Chapter

# The Role of Lifestyle Medicine in the Management of Diabetes Mellitus

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## Abstract

Lifestyle medicine is a medical specialty that involves the use of lifestyle in the prevention and management of non-communicable diseases like diabetes mellitus and cardiovascular diseases. Recent studies have shown that diabetes mellitus can be prevented following lifestyle modifications. Lifestyle medicine is a branch of medicine that promotes lifestyle modifications as a way of life. This includes promoting healthy eating which includes a whole plant-based diet, low fat, low sugar and low salt. It also includes exercises, sleeping healthy and reducing stress. This is involved in the management of diabetes mellitus. Diabetic management is expensive especially in low and middle-income countries where health insurance is not available for the entire populace and diabetics have to pay out of pocket for their medications.

**Keywords:** lifestyle medicine, diabetes mellitus, exercise, physical activity, whole plant based diet

## 1. Introduction

Globally, there is an increase in the prevalence of non-communicable diseases such as Type 2 Diabetes Mellitus, cancer, hypertension, other cardiovascular diseases and stroke. Most of these illnesses are related to a modification in the lifestyle worldwide costs of healthcare leading to morbidity and mortality are diseases linked to environmental factors and lifestyle modification [1]. There has been a steady increase worldwide in the prevalence of non-communicable diseases to an alarming rate including diabetes mellitus which is becoming an epidemic [2–4] as this increase has been on for the past 20 years [5–7]. According to the International Diabetes Federation (IDF), it is estimated that 387 million adults are diabetic with either type 1 or type 2 diabetes mellitus [3] and this number is predicted to rise to 392 million by 2035 [3, 8]. This predicted increase is due to globalization and urbanization [2]. Urbanization is affected by modifications in lifestyle with physical inactivity and sedentary lifestyle from various epidemiological and interventional studies have revealed that the majority of chronic illnesses such as diseases that affect the cardiovascular system such as hypertension, cancer and Type 2 Diabetes Mellitus result due to lifestyle behavior and habits that are caused by improper eating habits, eating unhealthy foods, and lack of physical activity [9–11]. In primary and specialist health facilities, the majority of the consultations are related to highly preventable lifestyle.

Lifestyle modification is the first line of treatment in the management of non-communicable diseases [12, 13]. The commonest form of diabetes mellitus affecting 90% of diabetics is Type 2 Diabetes Mellitus. Diabetes mellitus is an economic and health burden to the sufferer and health systems as it also affects the quality of life especially when complications occur [2, 4, 8, 9, 14].

Diabetes mellitus is a risk factor for cardiovascular disease, a common cause of blindness due to diabetic retinopathy, amputation of the lower limb following diabetic neuropathy and diabetic foot ulcer and other life-threatening complications such as end-stage kidney disease (ESKD) [9, 15, 16]. Globally, diabetes mellitus is the second leading cause of blindness and renal disease [17]. Therefore it is important to prevent diabetes mellitus as it causes loss of working hours due to the impact they have on the economy and the individual. This is worst in the low and middle-income countries with the poor healthcare system and lack of health insurance for the entire populace where people have to pay out of pocket when seeking healthcare.

Diabetes mellitus is a chronic non-communicable metabolic disease in which the plasma glucose is elevated [12], characterized by insulin resistance and deficiency in insulin secretion and it may be acquired or hereditary [17, 18]. Obesity and overweight are risk factors for diabetes mellitus [17]. This is because insulin resistance and metabolic syndrome are promoted by obesity and overweight [8, 17]. For the primary prevention of diabetes mellitus, a 5-10 kg weight loss is recommended [6, 8].

Sensitivity to insulin and glycaemic control is improved by engaging in moderate weight loss and increased physical activity [6]. Obesity is a risk factor for diabetes mellitus [6]. Ignoring lifestyle medicine leads to an increased workload on the healthcare system. Globalization and adaptation of the Western lifestyle are some of the reasons for the increasing numbers of chronic diseases including Type 2 Diabetes Mellitus. Making good choices in lifestyle can significantly help in lowering the risk of these chronic diseases as most of the risk factors for these diseases are related to lifestyle behavior [2].

The history of lifestyle is very important in history taking [7]. The component of lifestyle medicine which promotes weight loss and prevents obesity is essential in the management and prevention of diabetes mellitus [8, 19, 20]. Therefore diabetes mellitus can be prevented by maintaining an ideal weight, therefore, modification in lifestyle does not only prevent diabetes mellitus but also prevents other non-communicable diseases [3, 8, 21].

## 2. Research methodology

This is review article on the role of lifestyle medicine in the management of Type 2 Diabetes Mellitus. A search was done using Google scholar, and PubMed using the key words lifestyle medicine and diabetes, the role of the pillars of lifestyle and management of Type 2 Diabetes Mellitus. Articles that highlighted the management of Type 2 Diabetes Mellitus using hypoglycaemic agents were excluded in this study.

