ROLE OF LIFESTYLE MEDICINE IN THE PREVENTION AND CONTROL OF DIABETES MELLITUS AND ASSOCIATED COMORBIDITIES

Girija Kumari*, Vikram Singh, AK Jhinghan

Abstract—Diabetes Mellitus is a chronic lifestyle-related disorder that increases the burden of disease and deteriorates the Health-Related Quality of Life (HRQOL) of diabetes and other co-morbidity patients. This review analysis was conducted to investigate the effects of lifestyle medicine, (yoga practice, plant-based balanced diet, and meditation) in the prevention and control of Diabetes Mellitus and associated Co-morbidities. Research studies related to the effectiveness of lifestyle changes were extracted through the search of PubMed, Scopus, Google scholar, Cochrane Library, mad line, EBSCO, and IndMED databases. Type 2 diabetes mellitus can be prevented using the holistic approach of lifestyle modification and self-management. A healthy diet including the intake of fruits, vegetables, low fat and sugar-containing product along with physical exercises such as daily morning walk, yoga, and meditation play an important role in the prevention and control of lifestyle-related diseases including diabetes, obesity, hypertension, and cardiovascular diseases. Lifestyle changes provide the low-cost, successful and pre-emptive gains upstream of these metabolic disorders, and for that reason, it is a first-line or even parallel intervention in diabetes mellitus and coronary heart disease patients. There is a very urgent need to enhance public awareness regarding the importance of a healthy lifestyle, self-management, balanced diet, yoga, and meditation to improve their quality of life by preventing life-threatening chronic diseases such as coronary artery diseases and diabetes mellitus. Keeping it in view, this study was planned to report the impact of a plant-based balanced diet, yoga, and meditation on diabetes mellitus and associated disorder of cardiovascular.

Keywords: Lifestyle Medicine, Diabetes Mellitus, Hypertension, Cardio Vascular Diseases, Plant-based balanced diet, Yoga and Meditation.

INTRODUCTION

Diabetes mellitus is an expensive, non-communicable, lifestyle-related metabolic disorder and become a major health problem for individuals and healthcare systems. The prevalence of diabetes is rising steeply in developing countries like India and the major cause of mortality and morbidity around the world. At present India is facing an epidemiological change with more globalization, urbanization, and a speedy shift in the economy. As the results of these changes, lifestyle becomes altered, with a westernized dietary pattern such as high-fat, sugar, and calories containing junk foods, reduced physical activities, and stress due to over the burden of work and responsibilities. This change has led to a shift in the health burden of non-communicable diseases, predominantly diabetes, and heart attack [1-3]. The recent report of the International Diabetes Federation (IDF, 2017), estimated the global prevalence of diabetes is about 451 million people suffering from diabetes around the world and this prevalence will be probable to increase to 693 million by 2045. IDF 2017 report that around 72.946.400 diabetic people lives in Canada and the Prevalence of diabetes in 2045. IDF 2017 report that around 72.946.400 diabetic prevalence will be probable to increase to 693 million by 2045. The recent report of the International Diabetes Federation (IDF, 2017), estimated the global prevalence of diabetes is about 451 million people suffering from diabetes around the world and this prevalence will be probable to increase to 693 million by 2045. IDF 2017 report that around 72.946.400 diabetic people lives in India and the Prevalence of diabetes in adults’ population was 8.8%. Due to the increasing prevalence of diabetes, India has become the ‘Diabetic Capital’ of the world and has the second-highest number of diabetes patients after China. [4, 5]. Non-communicable diseases (NCDs) are mostly chronic diseases, which are not transmitted from one person to another person, but they are of a long duration and usually develop slowly. There are mainly four types of non-communicable, chronic diseases; diabetes mellitus, cardiovascular diseases, and chronic respiratory diseases. These non-infectious diseases affect low and middle-income countries, about 82% of deaths caused due to NCD [6]. Diabetes mellitus is mainly characterized by chronic hyperglycemia with the metabolic syndrome of glucose resulting from defects in insulin action [7]. Due to the chronic nature and multi-organ complications of diabetes, increase the frequent visits to the doctor and admission to health services which make a huge economic burden for both individual and national levels [8]. The cost for diabetes treatment per patient with or without complications is about to be Rs. 5000 per annum. Direct costs of diabetes include medical care, doctor consultation fee, hospital services, physician services, drugs, insulin, laboratory test, and the daily management of diabetes, like availability of products such as insulin, syringes, oral hypoglycemic agents and blood testing equipment and other daily lifestyle management services. Patients also have to tolerate other personal costs, such as increased payments for health services, and automobile insurance [9]. Glycemic control is the most important and achievable factor in management and control of diabetes and associated with improvement in the quality of life, health outcomes, reduction in severe life-threatening complications with the reduction in treatment cost [10]. Several studies exposed that Lifestyle modification is a very effective, novel, cost-effective tool in the prevention and control of diabetes and related co-morbidities. Lifestyle changes with special reference to a plant-based balanced diet, yoga asana, and meditation may significantly improve...
diabetes knowledge, HbA1c, blood glucose fasting and pp (glycemic control), quality of life and reduce treatment cost in T2DM patients [11, 12]. The balanced diet is an essential and important step to achieve better glycemic control, blood pressure and lipid profile, body weight, and delay or prevent the risk of diabetes-related complications. Due to the delay in the risk of diabetes-related complications, a plant-based balanced diet may improve metabolic indicators, QoL and cost-saving [13]. Yoga and Meditation are considered efficacious throughout in reducing sympathetic action, lowering cortisol level via modulation of the hypothalamic-pituitary-adrenal pathway, and minimizing negative behavioral activity. Studies have shown that along with decreasing Cardio Vascular fatality, the valuable effects of meditation improve conditions like hypertension, type 2 diabetes mellitus, dyslipidemia, in addition to high cortisol levels. However, future studies on the effects of meditation on coronary heart disease and type 2 diabetes mellitus are important to establish a nonbiased view of this emerging landscape [14]. Hence, this present study has been designed to screen out the role of a plant-based balanced diet, yoga, and meditation on diabetes mellitus and associated co-morbidities.

