globe. Consuming soft drinks and other sweetened beverages can significantly increase the risk of obesity and type 2 Diabetes mellitus.[53] A prospective study conducted in a Chinese population reported that consuming soft drinks more than two times per day has a relative risk of 1.42 for type 2 Diabetes mellitus.[54] It further concluded that consuming 200 ml of soft drinks had a significant effect on blood sugar levels. The results from meta-analysis based on eight cohort studies revealed that persons who consume soft drinks more than three times per day had 26 per cent more chance to develop type 2 Diabetes mellitus as compared to those who consume soft drinks less than once a day.[55]

A study conducted in Saudi Arabia among type 2 diabetics reported that 75 per cent of the patients had HbA1c above the normal range, and the median consumption of soft drinks was three (range 1–5) times per day.[56] Salazar[57] studied the relation between coffee consumption and risk of type 2 Diabetes mellitus and, the findings revealed that long term coffee consumption significantly lowers the risk of type 2 Diabetes mellitus. Over the past few decades, globally the consumption of energy drinks (red bull, power horse etc.) has increased dramatically. Several studies have reported adverse effect of energy drinks on health especially in adolescents. Moreover, it increases the risk of obesity, type 2 Diabetes mellitus and has a direct effect on blood sugar levels.[58] In Saudi Arabia, consumption of energy drinks is on the rise. Studies conducted in Dammam, Makkah, and Jeddah among university students revealed that more than 50 per cent of the students (males and females) consumed energy drinks more than twice per day.[58-60]

Pathophysiology of HbA1c

Metabolic abnormalities cause overproduction of reactive oxygen species (ROS). In turn, ROS, via endothelial dysfunction and inflammation, plays a major role in precipitating diabetic vascular disease.[61] The alterations in vascular homeostasis due to endothelial and smooth muscle cell dysfunction are the main features of diabetic vasculopathy favouring a pro-inflammatory/thrombotic state which ultimately leads to atherothrombosis. Macro- and microvascular diabetic complications are mainly due to prolonged exposure to hyperglycaemia clustering with other risk factors such as arterial hypertension, dyslipidaemia as well as genetic susceptibility. Interestingly, nephropathy, retinopathy, and diabetic vascular disease are in line with the notion that endothelial, mesangial, and retinal cells are all equipped to handle high sugar levels when compared with other cell types.[62]

Link between diet and HbA1c

HbA1c is an index of average glucose (AG) over the preceding weeks-to-months. Erythrocyte (red blood cell) life-span averages about 120 days. The level of HbA1c at any point in time is contributed to by all circulating erythrocytes, from the oldest (120 days old) to the youngest. However, HbA1c is a “weighted” average of blood glucose levels during the preceding 120 days, meaning that glucose levels in the preceding 30 days contribute substantially more to the level of HbA1c than do glucose levels 90–120 days earlier. There is a very predictable relationship between HbA1c and AG. Understanding this relationship can help patients with diabetes and their health-care providers set day-to-day targets for AG based on HbA1c goals and it is important to remember that HbA1c is a weighted average of glucose levels during the preceding four months. Unless the patient’s glucose levels are very stable month after month, quarterly measurement is needed to insure that a patient’s glycaemic control remains within the target range.[63]

Association between HbA1c and diabetes complications

Good glycaemic control minimizes the risk of developing microvascular and macrovascular diabetes complications and is also helpful in delaying their progression.[64] HbA1c has a very strong association with the onset of diabetes complications, and moreover, the progression of complications can be slowed if HbA1c is well maintained during the early stage of Diabetes mellitus.[65] In patients

with type 2 Diabetes mellitus, the risk of diabetes complications was strongly associated with glycaemic control. Any reduction in HbA1c was likely to reduce the risk of complications.[66]