## 3. What is lifestyle medicine

Lifestyle medicine is a relatively new medical specialty yet to be established in most countries. Lifestyle medicine has been defined by various scholars. Lifestyle medicine is the use of interventions and integration of lifestyle practices within conventional medicine to lower the risk of disease. It serves as an adjunct to the

management of illnesses [22, 23]. The practice of lifestyle medicine is evidence-based in scientific research and it addresses the root and underlying causes of diseases by empowering individuals with life skills and knowledge through a behavioral change in making healthy choices [24]. In this new medical discipline, it uses daily habits and practice impacts on both the prevention and treatment of diseases to improve the overall health of the individual in conjunction with both pharmaceutical and surgical therapy [3, 25]. All pharmaceutical agents have side effects as most drugs are metabolized in the liver and excreted by the kidneys. Hence it is very important to prevent them like diabetes mellitus. The Canadian Academy of Lifestyle Medicine defines lifestyle medicine as an evidence-based branch of medicine in which there is a comprehensive change in lifestyle including nutrition, physical activity, stress management, social connectedness and exposure to harmful environmental factors [26]. Lifestyle medicine is used to prevent and treat lifestyle-related diseases but it does not tell patients to abandon and stop their medications.

Lifestyle-related diseases (LRD) are illnesses in which lifestyle factors significantly influence the pathophysiology of the disease as there can be a significant improvement in the prevention and treatment of the disease following a change in the aetiological factors. Travel medicine and sports medicine, lifestyle medicine is a novel branch in the clinical practice of medicine [8] but it is gaining grounds due to its benefits. The prevention and reversal of chronic diseases linked to lifestyle can be done using evidence-based lifestyle therapeutic approaches. Lifestyle interventions affect physical and mental health positively, including a better quality of life [13]. The focus of lifestyle medicine programmes in the management of diabetes mellitus is to change the eating habits and physical activity behavior, especially in obese patients with type 2 diabetes mellitus is very important to control symptoms and it reduces the risk of cardiovascular-related morbidity and diabetic complications [27].

## 4. The pillars of lifestyle medicine

The components of lifestyle medicine are interventions that when they are practised lead to improvement in health and overall wellbeing. The modalities of lifestyle medicine are (**Figure 1**) [3, 13, 28]:

1. Increased physical activity and exercise.
2. Stress management.
3. Healthy eating by promoting consumption of whole plant-based diet.
4. Adequate sleep and good sleep hygiene.
5. Avoid consumption of tobacco and alcohol.
6. Increased mental and emotional wellbeing by having good social connectedness.

## 5. The role of lifestyle medicine in the management of diabetes mellitus

All the components of lifestyle medicine are important and play necessary roles in the prevention of Type 2 Diabetes Mellitus and management of Type 1 & 2 Diabetes Mellitus. This is because Type 1 Diabetes Mellitus has a strong