OVERVIEW OF DIABETES

Diabetes mellitus firstly discovered in an Egyptian manuscript from 1500 BC, after that, Indian physicians described diabetes as honey urine because of ants was attacked by patient’s urine In 400-500 BC, Indian physicians Sushruta and Charaka first classified Diabetes as separate conditions type 1 and 2 and type 1 diabetes with linking youth and type 2 with obesity. In 1600s Thomas Willis has added the term “Mellitus” or “from honey” because the urines of diabetic patients had sweet taste [15, 16]. Diabetes mellitus is a silent, non-communicable disease, and a heterogeneous group of metabolic disorders characterized by chronic hyperglycemia with deregulations of glucose, fat and protein metabolism resulting from defects in insulin secretion (insulin deficiency), insulin action(insulin resistance), or both [17]. Diabetes mellitus (DM) is a group of diseases in which a person has high levels of glucose in the blood, there are two reasons for a spiraling glucose level. First, when the pancreas does not produce insulin because there is autoimmune destruction of the pancreatic islet beta cells [18] and Second, when the body cells resist responding to the insulin that is produced [19] Insulin is a hormone which produced from β-cells of the pancreas and facilitates uptake of glucose from the bloodstream into the body cells mainly for energy. However, in the case of diabetic patients, the pancreas does not produce insulin or in very less amount so the cells do not respond to the insulin being produced. This condition is recognized as insulin resistance, which is a decrease in sensitivity or receptiveness to insulin in cells, muscle, and adipose tissue [20].

Classification of diabetes mellitus

Diabetes can be classified into the following categories:

1. Type 1 diabetes
2. Type 2 diabetes
3. Gestational diabetes mellitus
4. Latent autoimmune diabetes of adulthood (LADA)

5. Neonatal diabetes and maturity-onset diabetes of the young [MODY]

Type 1 diabetes

Type 1 diabetes also known as insulin-dependent diabetes mellitus (IDDM), and “juvenile or childhood-onset” diabetes. There are only 5-10% of cases, Type 1 DM (T1DM) is an autoimmune disease that occurs mostly in childhood or below 20 years of age youth and is characterized by a decrease in insulin secretion or degeneration of beta-cells of Langerhans of the pancreas leading to insulin insufficiency [21]. The disease is irreversible and it will require lifelong insulin replacement therapy by injection. Thus, T1DM requires daily administration of insulin. T1DM is not caused by lifestyle, but it may be hereditary with a strong family history, which cannot be prevented [22]. Type 1 diabetes, However, maintaining a healthy lifestyle, regular blood glucose testing, and medicating with insulin is very important to manage the health condition of people with T1DM. These patients are prone to ketoacidosis, coma, and death [20, 21].

Type 2 diabetes

Type 2 diabetes (T2DM) also known as non-insulin-dependent diabetes mellitus (NIDDM), and adult-onset diabetes mellitus because it usually affects older adults. It is seen above 30 years of age in the middle-age group, characterized by normal secretion of insulin but a decrease in sensitivity of the peripheral tissue to the insulin. T2DM accounts for 90-95% of people with diabetes around the world and it is associated with excess body weight and physical inactivity. All T2DM patients do not require insulin injections to stay alive, mostly T2DM patients use an antidiabetic agent to control their diabetes. Although up to 20% of T2DM patients are treated with insulin to under control their glycemic level. T2DM is characterized by a variable combination of insulin resistance with relative insulin deficiency [22]. Normally, insulin secretion acts on cells to transport glucose from the blood into the cell. In insulin resistance, however, the sensitivity of the cells to insulin is decreased. As a result, higher levels of insulin are needed for insulin to have its usual effect on sugar in the blood [23]. (disorder of insulin action); Type 2 diabetes (T2DM) is when the body loses the ability to produce and/or utilize insulin properly, and it is sometimes combined with an absolute insulin deficiency. It is often called “adult-onset” diabetes representing 90-95% of all cases of diabetes and it is related to an individual’s lifestyle habits that include poor diet and physical inactivity [24].

Gestational Diabetes Mellitus (GDM)

Gestational Diabetes Mellitus (GDM) develops in 2% to 5% of all pregnancies and may improve or disappear after delivery. The symptom and characteristics of gestational diabetes resembled type 2 diabetes in several aspects. Approximately 20-50% of women, affected gestational diabetes, develop type 2 diabetes in future life. This type of diabetes is diagnosed in the second or third trimester of pregnancy. Gestational diabetes was referred to as hyperglycemia or glucose intolerance with firstly recognize during pregnancy [22].

MODY
Maturity onset diabetes of the young (MODY), is a disease of the exocrine pancreas and drug or chemical-induced diabetes-like as with the use of glucocorticoid drugs during the treatment of HIV/AIDS, and after organ transplantation. MODY characterizes a group of autosomal dominant single-gene disorders resulting in decreased insulin secretion. The treatment and prognosis of MODY is different from type 1 and type 2 diabetes and required genetic counseling to control its complications [24,25].

