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Chapter - 4
Diabetes Mellitus and Dietary Management

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Chapter - 4

Diabetes Mellitus and Dietary Management

Dr. C. Kalapriya

Abstract

Diabetes mellitus is a condition where the body is not able to take up sugar (glucose) into its cells and use it for energy. This results to build up extra sugar in the bloodstream. Poorly controlled diabetes can lead to serious consequences and damage wide range of body's organs and tissues including heart, kidneys, eyes and nerves. This chapter elaborates Diabetes mellitus, types of diabetes and their symptoms, factors affecting diabetes, the diagnostics tests that are carried for diabetes mellitus, dietary management, food exchange lists, glycemic Index of foods, complications associated with diabetes.

Keywords: Diabetes mellitus, insulin, hyperglycemia, glycemic index

Introduction

The worldwide prevalence of diabetes mellitus has risen dramatically and is projected to rise to nearly 440 million people by 2030 (Shaw 2010). In India, it is projected to rise to 79.4 million individuals (Wild 2004). There is a lack of awareness about the condition, how to treat it, and the symptoms of diabetes amongst the general population.

Diabetes is a metabolic disorder in which there are high levels of sugar in the blood, a condition called hyperglycemia. During normal conditions, food is broken down to glucose which then enters the bloodstream and acts as fuel to the body. The pancreas produces a hormone called insulin which helps to carry glucose from the bloodstream into muscle, fat and liver where it can be used as fuel. Diabetics are not able to move this sugar out of the bloodstream because of two primary reasons:

- 1) The pancreas does not produce enough insulin.
- 2) The cells do not respond normally to insulin, a condition called insulin resistance.

Because of these condition people with diabetes have high blood sugar levels. Diabetes has reached an astonishing level globally. The World Health Organization (2019) states it affects 170 million people worldwide with a predicted increase to 366 million by the year 2030, 10 times the number affected by HIV/AIDS. Of that 366 million, more than 298 million will live in developing countries. India is one of many developing nations combating this epidemic. There is a lack of awareness by the general population, a lack of knowledge by healthcare providers on how to treat the disease, and no coordinated healthcare infrastructure to support chronic and acute treatment.

Types of diabetes and their symptoms

- 1) Insulin-dependent diabetes mellitus. (Type-I)
- 2) Non-insulin dependent diabetes mellitus. (Type-II)
- 3) Malnutrition related diabetes mellitus (MRDM)
- 4) Gestational Diabetes

1. Insulin-dependent diabetes (IDDM or Type-I)

Type-I of diabetes usually affects children or adolescents and is known as juvenile onset diabetes. There is little or no production of insulin and as a result, such individuals require daily insulin injections. There is usually a sudden onset. The symptoms get severe, when insulin injections are discontinued. The diabetic develops a life-threatening metabolic complication referred to as ketoacidosis.

Symptoms of Type 1 diabetes

- Extreme hunger
- Increased thirst
- Unintentional weight loss
- Frequent urination
- Blurry vision
- Tiredness

2. Non-insulin dependent diabetes (NIDDM or Type II)

This usually affects overweight or obese adults and is known as adult onset diabetes. Non-insulin dependent diabetes, develops slowly and is usually milder and more stable. The insulin production may be normal or even high. However the insulin produced is not as effective as normal insulin. Individuals with this type of diabetes, diet, exercise or oral anti-diabetic drugs may be enough to control the raised blood sugar.


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Symptoms of type 2 diabetes

- Increased hunger
- Increased thirst
- Increased urination
- Blurry vision
- Tiredness
- Sores that are slow to heal because of elevated glucose levels which is hard for the body to heal.

3. Malnutrition Related Diabetes Mellitus (MRDM)

This type of diabetes is mainly seen in some tropical countries like India and it occurs in young people between 15-30 years of age. Generally people with MRDM are lean and undernourished. In this type of diabetes, the pancreas fails to produce adequate insulin. As a result, these diabetics require insulin. In contrast to type 1 diabetics, these patients generally do not develop ketoacidosis, when insulin injections are discontinued.