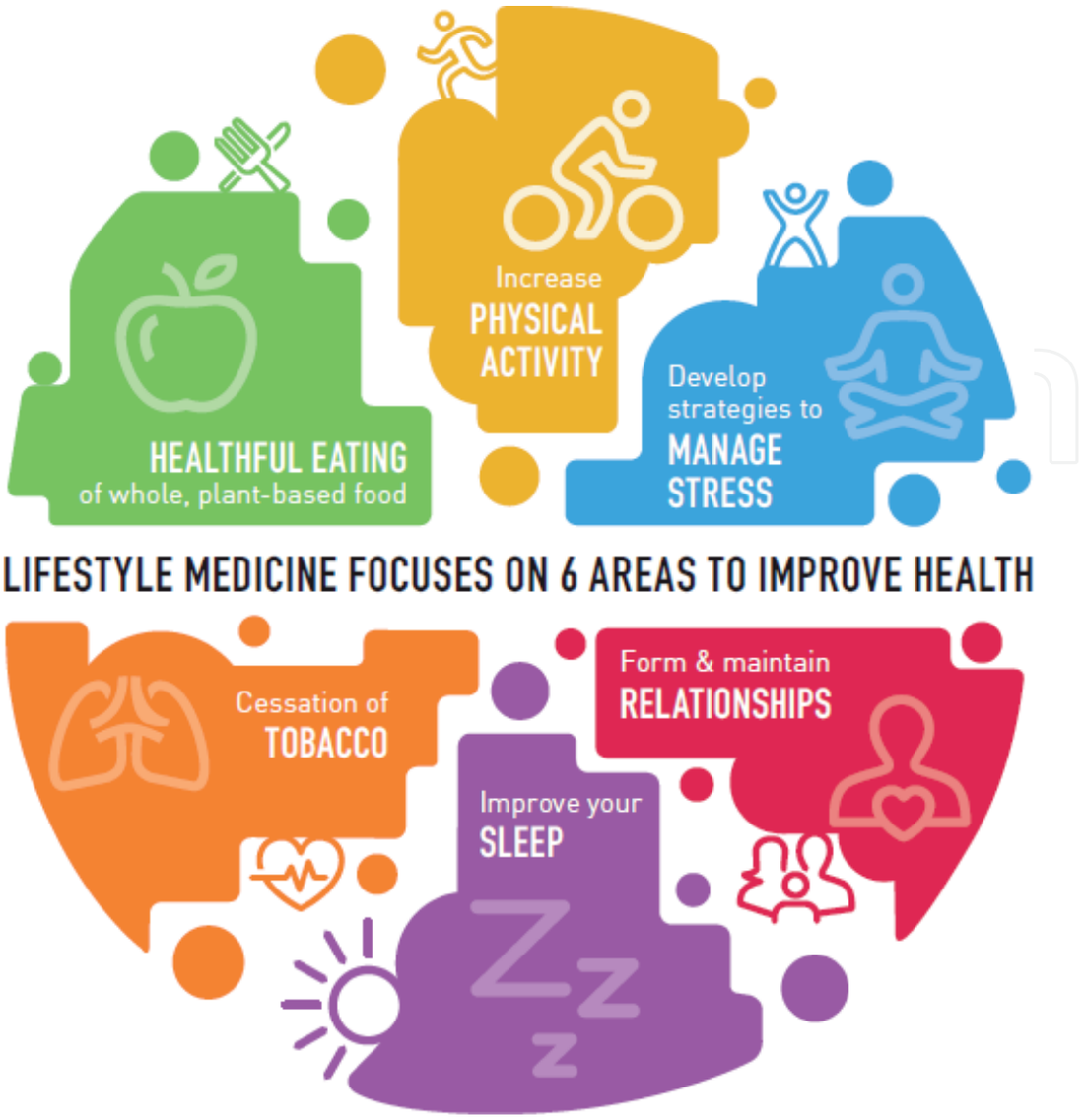


**Figure 1.**
*Courtesy American College of Lifestyle Medicine.*

relationship with genetics but lifestyle modification guides its management in the long-term to prevent diabetic complications such as diabetic neuropathy, retinopathy including diabetic foot ulcer. This is very important as it affects the overall wellbeing of the individual especially in developing countries where amputees are shamed and have general poor wellbeing and economic power. Type 2 Diabetes Mellitus can be prevented through modification in lifestyle by healthy living on a whole plant-based diet, prevention of obesity by weight control, having good sleep hygiene and avoiding unnecessary stress as much as possible [8, 12, 19]. This is because the risk factors of diabetes mellitus are related to modifiable lifestyle such as obesity [14]. The practice of lifestyle medicine is cost-effective in the management and prevention of diabetes mellitus because no special equipment is really necessary as what is involved is to be disciplined which has to be enforced by individuals on themselves [14]. Good healthy eating of a whole plant-based diet and increased physical activity is aimed at increasing energy uptake, reducing energy intake in food thereby preventing overweight and obesity which is a key risk factor for Type 2 Diabetes Mellitus and gestational diabetes mellitus [6]. Evidence from research has shown that remission of Type 2 Diabetes Mellitus with bariatric surgery can occur following intensive interventions in lifestyle but with few untoward adverse effects [11].

According to the American College of Lifestyle Medicine [11]:

1. Significant clinical improvement in patients with type 2 diabetes mellitus can occur following adequate intensive interventions in modifications of lifestyle.

2. Consumption of a whole plant-based diet in addition to participating in moderate exercise can lead to remission of diabetes mellitus and should be added to the optimal treatment of diabetes mellitus.

Lifestyle modification is also important in the prevention of pre-diabetes Mellitus before it progresses to diabetes mellitus [3]. In the Heart of New Ulm (HONU) Project, the heart screening programme showed that a decline in lifestyle modification especially increased body weight (overweight and obesity) and consumption of alcohol as well as a reduction in the consumption of fruits and vegetables over two years is associated with a higher incidence of metabolic syndrome including diabetes mellitus [11].

The result of this project showed a strong association between body mass index and metabolic syndrome [11]. In another study conducted in Nepal, there was a statistical relationship between type 2 diabetes mellitus and hypertension, dyslipidaemia, alcohol and tobacco use [14]. All these are diseases related to harmful healthy habits which can be prevented by modification in lifestyle. Evidence from other research has shown that remission of type 2 diabetes mellitus is possible with non-pharmacological interventions which include lifestyle modification that translates to the practice of lifestyle medicine [8, 11], increasing physical activity in the form of exercise and engaging in healthy dietary habits and reduction in weight is the primary goal of prevention of Type 2 Diabetes Mellitus [11].