**LADA**

Latent autoimmune diabetes of adulthood (LADA) is a form of type 1 diabetes often misdiagnosed as type 2 diabetes [72]. It is characterized by slower autoimmune destruction of β-cells that is seen in typical type 1 diabetes. An around 10% of patients over the age of 35 years having type 2 diabetes may suffer from LADA. LADA can be treated with insulin therapy [26].

**Risk Factors of T2DM**

A risk factor is a variable that is responsible to increase the prevalence and increase the risk of developing disease or infection. Waugh et al., state that there are mainly two types of risk factors for developing type 2 diabetes mellitus Non-modifiable risk factors and modifiable risk factors [27]. The increasing prevalence and progression of diabetes in India is usually associated with increasing urbanization, socio-demographic changes, industrialization, economic growth, Sedentary lifestyle, and globalization, supported with modifiable (increasing age, gender, family history, ethnicity, genetic factors, and low birth-weight) and non-modifiable risk factors such as unhealthy food, physical inactivity, smoking, use of tobacco and alcohol, impaired sleep, chronic stress, population growth, and non-adherence of medical checkups and medication being the main driver of the epidemic which can be managed through lifestyle management. These are strongly linked to morbidity, mortality, and disability in the short and longer-term [28-30].

**Non-Modifiable risks factors**

Some risk factors are beyond our control and not control through lifestyle management, technically known as the non-modifiable risks for diabetes mellitus. Forsen et al. stated that age, family history, gender, genetic factors, low birth-weight race, and ethnicity are the most common non-modifiable risk factors for type 2 diabetes [28].

**Age**

The risk for developing T2DM increases with the proceeding age, with the current peak incidence rate occurring between 40 and 59 years of age [31]. When examining the gender differences concerning age, it was found that women tend to develop T2DM at a slightly younger age than their male counterparts, with peak incidence occurring between 35 and 55 years of age. One possible reason for this occurrence has been postulated to be gestational diabetes mellitus (GDM) which affects approximately 20 percent of pregnant women and increases the risk of developing T2DM following the pregnancy [32]. While there is still a higher proportion of adults with T2DM relative to adolescents and children, youth onset T2DM is becoming more prevalent, with a substantial increase of approximately 35% over the last decade [33].

**Gender**

There is still no clear indication of whether men or women have a higher incidence of T2DM, with a number of studies indicating differences by the global region. However, studies examined precursors to T2DM, namely IGT and IFG, found differences in the incidences of T2DM between men and women. In these instances, men were found to have a higher incidence of IFG, whereas women have a higher incidence of IGT. Possible mechanisms for higher levels of IFG in men are related to lifestyle habits, where men are found to be more likely to smoke than women and insulin sensitivity purportedly decrease with regular smoking [34]. Furthermore, it has been shown that the eating habits of men are generally poorer than that of women, with lower levels of vegetables and higher levels of fats and sugars being consumed by men [35].

**Family History**

There is a growing body of evidence that suggests that a family history of T2DM predisposes an individual to develop the disease. It appears that underlying genetic predisposition is already present, but is triggered by certain environmental stimuli such as obesity, physical inactivity, and poor lifestyle habits [32].

**Modifiable risks factors**

Due to the dramatic increase of urbanization, industrialization, and globalization increase the incidence of diabetes globally, has been attributed to different changes in the human lifestyle and behavior. According to Wilson et al, some environmental factors such as unhealthy diet, physical inactivity, Over-weight and Obesity (abdominal obesity), stress, consumption of tobacco, smoking, excess intake of alcohol and sedentary lifestyle are responsible to increase the risk of developing type 2 diabetes mellitus. These lifestyle-related modifiable risk factors can be managed through healthy lifestyle intervention including healthy and balanced diet, intake of generous amount of fibrous food, increase physical activities, including brick walk and yogic exercises for at least 30 minutes per day, quit smoking and tobacco, reduce the intake of alcohol, stress management through meditation and routine medical checkups for screening of diabetes and its related complications [36-38].

**Dietary practices**

Several studies indicate that nutritional factors such as excess intake of fat and carbohydrate, contribute to a higher intake of calories and increase body weight, have been associated with diabetes [39]. Several studies carried out among different population and food cultures have steadily shown that changing from traditional or primitive dietary patterns to a Western or modern dietary habit including higher intakes of refined grains, high-fat sugar, and calorie-containing foods items has leads to increase the incidence of developing type 2 diabetes [40].

**Physical inactivity**

Several studies indicate lower levels of physical activity are further associated with obesity, IGT and increasing...
incidence of diabetes and heart disease [41]. Participation those are habitual in performing some types of physical activity associated with a decreased risk of developing T2DM and in some cases up to 34% reduction in risk were found [42]. A study carried out by Mohan et al in Chennai showed that the prevalence of diabetes was higher among subjects with light grade activity compared to heavy grade activity [43]. An important finding by Hu et al showed that walking may reduce the risk of developing T2DM to the same extent as higher intensity exercise, which, considering the high levels of obesity in T2DM individuals is encouraging due to the decreased load on the joints, and therefore reduced risk of injury [44].