Diabetic Nephropathy

The incidence of end stage renal disease (ESRD) has increased dramatically in the Western world. However, its progression is still slow in the European countries.[67] The findings of a seven year follow-up study showed that uncontrolled lipid profile, blood pressure and HbA1c significantly predicted the progression of diabetic nephropathy (DN).[68] In type 2 diabetics with nephropathy, HbA1c and microalbuminuria were significantly positively correlated; this correlation showing that diabetic patients were progressing towards ESRD.[69] Keane[70] reported that in type 2 diabetic patients with nephropathy, proteinuria, and a degree of renal failure, serum albumin, and haemoglobin level were independent risk factors to predict renal outcomes. Results of a double blinded randomized controlled trial revealed that elevated blood pressure, total cholesterol and HbA1c predicted an 8.1 fold increased risk for progression towards ESRD. Data from Saudi Arabia regarding the prevalence of diabetic nephropathy is scarce. However, according to a study 30–45 per cent of patients on dialysis were diabetics.[71] One study in Saudi Arabia retrospectively analysed 25 years data (1989–2004) of type 2 diabetic patients to identify the factors affecting the progression of diabetic nephropathy. The study concluded that diabetic nephropathy tends to be progressive among Saudis, with glomerular filtration rate (GFR) deteriorating at a rate of 3.3mL/year and with a doubling of serum creatinine level in 40.3 per cent of patients in 9.9 years.[72]

Cardiovascular Diseases

Various epidemiological studies have shown a relationship between HbA1c and cardiovascular events in patients with type 2 Diabetes mellitus.[73] A study conducted by Stratton[66] stated that after adjustment for other risk factors, an increase of one per cent in the HbA1c was associated with an increase of 18 per cent risk of cardiovascular events, an increase of 12–14 per cent in the risk of death, and an increase of 37 per cent in the risk of retinopathy or renal failure. Mortality from coronary artery disease was significantly more in type 2 diabetics with HbA1c more than eight per cent as compared to those having HbA1c level less than 8 per cent (p<0.001).[74]

A randomized controlled trial evaluated two cardiac treatment strategies and two glycaemic treatment strategies in patients who were receiving uniform glycaemic control and intensive therapy for cardiac risk factors. The trial concluded that there was no significant difference in the rates of death and major cardiovascular events between patients undergoing prompt revascularization and those undergoing medical therapy or between strategies of insulin sensitization and insulin provision.[75]

A study conducted in Saudi Arabia reported that HbA1c is not only a useful biomarker of long-term glycaemic control but also a good predictor of lipid profile. Thus, monitoring of glycaemic control through HbA1c have additional benefits of identifying diabetic patients who are at a greater risk of cardiovascular complications.[76] It was also reported that among Saudis, glucose intolerance is a major risk factor for vascular events, especially cerebrovascular disease and myocardial infarction.

Diabetic Neuropathy

The Diabetes Control and Complications Trial (DCCT) has shown that in diabetic patients, the risk of diabetic painful neuropathy (DPN) and autonomic neuropathy can be reduced with improved blood glucose control. Although data from a small number of trials are much less strong for type 2 diabetic patients, DCCT data and data from epidemiologic studies including studies of type 2 patients strongly suggest that optimal blood glucose control helps to prevent DPN and autonomic neuropathy in both type 1 and type 2 diabetic patients.[77,78] A study done by Tesfaye[79] concluded that age, duration of diabetes and glycaemic control were significantly associated with progression of diabetic neuropathy (DN). The results of a randomized controlled trial revealed that drugs that reduced HbA1c level to 6.5 per cent yielded a 21 per cent relative reduction in DN.[80] In Saudi Arabia, a rapid rise in prevalence of DN was also observed. In 1998 the prevalence of DN was 22.7 per cent and 31.4 per cent in 2010.[81,82] In another study conducted in Saudi Arabia, old age, long duration of type 2 Diabetes mellitus, poor glycaemic control and smoking were risk factors associated with symptomatic diabetic neuropathy (p<0.001, p=0.09, p<0.001, p=0.04, p=0.08) respectively.[83]