Modification in lifestyle is the first line of management of diabetes mellitus. Weight loss is necessary for Type 2 Diabetes Mellitus and hypertension related to obesity. Exercise and healthy eating are necessary to lose weight and there are some of the pillars lifestyle medicine [29]. The reduction in weight is important as a preventive measure of cardiovascular disease and non-communicable disease as obesity serves as a risk factor for these diseases. The modification in lifestyle required for the management of diabetes mellitus are Medical Nutrition Therapy (MNT), Diabetes Self-Management Education and Support (DSMES), physical activity, cessation of the use of tobacco and counseling [30]. The results of the study conducted by Johansen et al. [31] in which 98 participants were randomized. There was a change in the level of glycosylated hemoglobin ($HbA_{1c}$) from 6.65 to 6.34% in the group where there was an intervention in the modification of their lifestyle, there was a reduction in the dose of oral hypoglycaemic agents in 73.5% of the study participants [31].

## 6. The role of the pillars of lifestyle medicine in the management of diabetes mellitus

### 6.1 The role of stress management in the management of diabetes mellitus

Stress management is one of the pillars of lifestyle medicine. Stress can be defined as the response the body makes to any demand that is made on it. Being a diabetic is stressful already and diabetes mellitus is also stressful to the body; the worst is when there are diabetic complications. During stress, several hormones are released such as cortisol and other hormones that mobilized energy [32]. These hormones lead to hyperglycaemia as stress affects the endocrine system leading to

changes in the mechanism of metabolism of glucose. Chronic exposure to stress has several deleterious effects on the body [33]. The rise in the blood glucose following stress is not associated with physical stress alone but with any form of stress including emotional and psychosocial stress [34], which may be experienced daily.

There is an undiagnosed and underestimated incidence of depression, anxiety, the stress in diabetics [32], and there is a correlation between these mental problems with non-communicable diseases including diabetes mellitus. Some diabetics have co-morbid mental health disorders that are not recognized by the physician hence they are not diagnosed [32]. In a case–control study conducted by Krishna [34] among Type 2 diabetics on depression, anxiety and stress, there was a lower level of depression, anxiety and stress in the healthy controls compared to those diagnosed with diabetes mellitus as the diabetics had a higher incidence of depression, anxiety and stress. Hence, stress management is key in diabetes mellitus management.

Emotional problems are common in diabetics and diabetics are at risk of various emotional and psychological problems such as depression, anxiety and diabetes-specific distress [35]. One of the sources of distress in diabetes is the lifelong treatment which is required [36]. Faridah et al. [36] in their study on the relationship between emotional distress and quality of life of patients with Type 2 Diabetes Mellitus used the diabetes distress scale for their study. In this study, a significant relationship was observed using linear regression between emotional distress characteristics p-value >0.05 [36]. There was a positive relationship between glycaemic control and emotional distress in another study conducted by Strandberg et al. (2019) [37] where 319 adults with Type 1 diabetes mellitus were studied. This study proposed that during every clinical consultation with a diabetic, depression and diabetes specific emotional distress should be watched out for [37].

In a South African cohort study conducted to investigate distress related to diabetes mellitus in patients with Type 2 Diabetes Mellitus, diabetes distress scale was used for this study. Distress was seen in 44% of the study participants [38]. This study recommends that attention should be paid to the psychological requirements of the patients as it has a great impact on the outcome of the disease [38]. In a randomized trial of Type 2 Diabetes Mellitus by Survit et al. [39], a significant reduction in $HbA_{1c}$ occurred following education on stress management (0.5%). There was a lower level of the HbA1c after one year in subjects who were educated on stress management [39].

## 6.2 The role of adequate sleep and good sleep hygiene in the management of diabetes mellitus

Sleep is important for good health and adequate sleep is important for the management of sleep. Sleep may be defined as a state of unconsciousness in which the body rejuvenates itself and the soul is also nourished [15]. During sleep there is a healing of the physical body leading to the enhancement of health. The prescribed amount of sleep required daily is eight hours within 24 hours and at least 30 minutes of nap in the afternoon [15]. When sleeping, stress reduces including regaining energy and strength after tiredness as there is a reduction in the levels of hormones released during stress such as cortisol. Poor sleep or insufficient sleep can cause deleterious effects on the body, especially mental and physical health. Sleep is necessary for the regulation of several physiologic functions and processes. Some of these processes are related to the regulation of metabolism including the metabolism of glucose in the body [40]. The human mind and body need sleep to function healthily [41]. Several factors affect sleep including stress. In the management of diabetes mellitus, adequate sleep is important [42] as it is required for the effective maintenance of good glycaemic control [33]. In Type 2 diabetes mellitus, there is a

correlation between glycaemic control and disturbances. In sleep, as evidenced by epidemiologic studies, although the extent remains unclear [42]. Results of some studies have shown that loss of sleep causes an increase in calorie intake within 24 hours [40]. Although there is a novel discovery that insufficient sleep has been associated as an important risk factor for the development of diabetes mellitus, these studies are not yet conclusive [40].