Smoking
The regular smoking has been associated with an increase in the risk of developing T2DM, with an almost two-fold. Two recent studies Ko et al and Wei et al have reported that those individuals who are exposed to passive or environmental smoke are also at risk for developing T2DM, when compared to those who are not exposed, providing the evidence that non-smokers are also at risk [45, 46]. Smoking can lead to insulin resistance and agitation of insulin secretion so that active smokers are at increased risk of diabetes [47]. Certain health problems like high blood pressure, high blood cholesterol levels, reduced oxygen levels in the blood, reduced blood circulation and impaired ability to heal wounds, difficulty in controlling blood glucose levels and managing diabetes, neuropathy or nerve damage especially in the feet and hands, impotency, kidney disease eye problems, periodontal (teeth) problems, premature death, increased body fat, body inflammation, oxidative stress, and impaired endothelial function are found to aggravate with smoking among people who are diabetic [48]. Smoking is known to increase central fat accumulation and increases the risk of developing type 2 diabetes [47, 49]. There is evidence that smoking increases the risk of coronary artery disease in type 2 diabetes.

Smoking has also been shown to exacerbate markers of kidney failure in this population, such as microalbuminuria [50].

Stress
Stress is the major risk factor to develop T2DM and has promoted to increase blood glucose levels and make the disease more difficult to control and help to develop more complications. Stress is a physiological response to an apparent attack or an event that produces strain. The presence of depression implicates the possible risk factor for T2DM [98]. Sleeping duration is indirectly related to depressive symptoms, is also implicated in the risk of developing T2DM, with individuals sleeping more than nine hours, or less than six hours being equally at risk, while those who slept between seven and eight hours an occasion, had the lowest risk [51, 52].

Urbanization
Over the last decade, there has been a slow but steady rise in the number of individuals who are transitioning from rural to urban areas as places of residence. This change has resulted in many lifestyle-related challenges, such as reduced occupational and recreational physical activity and increased stress levels. Furthermore, changes in nutritional habits to more refined and convenience foods are additional compounding factors that increase the likelihood of an individual developing T2DM. It is found that those individuals who moved from a rural environment into an urban environment were more likely to have a higher BMI than those who had lived in an urban environment for most of their life [53].

Sedentary lifestyle
While physical inactivity has in the past incorporated sedentary behavior as part of its global definition, there is an overwhelming number of studies that have been published over the last five years that provide substantial evidence as to why sedentary behavior should be considered an independent risk factor for the development of T2DM and other NCDs [54]. Sedentary behavior is traditionally measured via the use of an accelerometer and can be quantified depending on the type of activity a person engages in [55]. These activities could range from sitting watching television, extended periods of driving in a vehicle or sitting for extended periods as part of an individual’s occupation [54]. Several studies have been conducted in T2DM populations, with lower levels of sedentary behavior; in conjunction with increased levels of physical activity have shown to improve insulin sensitivity and weight loss over an extended period [56].

Symptoms and Diagnosis of T2DM
Diabetes is usually known as a silent disease because no symptoms are seen until it progresses to develop severe complications. Diabetes patients may or may not show the symptoms of disease [57]. The major symptoms of diabetes mellitus include excessive thirst and hunger, frequent urination, weight loss, frequent infections, blurred vision, and severe cases and pre-coma [58]. In general, T2DM patients in its early stages have no signs and symptoms at all and are only diagnosed after the routine medical screening, which finds a high blood glucose level or glucose in the urine. Due to late diagnosis, people with T2DM may have had the disease for many years unknowingly and can have significant complications already present at the time of diagnosis [59]. The diagnosis of diabetes is established with symptoms and blood sugar values. The values are diverse in diabetic patients and non-diabetic persons. In nondiabetic patients, the fasting blood sugar levels are less than 100 mg/dl whereas in a diabetic, it is more than 126 mg/dl; and the postprandial blood sugar levels are less than 140 mg/dl in a non-diabetic and more than 200 mg/dl in a diabetic [60].

Co-morbidities associated with Diabetes Mellitus
Diabetes mellitus is a very costly pandemic disease of the 21st century, has become a major cause of hasty death and infirmity around the world, and significantly increases the risk for both microvascular complications [61, 62]. DM is associated with several co-morbidities which are the root cause of long-term complications. The progression of type 2 diabetes mellitus, leads to developing various life-threatening complications such as retinopathy (loss of vision or blindness), neuropathy (gastrointestinal, genitourinary, and sexual dysfunction), nephropathy (kidney failure), peripheral neuropathy (nerve damage and foot
ulceration or amputation), hypertension, cardiomyopathy (heart failure) and cardiovascular ailments such as stroke and heart attack, the principal morbidity, and mortality causes among individuals with diabetes cuts or bruises that are slow to heal, periodontitis or gum disease recurring skin, or bladder infections, and anxiety/depression that can complicate the management of the disease [63]. Diabetes and its related complications have huge implications on health care costs, mortality, disability, and morbidity. A diabetic patient had more than twice-higher expenditures on medical treatment costs than those without diabetes. T2DM is one of the major causes of death; it was the seventh leading cause of deaths recorded on death certificates. There were 71,383 deaths in 2007 because of diabetes alone an additional 160,022 deaths listed diabetes as the contributing cause of death [64].

Management and prevention of T2DM
Management and treatment of diabetes focus on retaining and maintaining blood sugar levels within the normal range, so reduce the risk of fetal complications. Diabetes is a huge threat to public health, it deteriorates the quality of life and increases health care costs in the absence of proper treatment and adherence to the treatment. Therefore affordable, cheap strategies and concepts are needed for primary prevention. To maintain blood sugar levels under control in diabetes patients requires, to engage in a wide range of self-management behaviors, and adhere to lifestyle modification components such as dietary modifications, physical activity (yoga practice), and stress management[65].