Diabetic Retinopathy

A study done by Yun[84] on association between diabetic retinopathy (DR) and HbA1c concluded that DR was significantly more in patients having higher levels of HbA1c (odds ratio: 3.46). Moreover, DR was more prevalent in patients with duration of diabetes less than 10 years. Buscemi[85] stated that hyperglycaemia is associated with the progression of DR. Furthermore, HbA1c is a good indicator of glycaemic control as it can help diabetic individuals in

deterrence of microvascular complications especially DR. According to the study conducted by Hou[86] less than 50 per cent of the participants had heard of HbA1c and 17 per cent had actually understood its true meaning. It shows that knowledge of diabetics regarding Diabetes mellitus is also an important factor to consider. Severity of progression from NPDR to PDR with respect to HbA1c values have been studied by many authors and almost all of the studies were in accord and pointed out that elevated glycaemic control resulted in worsening of DR.[87–89] In addition, a population based study in Chennai conducted in 2008 concluded that type 2 diabetics having HbA1c more than eight per cent gave maximum capitulate to vision-loss-retinopathies.[90] DR is emerging rapidly as one of the commonest causes of blindness. Worldwide, there are 37 million cases of blindness of which DR accounts for 4.8 per cent of the cases.[91] DR is also highly prevalent in Middle East and Asian countries, A DR prevalence of 19 per cent was reported in the United Arab Emirates. In Kuwait it was 23.5 per cent, Oman 13.4 per cent, India 16.6 per cent, Pakistan 14.7 per cent, Egypt 32.8 per cent, Jordan 34.1 per cent and in Malaysia it was 14.3 per cent.[92]

The first study to report the prevalence of DR in Saudi Arabia was conducted in the Asser region and that revealed a prevalence of 11.3 per cent. The study further concluded that the DR was more among patients living in urban areas as compared to their rural counterparts.[93] A study conducted in Al-Madina Al-Munawarah, Saudi Arabia reported a DR prevalence of 31 per cent.[94] Al-Shehri[95] studied the Quality of Life of Saudi diabetics who were affected by diabetic retinopathy, nephropathy, neuropathy and diabetic foot. DR had the highest prevalence (42.5 per cent) as compared to nephropathy (10.8 per cent), neuropathy (28.35 per cent) and diabetic foot (five per cent). Moreover, patients with DR reported worst quality of life as compared to other complications. In another study conducted by Al-Ghamdi[96] in Taif, Saudi Arabia, the reported prevalence of DR was 36.8 per cent of which 17.5 per cent diabetics had sight threatening DR (STDR). Recently, in 2016 a study conducted in Saudi Arabia has found 36.4 per cent DR prevalence among the type 2 diabetics. The ocular complication consisted of early mild non-proliferative diabetic retinopathy (NPDR), moderate NPDR and PDR, the prevalence of which were 13.0 per cent, 5.3 per cent and 1.4 per cent respectively.[97] A report published by Irfan[98] in Arab News reported that Saudi Arabia spends approximately SR 30 billion every year on the treatment of diabetes. If there are no diabetes complications a patient's treatment costs the government SR 5,000 per year. The treatment of one common diabetes complication, diabetic retinopathy, renal failure and cardiovascular diseases costs the government between SAR 98,000–180,000 thousand per year for only one patient.