Some other studies have investigated the association between diabetes mellitus and sleep apnoea, have revealed that autonomic neuropathy may be the reason for a dysfunction in the central respiration control of the diaphragm and also a decrease in the upper airway [16]. Also sleep apnoea in diabetes mellitus may also be related to obesity, as obesity is a risk factor for diabetes mellitus and sleep apnoea in a study by Bing-Qian et al. [33] on the impact of the quality of sleep on glycaemic control on patients with Type 2 Diabetes Mellitus, there was no significant relationship seen between the sleep efficiency and glycaemic control [1] although the researchers acknowledged that good sleep is necessary for improving the quality of life of diabetics. In a systematic review and meta-analysis on the impact of the amount of sleep and quality of sleep on glycaemic control in Type 2 Diabetes Mellitus, there was not enough evidence to conclude to relate the quality of sleep and the level of glycosylated hemoglobin although it was found that higher levels of glycosylated hemoglobin were seen in diabetics with sleep disturbances the glycosylated hemoglobin was not affected by disturbed sleep [42]. However glycaemic control in patients with Type 2 Diabetes Mellitus is disrupted with too much or too little sleep.

According to Surani et al. [41], there is a disruption in the glycaemic control following impaired quality of sleep which may have some deleterious effects on the body and the quality of life [42] as poor sleep leads to impaired decision making, loss of concentration. This will affect taking decisions on healthy food choices hence patients will choose unhealthy habits that will worsen the glycaemic control and overall management of the patients. In diabetics, there is speculation that reduced quality and duration of sleep can affect glucose control negatively [41, 43]. Also poor sleep in diabetics may be due to poor glycaemic control leading to poor quality of sleep which is required for the general wellbeing of every human being [43]. Hence for good glycaemic control, good sleep hygiene is necessary [15]. As sometimes disturbance of sleep may be an unrecognized health issue in diabetics.

### 6.3 The role of increased physical activity and exercise in the management of diabetes mellitus

Physical inactivity and sedentary lifestyle are one of the risk factors for non-communicable diseases and obesity and obesity is a risk factor for diabetes mellitus. There are short and long term advantages of physical activity including exercise and this cause a reduction of illnesses with obesity and physical inactivity as its predisposing factors including diabetes mellitus [24]. According to the results of several meta-analytical epidemiological studies on physical exercise including the Diabetes Prevention Programme (DPP) in the United States, diet and exercise and other components of lifestyle medicine causes a reduction in the progression of impaired glucose tolerance (IGT) in Type 2 Diabetes Mellitus [44].

During physical activity and exercise, it acts as physical stress on the body thereby leading to changes in the transportation of glucose thereby satisfying the increased energy demand that occurs during exercise [8]. Hence among the core components of lifestyle medicine in the management of diabetes mellitus [12]. Results of some observational studies have revealed that one of the non-invasive therapies for the prevention and management of diabetes mellitus is exercise; this extends to pregnant women, hence exercise also serves as a preventive measure and

for management of gestational diabetes mellitus [45] low impact exercises can be done by pregnant women.

In diabetes mellitus, there is an inadequate amount of insulin and hyperglycaemia also results from increased insulin resistance [19]. Insulin resistance is promoted by obesity and physical inactivity. In the muscles that are not exercised, deposition of visceral fat and also deposition of fat in the liver and muscle occurs by the sequestration of glucose transporter 4 (GLUT-4) [8]. This deposition of fat increases obesity and also worsens insulin resistance. Exercise burns off deposited fat which will definitely in turn positively affect insulin resistance. Improvement of the tolerance of glucose, reduction of insulin resistance and improvement in the lipid profile occurs during exercise thereby increasing and improving cardiovascular and cardiopulmonary function [10]. This improves the sensitivity of insulin and also helps in weight loss, which in turn improves the overall wellbeing of the diabetic and also serves as a preventive measure of other non-communicable diseases [5, 10, 45]. It also stimulates the uptake of glucose. In a study conducted by Miyauch et al. [46], the levels of glycosylated hemoglobin were decreased was seen in patients who engage in an exercise regimen [46]. The aims of exercise in both the prevention and management of Type 2 Diabetes Mellitus are to achieve good metabolic control of diabetes mellitus, weight reduction, increased physical activity, improvement of the cardiovascular function, improvement in dyslipidaemia by reduction of the blood lipids and the general sense of wellbeing and quality of life [10]. Exercise is also necessary for the management of Type 1 Diabetes Mellitus.