Role of Lifestyle medicine in the prevention and control of Diabetes mellitus
Lifestyle modification and self-management comprises the non-pharmacological management of diabetes include diet management, increasing various types of physical activities such as walking, yogic exercise, stress management through meditation and motivational counseling, management of risk factors such as weight management, tobacco, and alcohol cessation and adherence to routine medication and regular monitoring of blood glucose level, blood pressure, and screening of complications which improves patient’s health outcomes and quality of life along with reduce the burden of disease[65]. Lifestyle interventions continue to play an important role in glycemic control and managing CVD risk in more advanced stages of type 2 diabetes, and may be supported by allied health and specialist support services. It is documented that intensive lifestyle intervention can reduce the prevalence of T2DM by 58% over 3 years. The main goal of lifestyle intervention is to improve self-care behaviors, health status, reduce the risk of complications, and improve clinical outcomes, and quality of life in a cost-effective manner [66]. Diabetes management not only depends on medication treatment or drug therapy, but also requires lifestyle intervention therapy on physical exercise, diet, and other lifestyle changes [67]. As referred by several studies, self-care behaviors were defined as the activities diabetic patients perform to manage their health in terms of following a healthy eating plan (i.e., diabetic diet), exercise, self-glucose monitoring, and diabetes medication and/or insulin intake [68]. Modern treatment of diabetes does not only require pharmacologic therapy but also health education by physicians and other health care providers. Diabetes education has changed the health belief, compliance, and metabolic control of patients. Diabetes lifestyle intervention counseling is the fundamental way to care for all diabetes patients, improve their health outcomes and facilitating the coping skills, knowledge, and increase the ability necessary for diabetes self-management. The purpose of diabetes lifestyle intervention education is to optimize metabolic control, improve self-care behaviors and health status, prevent acute and chronic diabetes-related complications, and improve health-related quality of life [69].

Role of plant based balanced diet in management of Diabetes Mellitus
A good nutritious diet provides a stronger immune system, reduced sickness and provides better health outcomes for all ages’ group population. The use of an effective dietary approach is the cornerstone of successful prevention and management of the different characteristics of diabetes mellitus [70]. Plant-based balanced diet therapy is an important and essential component in preventing diabetes, managing already present diabetes, and stopping or reducing the rate of development of diabetes-related complications. Therefore, it is important at all levels of diabetes prevention. It is also a vital component of diabetes self-management practice [71]. Numerous observational and interventional studies provide evidence that the Mediterranean diet has favorable effects on diabetes, cardiovascular problems, obesity, and other chronic diseases. The Mediterranean diet is low calorie, saturated fat, and rich in fiber, unsaturated fats, antioxidants, polyphenols, calcium and magnesium [72]. Diet therapy is the primary and most important step in the management and control of T2DM and is commonly used as a first step intervention therapy (UK Prospective Diabetes Study) [119]. A balanced diet is a fundamental aspect and considered as the cornerstone in the management and treatment of type 2 diabetes. A review has shown that a healthy and balanced diet can reduce HbA1c 0.5 to 2% [73]. A variety of different dietary approaches have shown to be effective in diabetes management including, low-fat diets, low glycemic index diets, low carbohydrate diets, and Mediterranean diets. Evidence at this point does not suggest that any dietary approach offers greater weight loss or improvements in glycemic control [74, 75]. A recent critical review of 9 meta-analyses was the first review to evaluate actual carbohydrate intake at the final follow up [76]. A study found that high consumption of sugar, refined products, and trans-fat are associated with an increased risk of developing T2DM, while consumption of monounsaturated fats, fiber, and fresh vegetables are associated with a decrease in risk of complications. Dietary control is the mainstay of treatment in type 2 diabetes, and the component of a healthy and balanced diet including carbohydrate, fat and fiber intake Balanced diet therapy is a vital approach in diabetes prevention, control, and management. A systemic review provides evidence that diet management in type 2 patients reduces HbA1c reduction of 0.5 to 2%. A healthy and balanced diet may help to achieve better glycemic control, maintain blood pressure maintain body weight and delay or prevent complications of diabetes [77]. A pre-test-post-test study conducted among 98 elderly adults was
randomized to the experimental group and for the control group. This study was conducted to evaluate the impact of nutrition intervention on glycemic control. Out of 98, 92 people (94%) were completed the whole study. The experimental group had greater improvement in fasting plasma glucose. The study revealed that nutrition education can improve glycemic control, reduce the rate of severe complications and premature deaths associated with diabetes [78].

A study carried among 75 participants to identify factors that contribute to the barrier to dietary adherence in individuals with diabetes, and strategies to overcome this barrier. At the conclusion factors identified as the greatest contributors to the barriers being evaluated include lack of time, lack of symptoms, lack of education, poor self-esteem, lack of empowerment and misinformation from family, peer group and others with diabetes[79]. A study was carried out among 1467 participants to assess the effects of the kind and occurrence of different types of dietary advice. The studies all measured. Other outcome measures of this study were weight and glycemic control mortality, blood pressure, serum cholesterol, serum triglycerides. The result of this study suggested that the adoption of dietary advice is a good way to promote better glycemic control [80]. Recent studies suggested a potential role for coffee, dairy, nuts, magnesium, and calcium in preventing diabetes. In summary, a balanced plant-based healthy diet is very useful to prevent type 2 diabetes mellitus and several studies used the diet charts as a tool for the management of diabetes and related co-morbidities [81].