Symptoms of malnutrition related diabetes mellitus

- Reduced appetite.
- Lack of interest in food and drink.
- Feeling weaker.
- Wounds taking a long time to heal.
- Poor concentration.
- Feeling cold most of the time.
- Getting ill often and taking a long time to recover.
- Feeling tired all the time.

4. Gestational diabetes

Diabetes developed during pregnancy is described as gestational diabetes. It occurs rarely in about 1% of pregnant women. Gestational diabetes increases the diabetes related complications during pregnancy and also the subsequent development of diabetes after the delivery.

Symptoms of gestational diabetes

- Increased thirst.
- Increased, frequent urination

- Nausea and vomiting
- Fatigue.
- Blurred vision.
- Weight loss even with increased appetite.

Predisposing factors and symptoms

- 1) **Heredity:** The strongest predisposing factor is family history. Offspring of diabetics have insulin resistance and decreased insulin sensitivity.

Familial risk of developing diabetes

- a) If both parents are diabetics 99%.
 - b) If one parent is a diabetic and the other.
 - c) from a family with a history of diabetes 70%.
 - d) If only one parent is a diabetic 40%.
 - e) If there is no history of diabetes in family 20%.
- 2) **Obesity:** The chances of developing diabetes in obese individuals is 3 times higher than in non-obese individuals.
 - 3) **Waist circumference:** Is a reliable method of identifying people with a higher risk of developing diabetes. Waist circumference expands with increasing body waist. If waist circumference is greater than 94 cm in women and 80 cm in men, the person is twice as likely to have more than 2 risk factors. Diabetics have a higher waist to hip ratio (WHR). If the WHR is greater than 1.0 in men and greater than 0.8 in women, there is a greater risk to develop diabetes mellitus.
 - 4) **Age and sex:** Individuals over 35 years of age have a 2-3 fold increase in developing diabetes especially if they are 50%.
 - 5) **Physical activity:** Lack of physical activity increases the chance to develop obesity which increases the risk for developing diabetes. Physically inactive individuals have a 40% chance of developing diabetes mellitus.
 - 6) **Under nutrition:** Under nutrition impairs b cell function by increasing the susceptibility of individuals to genetic and environmental influences.
 - 7) **Stress:** Stress precipitates diabetes in susceptible individuals. In stress the body releases adrenaline, noradrenalin, cortisone that raise blood glucose levels and counteract available insulin.

- 8) **Intake of simple sugars:** A high intake of sugar is associated with a prevalence of obesity and hence diabetes mellitus. Sugar also depletes chromium which is essential for regulating blood sugar levels.
- 9) **Alcohol:** Short term risk of heavy or continuous alcohol intake include hypoglycaemia, glucose intolerance and ketone accumulation.

Symptoms

Many diabetics are not aware that they have the disease. Following are the symptoms:

- 1) Polydipsia (Excessive thirst).
- 2) Polyphagia (Increased appetite especially for sweets).
- 3) Polyuria (frequent urination) and nocturia.
- 4) Itching.
- 5) Easy tiring, weakness or irritability.
- 6) Drowsiness.
- 7) Slow healing of cuts and wounds.
- 8) Frequent infections of the skin, gums and vagina and pain in the legs, feet, urinary tract or fingers.
- 9) Blurred vision.
- 10) Hyperglycaemia (elevated blood sugar level) above 140mg/100ml, the normal level being 80-100 mg/100 ml-A deficient supply of functioning insulin affects the metabolism of carbohydrates, fats and Proteins. As a consequence glucose enters the circulation and hyperglycemia follows.
- 11) Glycosuria (sugar in the urine).

Diagnostic tests

Diabetes may be present when sugar is present in the urine or when the blood sugar after fasting (12 hours after the last meal) or two hours after meals (post-prandial) is higher than 120mg/100ml. Diagnosis of diabetes is confirmed after an oral glucose tolerance test.

Oral Glucose Tolerance Test (OGTT)

This test is carried out after 12 hours of overnight fasting. Glucose-75g in adults and 1.75g/kg of body weight in children is orally administered. Before the glucose load and two hours after it, blood samples are collected and glucose levels are estimated.