Mechanism of improvement of blood glucose through exercise therapy [18]:

- Increased intake of glucose
- Increased utilization of glucose
- Improved insulin sensitivity
- Protection of the function of beta cells of the pancreas

The recommended international guidelines for exercise for adults 18 years and above is to engage in an exercise of moderate intensity for 150 minutes or aerobic exercise and physical activity of vigorous activity for 15 minutes weekly. This can be done as episodes of ten minutes including exercises that strengthen the body involving the major groups of muscles performed on two or more days per week [8]. An exercise regimen begins with a warm-up exercise to stimulate the muscles followed by the conditioning phase and ending with the cooling-down phase. All the phases of exercise are important to prevent injury and muscle soreness. Exercise can act as medicine to the body but diabetics should still be counseled on taking their medications and not to avoid regular check-ups. Diabetics should avoid high impact and vigorous exercises except under the guidance of a physician. Diabetics who should not participate in exercises:

1. Diabetics with retinopathy
2. Diabetics with neuropathy
3. Recurrent hypoglycaemia
4. Recurrent hyperglycaemia

Exercise is very important in the prevention of Type 2 Diabetes Mellitus, it is also important in the management of Type 1, 2 and gestational diabetes mellitus [10, 18, 38].

### 6.4 The role of eating whole plant-based diet in the prevention and management of diabetes mellitus

Eating a whole plant-based diet involves eating meals composed of plants and removing processed meals, animal and animal products, high salt, sugar and fat. This is because they are all risk factors for non-communicable diseases and diabetes mellitus. These meals are referred to as unhealthy foods because of the negative effects. Consumption of a whole plant-based diet involves eating food rich in fruits, vegetables, and legumes. Fruits, vegetables and legumes are available globally and should be encouraged. Good nutrition is very important in any lifestyle intervention [24]. In whole food plant-based diet, consumption of fruits, legumes, whole grains, including nuts and seeds are emphasized. Also, the consumption of animal products and unhealthy foods such as red and white meat, poultry, fish, eggs, dairy products, refined and processed meal, added sugars and oils are minimized and if possible eliminated from the diet [11]. It has been shown that vegetarians who do not eat any animal product have a low prevalence of diabetes mellitus 2.9% with omnivores having a prevalence of 7.6%. Various data have shown between the consumption of processed meat such as bacon, sausage, and hot dog including consumption of eggs and diabetes mellitus [9]. Counseling patients on nutrition is very important in the management of diabetes mellitus. Every diabetic should always have a counseling session during their follow-up visit which should include diet from food available in the locality. The etiology of a wide range of diseases is linked to diet. One of the fundamental determinants of human health is the amount and type of food consumed [5].

It is very important to balance calorie intake and physical activity as a strategy to maintain an ideal weight and preventing overweight obesity and chronic diseases [3]. To fill up the satiety while consuming low calories, complex carbohydrates with a low glycaemic index should be consumed. Other dietary restrictions such as fasting improve the blood glucose but it should be done under the supervision of a physician preferably an endocrinologist and a diabetologist if available to avoid rebound hyperglycaemia which can lead to non-diabetic ketoacidosis and hyperglycemic hyperosmolar state. Intermittent fasting can be practised by diabetics as it is effective but not strict fasting [11].

Decreased consumption of fruits and vegetables is associated with metabolic syndrome [11]. Nutrition is very important in the practice of lifestyle medicine, various guidelines on nutrition for diabetes mellitus have recommended diets lows in red and processed meat, refined grains, added sugar, food sweetened with sugar and salts and saturated and trans-fat [3].

Lifestyle medicine promotes the eating of whole plant based diet which is one of the pillars of lifestyle medicine. There are various other diets plans that has been found to be beneficial in the management of diabetes mellitus such as the low glycaemic diet, dietary approaches to stop hypertension diet (DASH) and the Mediterranean diet.

In a study conducted by Paula et al. [47], they found out when the DASH diet was combined with walking, the result is a reduction in the ambulatory blood pressure monitoring in hypertensive patients with diabetes mellitus [47].

## 7. Conclusion

Diabetes mellitus is a non-communicable disease that can be prevented and managed using lifestyle modification which involves eating a diet that is rich in

complex carbohydrates and roughage. People with a family history of diabetes mellitus can prevent it from manifesting in them by modifying it. Good glycaemic control in diabetics can be achieved through good dietary control. This is because of financial commitment to diabetic management in patients without access to health insurance. It also helps to eliminate the psychosocial aspect diabetics go through having to take drugs throughout their lifetime.