A recommended plant-based balanced diet chart for diabetes mellitus and coronary heart disease patients

<table>
<thead>
<tr>
<th>24 Hours Food Intake:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FOOD</strong></td>
<td><strong>QUANTITY</strong></td>
</tr>
<tr>
<td>Cereal (Atta / Oats / Dalia)</td>
<td>200gm (8 chapatti ) (1 chapatti = 25gm)</td>
</tr>
<tr>
<td>Dal (Whole / Roasted / Sprouted )</td>
<td>50gm (2 Katori)</td>
</tr>
<tr>
<td>Vegetables (Seasonal )</td>
<td>400-500gm (2 Katori + Salad)</td>
</tr>
<tr>
<td>Fruits (Seasonal )</td>
<td>100gm (1 medium sized)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calories break up</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>70%</td>
</tr>
<tr>
<td>Protein</td>
<td>20%</td>
</tr>
<tr>
<td>Fat (Invisible form)</td>
<td>10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Menu for whole day</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast (7 am – 8 am) Calories: 320 (20%)</td>
<td>1 bowl of Dalia made of oat-bran, whole wheat, maize or sprouts or 1 cup herbal tea with biscuits / brown breads</td>
</tr>
</tbody>
</table>

| Mid- Morning (10 am-11 am) Calories: 160 (10%) | 1 small katori Roasted chana / sprouted dal / 1-2 medium size fruits |
| Lunch (1 pm – 2 pm) Calories: 480 (30%) | 3-4 chapatti (made of whole wheat, gram & soya flour) + 1 katori sabzi / dal + salads / Khichri (Atta : 60 % wheat, 20% soya & 20 % gram) |
| Evening Tea (4 pm – 5 pm) Calories: 160 (10%) | 1 medium size fruit or 1 cup herbal tea with 2-3 biscuits (no sweet) |
| Dinner (7 pm – 8 pm) Calories: 400 (25%) | 2-3 chapatti + 1 katori sabzi + salad + dal / Khichri |
| Bed – Time (9 pm – 10 pm) Calories: 80 (5%) | 1 small glass Milk (skimmed), if required |

Food items to be avoid for diabetes patients:
1. Fried foods: Puri, pakoda, parantha, samosa, namkeen, bargar, Chat papadi (all junk foods)
2. Sweets, Cake, Chocolate, Jam, Ice cream (All sweet items)
3. Cold drinks, Sugar cane juice (All caffeine containing soft drinks)
4. Nuts & Dry fruits: Groundnut, Cashewnuts, Almonds, walnut, coconut & raisins
5. Fruits: Grapes, Mango, Banana, Chikoo, Lichi, & all sweet fruits except unripened papaya & Kino
6. Vegetables: Potato (alone), Arbi, Shakarkandi
7. All Cooking oils, Cream, Cheese, Butter, Ghee, Dalda, Egg yolk, Meat
8. All alcoholic drinks
9. All Non – Vegetarian foods
10. Full cream Milk

Role of physical activity (yoga practice) in management of T2DM
The yoga is type of physical activity and an important part of mind/body approaches to bring balance in physical, mental, emotional, and spiritual health of the individual and promote better health, which includes sequences of physical postures, meditation, relaxation techniques, visualization, and feedback, breathing exercises, cognitive behavioral therapy and spirituality [82, 83]. Yoga is the complementary and unconventional practices used by community in the prevention and management of diabetes [84,85]. Yoga was started more than 5000 years ago in India as a form of traditional mind and body training for treating and controlling [86, 87] several chronic, and life threatening diseases, like as diabetes hypertension, asthma, obesity, chronic obstructive pulmonary disease and coronary heart diseases [88, 89]. Yogi exercise can improve blood supply, lipid profile, blood sugar level, and enhances insulin receptor expression. An interventional study involving 98 T2DM patients, shown significant improvement in fasting blood sugar, HDL-C low-density lipoproteins (LDL), serum total cholesterol, very-low-density lipoproteins (VLDL), and triglycerides were significantly
lower, after performing yoga [90]. An intervention study was conducted among 44 Type 2 DM patients. Intervention group patients were taught yoga and pranayama for 3 months, 1 hour every day in the morning, through a yoga expert teacher. The result of this study showed a significant decrease in blood sugar levels (FBS, PPBS, and HbA1c), BMI, waist and hip circumference total cholesterol, triglycerides and improved posture, and stability of Intervention group after a week of intensive yoga course [91]. Various studies have been reported that yoga practice is helpful in weight management; maintain BMI and waist-hip ratio, stress reduction, self-efficacy improvement in mood, and quality of life of patients. Several studies provide evidence that Yogic exercise is helpful in the improvement in the management of diabetes and its related complications [90, 92]. Several studies stated that the yoga practice can reduce Insulin resistance and shows potential results in the improving signs, prognosis and reducing complications of disease[89,93,94]. Various studies shows that the development of diabetes from the pre-diabetic condition can be either postponed or ameliorated by the regular physical activity (yoga practice)[95-97], plant based healthy diet [96] and active stress management [98,99].

Prior studies have demonstrated that yoga can reduce glycosylated hemoglobin A1C, fasting blood sugar and lipid levels which is associated with the improving quality of life of diabetes patients [100-102]. Several systematic reviews also demonstrates the effectiveness of yoga on glycemic control, insulin sensitivity, lipid profile, anthropometric and physiological measures stress management, and quality of life diabetes patients [103, 104]. A systematic review of 25 controlled trials demonstrated that the yoga intervention help in the management of diabetes and improve blood glucose level, lipid levels and body fat and body mass index and cortisol level(stress hormone) [105]. There are several yoga asana which help in the prevention and management of diabetes and other chronic disorders such as obesity, hypertension and CHD etc.