Discussion

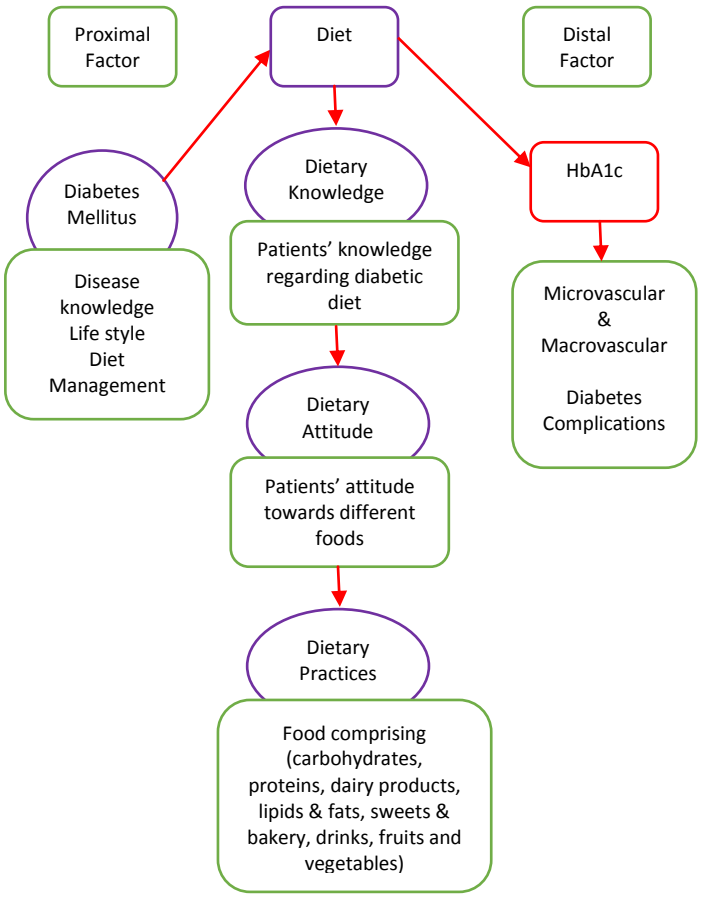
Review of the literature highlights the importance of diet in the management of type 2 Diabetes mellitus. Diet low in carbohydrate is helpful in maintaining good glycaemic control. Use of more polyunsaturated fats should be emphasized instead of saturated fats. Frequent intake of moderate-to-high protein diet is recommended after 35–40 years of age. Consumption of red meat more than three times a week significantly increases the risk of type 2 Diabetes mellitus. Whereas, regular consumption of legumes in all populations is associated with good glycaemic control in diabetics, sweetened beverages significantly raise the HbA1c level. Low fat dairy products and increased intake of fruits and vegetables by diabetics are also beneficial in maintaining good glycaemic control. Mediterranean diet which is mainly based on consumption of virgin olive oil leads to the reduction in progression of type 2 diabetic retinopathy. Elevated HbA1c level has a significant influence on both microvascular and macrovascular diabetes complications. This review also highlights that physicians should encourage diabetics for routine eye evaluations so as to detect early ocular complications that may arise from Diabetes mellitus.. The presence of DR can also predict the presence of other diabetes complications like diabetic nephropathy and CVD. Awareness regarding a healthy diet should be provided through nutrition intervention programme. In addition, nutrition clinics should be setup at primary healthcare level to guide the patients at initial and individual level. Henceforth, to reduce the incidence of type 2 Diabetes mellitus and its chronic complications, it is the need of the hour to pay special emphasis to dietary assessment of type 2 diabetics.

Dietary consultation model for diabetes care

There are various proposed consultation models and frameworks for the management of Diabetes mellitus. There is not much evidence that any one model is better than another; they are all valid and useful in different ways. There is also duplication between them. After all they are models based on the same fundamental activity, but with different emphasis related to their origins.[99] The healthcare providers can select and use a part of any model which they think can help in better management of Diabetes mellitus.[100] The principal step in the management of Diabetes mellitus is to the train the patients in self-management care to prevent them from developing early

microvascular and macrovascular diabetes complications. Dietary management is considered as a corner stone in the management of Diabetes mellitus. Figure (1.1) shows a dietary consultation model for diabetes care that has been proposed in this article. This proposed dietary consultation model is relatively different from the already available diabetes consultation models. Six influential factors, Diabetes mellitus knowledge, dietary knowledge, dietary attitude, dietary practices, HbA1c and diabetes complications have been identified. In other words, to delay the early onset and progression of diabetes complications, the healthcare provider should pay special emphasis to patients "Diabetes mellitus knowledge, dietary knowledge, dietary attitude and dietary practices". There exists a relationship between the identified factors that has been discussed in a separate article by the same authors.

Figure 1: Dietary consultation model for diabetes care



Conclusion

Dietary management is a superior option for glycaemic control in type 2 Diabetes mellitus. It is important to keep the HbA1c level in an acceptable range to delay the onset and progression of diabetes complications. In this review, various food groups that can have beneficial and adverse effects on HbA1c have been identified. Diabetic Retinopathy stood out as the most prevalent complication of poorly managed Diabetes mellitus in Saudi Arabia. The dimensions of the proposed consultation model are based on the assessment of diabetics' Diabetes mellitus knowledge, dietary knowledge, attitude and practices. This assessment if carried out at the initial stage of Diabetes mellitus can be helpful in delaying the early onset and progression of microvascular and macrovascular diabetes complications.

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CONFLICTS OF INTEREST

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