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## References

[1] Sagner Mikatz D, Egger G, Liannow I, Schulz KLT, Braman M, et al. Lifestyle medicine potential for reversing a world of chronic disease epidemics: from cell to community. The International Journal of Clinical Practice. 2014, 68, 11, 1289-1292. Doi.10.1111/ijcp.12509

[2] Bodai BI, Nlakata TE, Wong WT, Clark DP, Lawenda S, Tson C, et al. Lifestyle medicine: a brief review of its dramatic impact on health and survival. Perm J. 2018, 22; 17-25. Doi. 10.7818/TPP/17-25

[3] Rippe JM. Lifestyle medicine: the health-promoting power of daily habits and practices. American Journal of Lifestyle Medicine. 2018, 12, 12(6), 499-512 doi.10.1177/15598276185554

[4] Nwatu CB, Onyekonwu CI, Unaogu NN, Ijeoma UN, Onyeka TC, et al. Health-related quality of life in Nigerians with complicated diabetes mellitus. A study from Enugu, South-East Nigeria. Nigerian Journal of Medicine. 2019, 28(2) 138-147

[5] Asif M. The prevention and control of type 2 diabetes by changing lifestyle and dietary pattern. J Educ Health Promot. 2014, 3:1, doi.10.41031/2277-9531.127541

[6] Yin-Ming L, Chin-Hsiae T. Lifestyle modification to manage type 2 diabetes. Tznchi Medical Journal. 2013, 25, 254-255

[7] Houlden RL, Yen HH, Mirranlinu A. The lifestyle history: a neglected but essential component of the medical history. American Journal of Lifestyle Medicine. 2018, 12(5), 404-415

[8] Galariz KI, Narayan V, Lobelo F, Weber WB. Lifestyle and the prevention of type 2 diabetes: a static report. American Journal of Lifestyle Medicine. 2018, 12(1), 4-20

[9] Bodai BI, Nlakata TE, Wong WT, Clark DP, Lawenda S, Tson C, et al. Lifestyle medicine: a brief review of its dramatic impact on health and survival. Perm J. 2018, 22; 17-25. Doi. 10.7818/TPP/17-25

[10] Khan S. Exercise for the management of diabetes mellitus: a review of the evidence. Journal of xxx Medical College. 2013, 3(2), 99-108

[11] Kelly J, Karlson M, Steinke G. Type 2 diabetes remission and lifestyle medicine: a position statement from the American College of Lifestyle Medicine. American Journal of Lifestyle Medicine. 2020.DOI;10.10.1177/1559827620930962

[12] Mekonnem OK, Abate HK, Fegeane ET. Modification among diabetes mellitus patients attending the University of Gondar. Comprehensive Specialized Metabolic Syndrome and Obesity Targets and Therapy. 2020, 13, 1969-1977

[13] Ripal RM. Lifestyle medicine: the importance of considering all the causes of disease. Revista de Psiquiatria Salud Menta. 2012, 5(1), 48-52

[14] Shrestha B, Nepal B, Shakya YL, Reyni B. Lifestyle factors associated with the risk of type 2 diabetes mellitus. Grande Medical Journal. 2019, (2), 77-83

[15] Dricy A, Baba V, Durai S, Asha HS, Belavendra A. A relationship between sleep quality and glycaemic control among subjects with type 2 diabetes mellitus. Indian Journal of Continuing Nursing Education. 2017m 18(2), 39-49

[16] Bopparu S, Surani S. Sleep and diabetes. International Journal of Endocrinology. 2010 doi.10.1155/2010/759505

[17] Riaz S. Diabetes Mellitus. Scientific Research and Essay. 2009, 4(5), 367-373

[18] Yang D, Yang Y, Li Y, Han R. Physical exercise as therapy for type 2 diabetes mellitus: from mechanism to orientation. Annals of Nutrition and Metabolism. 2015, 74, 313-321 doi.10.1159/000500110

[19] Olokoba AB, Obaterus OA, Olokoba CB. Type 2 diabetes mellitus: a review of current trends. Oman Medical Journal. 2012, 27(4), 269-273

[20] Mimich DM, Bland JS. Personalised lifestyle medicine: relevance for nutrition and lifestyle recommendations. The Scientific World Journal. 2013. Doi. http://dx.doi.org/10.1155/2013/129841

[21] Pok GK, Battjes-Fries MCE, Patjo ON, Vanderzji N, Piji H, Voshol P. Lifestyle medicine for type 2 diabetes: practice-based evidence for long-term efficacy of a multi-component lifestyle intervention (Reverse diabetes 2 Now). BMJ. Doi: 10.1136/bmjnph-2020-00081

[22] American College of Preventive Medicine, 2009, Lifestyle Medicine Evidence Review

[23] Yeh B, Kong D. The advent of lifestyle medicine. J Lifestyle Medicine. 2013, 13(1), 1-8

[24] Rooke J (Ed). Gobble J, Ballard T, Oglesby W, Guttrie G, Howard C, Newsam RJ. Lifestyle medicine standards task force. Lifestyle medicine standards. American College of Lifestyle Medicine. www.lifestylemedicine.org. ACCM-Standard

[25] Egger G. Defining a structure and methodology for the practice of lifestyle medicine. American Journal of Lifestyle Medicine. 2016, DOI, 10,1177/155982 7616669327, XX(X), 1-8