**Yogic Exercises**

1. **Health Rejuvenating Exercises (HRE):** These exercises are aimed mainly at improving the general tone and flexibility of various parts of the body. These will also be performed during warming up and to prepare for the next step, i.e. the Asanas.

2. **Breathing exercises:** Anulom Vilom—alternate nose breathing, Nadi Shodhana pranayam.

3. **Asanas:** These are the yogic postures and exercises mainly aimed to stretch and relaxation for body and mind.

1. **Standing Posture**
   (A) **Pada Hasta Asana**
   **Position:** stand erect with both feet together.
   **Movement:** Raise arms, palms facing forwards over the head while inhaling. Exhale slowly while you bend forward, bring the palms down to hold the ankles and touch forehead to the knees. Try to keep knees and ankles straight. While you bend your body up to the level where you can bend easily keep in mind that the goal is to touch forehead to knees. Slowly raise your body while inhaling and taking arms up, exhale and bring the arms down.
   **Caution:** Persons with slipped disc (disc prolapse) should not do this asana.

(B) **Trikon Asana**
**Position:** In standing position steps the left leg out to the side, away from the right leg. Turn the left foot out to the left. You need to bend left leg and put your left palm beside the foot. After this you need to stretch your right arm and take the breath normally.

**Caution:** People having any complaints regarding the hips, spinal column or knees should practice this asana with caution.

2. **Sitting Posture**
   (A) **Shasank Asana**
   **Position:** Sit in Vajrasana posture and put palms together on the knees, keeping both arms straight.
   **Movement:** Inhale and raise joined arms over the head. Ensure that the arms touch the ears. Exhale and bend forward touching the floor with the palms. Inhale and exhale and maintain this posture for 5 breaths. Inhale and raise the arms along with the head. Exhale and bring the hands down. Do it twice.

(B) **Ardh Vakrasana**
**Position:** Sit on the floor with both legs stretched straight in front.
**Movement:** Raise the right leg a little and bend the left leg and let the heel touch the right hip. Put the right leg and foot by the outer side of the left knee, sole on the floor. Bring the left arm pit over the right knee. Hold the right ankle with your left hand. Exhale and stretch the right arm and swing back to touch the navel. Breathe evenly and maintain this posture for half a minute. Inhale and bring the right arm to the right side, exhale and free left hand and legs. Repeat this on the other side.

3. **Lying on the abdomen**
   (A) **Bhujang Asana**
   **Position 1:** Lie face down keeping heels and toes together. Place palms about 30 cms apart from the body.
   **Movement:** Inhale and come up 15 cms. Exhale with hissing sound from the mouth, pulling the navel inside. Inhale and raise the trunk on the palms and thighs and look skywards; slowly exhale with hissing sound and bring down the trunk to the floor.
   **Position 2:** Bring the hands near to the body by about 15 cms.
   **Movement:** The rest of the movements are the same as that of the 1st position.
   **Position 3:** Bring the hands close to the body.
   **Movement:** Inhale and raise the body 15 cms above the floor. Exhale with hissing sound from the mouth. Inhale and raise the trunk a little higher while the navel should touch the floor. Exhale with hissing sound and bring down the trunk on the floor. Spread hands beyond head on the right side of the face, keeping the toes together and heels open, relax the whole body. Turn the face and relax.

(B) **Shalabih Asana**
**Position:** Lie down on your chest with arms parallel to the body and chin on the ground.
**Movement:** 1. Inhale, turn toes inward, heels high, exhale, make the body stiff and raise right leg up from the floor as
high as you can. Hold, inhale and exhale for one minute. Inhale and bring down the leg on the floor slowly and exhale.
2. Repeat with the other leg.
3. Now repeat with both the legs.

(4) Lying on the back
(A) Uttanpad Asana
Position: Lie down on your back keeping the fingers locked together, under your neck, and elbows on the ground. Keep both the feet 15 cms apart. You can also keep the hands parallel to the body.
Movement: Inhale and exhale and raise both the legs 15 cms high above the floor. Inhale and exhale 5 times (inhale and bring your legs down and then exhale).
Position 2. Keep both the legs 25 cms apart.
Movement: Heels out, toes in, raise your legs 15 cms above the floor. Inhale and exhale 5 times. While inhaling, bring your legs down and exhale and relax.
Movement: Do the same set of movements and relax.

(B) Merudand Asana
Position & Movement: Lie on your back with arms stretched at right angles to the trunk. Lift the left heel and put it on the right foot in the space between the big toe and the second finger, thus keeping your feet straight one above the other. Now stretch and rotate the upper part of the body (head and neck) towards the left and the lower parts (waist, thighs and feet) towards the right while you inhale. The left toe should now touch the ground and the arms and shoulders remain in the same position as before. Now come back to the original position while you exhale. Now repeat the same on the other side. Repeat the whole exercise after changing the leg position (right heel over the left foot). Exercise is a more specific form of physical activity that is structured and designed to improve physical fitness and it is an important part of the diabetes management plan. Both physical activity and exercise are important. Participation in regular aerobic exercise, irrespective of intensity, has been reported to have beneficial outcomes on glycemic control, diabetes-related complications and HRQoL [106]. A randomized controlled trial verified that physical activity with dietary changes can delay the progression of type 2 diabetes. In type 2 diabetes mellitus patients, regular physical activity significantly improves glycemic control, reduces cardiovascular risk factors, chronic medication, depression and improves health-related quality of life [107]. Regular physical activity derives by T2DM patients provides several benefits including maintain weight, reduce abdominal and the overall fat percentage, improve glycemic control, blood pressure, blood lipid profile, well-being, cardio respiratory fitness and decrease insulin resistance, stress, and anxiety [108].

Role of stress management in the prevention and control of Diabetes
Stress defined as any uncomfortable physical and emotional experience accompanied by expected mental, biochemical and behavioral changes to remove the stressor. 4 Diabetes mellitus and its related co-morbidities are linked with psychological stress. Chronic stress, cognition, and negative mood are major risk factors for the development of obesity, diabetes, hypertension, and cardiovascular disease [109]. Adaptation and good coping skills are required to live with diabetes. There is a high prevalence of anxiety and depression in diabetic individuals and depression often tends to be severe but ignored, unrecognized and unaddressed [110]. Using the Diabetes Distress Scale, Fischer et al. reported a high prevalence of diabetes distress among adults with type 2 diabetes and this was associated with poorer outcomes concerning lifestyle modification, self-efficacy, and glycemic control. Additionally, there may be associated with eating disorders and substance abuse. Diabetic individuals often report disease-related stigmatization, in both personal and professional domains [111].

Hence, mind-body therapies that aim at physical, mental and emotional wellbeing may have a significant role in the reduction of diabetes distress, stress describes the person’s physical and emotional response to irritability, headaches and muscle tension. Lifestyle changes with relaxation techniques is the effective way to control stress. It can be managed with positive beliefs and social interaction with more activities. In general, one can cope with stress by focusing either on the emotional effects of stress or solving the problems of stress, or both. The focus of managing chronic diseases such as diabetes must change from ‘didactic provision of information to interventions teaching problem solving and coping skills’ [112,113]. Meditation has been performed since ancient times, with the earliest references going back to the Vedas. It was principally considered a tool for the achievement of spiritual salvation and performed by saints. In 1900s scientific enquiry of meditation began and mainly used stress reduction technique, mental relaxation and self-improvement.

Meditation is a status of consideration, alertness, awareness and reflection which aim to improve spiritual, mental and emotional wellbeing (114). Meditation is an adjunctive intervention to conventional treatment for diabetes which has both direct (improve sleep, emotional regulation, anxiety, depression and reduce stress, body weight, and systolic and diastolic blood pressure) and indirect potential effects (reduction in Cortisol serum levels, albuminuria, and HbA1c) on diabetes patients [115]. Meditation is a preventive and adjuvant therapy in patients with diabetes, depression, anxiety, chronic pain, cardiovascular disorders, and other non-communicable diseases [116]. A recent systematic review and meta-analysis did by Gotink et al., observed significant improvement in depression symptoms, anxiety and stress, improving the life quality and physical functioning of diabetes patients [117]. Keyworth et al found a significant improvement in glycemic control and stress levels in T2DM patients through meditation [118]. Several research studies used meditation as a tool for managing stress. These studies validate [116-118] the beneficial effect of meditation and relaxation techniques in the management of stress. The main aim of Meditation is to purify the mental state. When the mind is clean, peace of mind automatically surfaces. Balance of mind, equanimity and the state of well-being are experienced simultaneously.

Basic components of Meditation:
1. Quiet atmosphere around surroundings
2. Posture: comfortable with spine straight and eyes closed
3. Passive attitude
4. Theme to follow

Technique: Perception of Deep Breathing: Breathing is linked with the conscious mind. The mind is always restless; it is extremely difficult to steady the wandering mind directly. An efficient and easy way to control mental activities is concentrated perception of breath. At the same time, the rate of breathing can be reduced from 15-17 per minute to 10-12 per minute and by further practice to 4-6 per minute. There are steps of perception to start with, and perception of breath is an important step in this system.

- Step: 1. Do deep breathing and relax the whole body and feel it relaxed.
- Steps: 2. Direct your full attention to your breath, removing all thoughts and sensations. Take deep and regular breathing. Focus your attention on the navel and become fully aware of contraction and expansion and expansion of the abdomen accompanying exhalation and inhalation simultaneously.
- Step: 3. continuing the slow, deep and rhythmic breathing, shift your attention from the navel, and focus it inside the junction of the nostrils, from your attention on the process of respiration. Each and every inhalation and exhalation is to be perceived i.e. each and every breath is to be watched, felt and intentionally, consciously inhaled and exhaled.
- Step: 4. If you are distracted return your attention to your breathing. If it is frequent, then hold your breath for a few second and then breath again normally.
- Step: 5. To finish meditation, take two or three long breaths. Exhale for three times and pay obeisance by bending forward.

Clinical research studies have proved that this form of therapy with the combination of veg diet, yoga, and meditation) not only improves the individual's proficiency but also maintained the levels of blood sugar, blood pressure and reduced chances of obesity and coronary heart disease. No form of medicine is effective in preventing lifestyle-related disorder as diet, yoga, and meditation.

CONCLUSION
In summary lifestyle medicine (plant-based balanced diet, yoga, and meditation) play a vital role in the prevention and control of diabetes mellitus and associated disorders – obesity, hypertension, and coronary heart disease. The review concludes that lifestyle medicine may improve glycemic control, blood pressure, BMI, lipid profile, physical, mental and social health of diabetic patient and this medicine may decrease the risk of major complications related to diabetes, which directly reduce the treatment and management cost of diabetes. These are considered efficacious in the prevention and management of lifestyle-related disorders. So there is need to conduct further lifestyle-related prevention and awareness programs to control these major health concerned diseases - Diabetes & Coronary Heart Disease.

CONFLICT OF INTEREST
There is no conflict of interest in relation to the publication of this manuscript.

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