[26] Canadian academy of lifestyle medicine. www.canadalifesty lemedicine.ca

[27] Forey JP, Posha WSC. The challenge of diet, exercise and lifestyle modification in the management of the obese diabetic patient. International Journal of Obesity. 1999, 23 Suppl 7,S5-S12

[28] Lindetrom J, Laicheranti TA, Mameli M, et al. Finnish diabetes prevention study group. The Finnish Diabetes Prevention Study Group (DPS): lifestyle intervention and 3-year results on diet and physical activity. Diabetes Care. 2003, 26, 3230-3236

[29] Masuo K. Lifestyle modification is the first line treatment for Type 2 Diabetes. www.intechopen.com 2003. http://dx.doi.org/10.5772/56377

[30] American Diabetes Association. Lifestyle management standards of medical care in diabetes. Diabetes Care. 2018, 14(1), s38-s50.

[31] Johansen MY, MacDonald CS, Hansen KB, Karstoft K, Christensen R, Peterson M et al. Effect of an intensive lifestyle intervention on glycaemic control in patients with Type 2 Diabetes, a randomized clinical trial. JAMA. 2017, 318(77), 637-646.

[32] Kaur H, Kocher R. Stress and diabetes mellitus. International Journal of Health Sciences and Research. www.ijhsr.org. 2017, 7(7), 265-272

[33] Bing – Qian Z, Xiao – Mei L, Dan W, Xing – Feng Y. Sleep quality and its impact on glycaemic control in patients with type 2 diabetes mellitus. International Journal of Nursing Science. 2014(1), 260-265

[34] Krishna P. Depression, anxiety and stress levels in patients with type 2 diabetes mellitus. National Journal of

Physiology, Pharmacy and Pharmacology. 2018,8(1),1570-1571

[35] Pouver F. Should we screen for emotional distress in Type 2 Diabetes Mellitus? Nat Rev Endocrinol. 2009, 5, 665-671.

[36] Faridah IN, Perwitasari DA, Pusfita M, Jasman H. Relationship between emotional distress and quality of life on Type 2 Diabetes Mellitus patients in Merati Island, Regency Hospital. IOP Conference Series Materials: Science and Engineering. 259,2017.0.2002. doi: 10.1088/1757-899x/259/1/012002

[37] Strandberg RM, Graue M, Wentzel-Carson T, Peyrot M, Rokne B. relationships of diabetes-specific emotional distress, depression, anxiety and overall well-being with $HbA_{1c}$ in adult persons with Type 1 Diabetes. Journal of Psychosomatic Research. 2014, 77(3), 174-179

[38] Ramkisson S, Pillary BJ, Sartorius B. Diabetes distress and related factors in South African adults with Type 2 Diabetes. Journal of Endocrinology, Metabolic and Diabetes of South Africa. 2016, 21(2), 35-39.

[39] Survit RS, Triburg MAL, Zucker N, McCaskill MC, Parekh P, Feinglos MN et al. Stress management improves long-term glycaemic control in Type 2 Diabetes. Diabetes

[40] Grandner MA, Seixas A, Shetty S, Shenoy S. Sleep duration and diabetes risk: population trends and potential mechanisms. Current Diabetic Reports. 2016, 16(11), 106. Doi.10.1007/S/1892-016-0805-8

[41] Surani S, Biito V, Surani A, Ghamande S. Effect of diabetes mellitus on sleep quality. World Journal of Diabetes. 2015, 6(6), 865-874

[42] Lee SWH, Ng. KY, Chin WK. The impact of sleep amount and sleep quality on glycaemic control in type 2 diabetes: a systematic review and meta-analysis. Sleep Medicine Reviews. 2017, 31, 91-101

[43] Knutson KL, Ryden AM, Mander BA, Cauter EV. Role of sleep duration and quality in the risk and severity of type 2 diabetes mellitus. Arch Intern Med. 2006,166: 1768-1774

[44] Sati T. Physical exercise for diabetes mellitus: the effective programmes for treatment. JMAS: 2003, 46(7), 314-320

[45] Wang C, Gyelfi KJ, Hiu-Xia Y. Exercise and its role in gestational diabetes mellitus. Chronic Diseases and Translational Medicine. 2016, 2, 208-214

[46] Miyauchi M, Toyoda M, Kaneyema N, Miyatake H, Tanaka E, Kimura M, Umezono T, et al. Exercise therapy for the management of type 2 diabetes mellitus: superior efficacy of activity monitors over pedometers. Journal of Diabetes Research. 2016. http://dx.doi-org/10.1155/2016/5043964

[47] Paula TP, Viana LV, Neto ATZ, Leitao C, Gross JL, Azevedo MJ. Effects of DASH diet and walking on blood pressure in patients with Type 2 Diabetes and uncontrolled hypertension: a randomized trial. The Journal of Clinical Hypertension. 2015, 17(1), 895-901