The diagnostic criteria for diabetes and impaired glucose tolerance test (IGT) are given below. In normal persons without diabetes the fasting sugar levels vary between 80-110mg/100ml. The blood sugar levels increase after the glucose load and come down to basal level within two hours.

Urinary sugar

Glucose is excreted into the urine when the blood glucose levels are elevated beyond 180mg/100ml. Diabetics lose varying amounts of glucose depending on the severity of disease and the dietary intake of carbohydrates. The approximate amount of urinary sugar can be easily monitored by the available diagnostic strips (uristix). The changes in the colour of the reagent or strip indicate sugar levels in the urine.

Benedict's test

Eight drops of urine and 5 ml of Benedicts solution are taken in a test tube and mixed. The test tube is kept in boiling water for 5 minutes and colour is noted. It is better to carry out this test on the second urine sample collected in the morning as urine sugar in this sample will more or less reflect blood sugar level.

Test carried to detect pre-diabetes

Glycosylated hemoglobin-(Hb A_{1c})

As the concentration of glucose in blood rises, more glucose gets attached to hemoglobin (a pigment present in RBC) and the combined molecule is chemically estimated as glycosylated hemoglobin. It reflects the general trend of glucose levels in the blood during the previous 2-3 months. In normal individuals the glycosylated hemoglobin concentrations vary from 4-7% while in diabetics it is 8-18% of the total hemoglobin depending on the blood sugar level.

Dietary management

Diabetes can be treated by diet alone, or diet and hypoglycaemic drugs or diet plus insulin depending on the type and severity of the condition. There is no cure for diabetes but it is a manageable disease (National Institute of Diabetes and Digestive and Kidney Diseases 2016). The main modes of treatment of diabetes are diet, exercise, drugs and education.

Objectives in the management of diabetes

- 1) Reduce the sugar in blood and urine.
- 2) Maintain ideal body weight.


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- 3) Treat the symptoms.
- 4) Reduce serum lipids.
- 5) Provide adequate nutrition.
- 6) Avoid acute complications.
- 7) Prevent vascular complications.

Principle of diet

The diet should be high in dietary fibers, vitamins, minerals, moderate in protein and low in fat and complex carbohydrate. Intake of calorie should be according to body weight and it should help to maintain appropriate body weight, age and the nature of work.

Dietary management

Diabetic diet need not be a complete deviation from the normal diet. Indian diets are generally high in carbohydrate and low in fat, with carbohydrates providing 60-65% of total calories and fat providing 15-25% of total calories. The rest of the calories 15-20% is derived from proteins. The nutrient content of a diabetic diet has to be planned based on the age, sex, weight, height, physical activity and physiological needs of the patient.

Diet for a diabetic can be planned using

- 1) Food exchange lists.
- 2) Glycemic index of foods.

1. Food exchange lists

Food exchange lists are groups of measured foods of the same caloric value and similar protein, fat, carbohydrate and can be substituted one for another in a meal plan. A balanced diet is one in which all the five food groups are included in required amounts in order to meet the recommended dietary allowances for individuals.

The food exchange lists help the patient to restrict the foods intake according to the insulin prescription so that hyperglycemia and hypoglycemia can be prevented and to have variety in the diet.

2. Glycemic index

The glycemic index indicates the extent of rise in blood sugar in response to a food in comparison with the response to an equivalent amount of glucose. The ability of the food item to raise the blood sugar is measured in terms of glycemic index.

Glycemic Index = (Blood glucose area of test food/Blood glucose area of reference food) x 100

Factors that affect the glycemic response to food are

- 1) Rate of ingestion of food.
- 2) Food form.
- 3) Food components-fat content, fibre content, protein content.
- 4) Method of cooking and processing food.

The glycemic index is therefore useful in planning diet for diabetics. Cereals like wheat, rice, root vegetables like potato and carrot have a high glycemic index (65 - 75%). Fruits have an intermediate glycemic index (45 - 55%) and legumes have a low glycemic index (30 - 40%) and are hence beneficial to diabetics.

Energy

The calculated calorie requirement should allow the patient to lose or gain weight as required and maintain body weight 10% lower than the ideal/desirable body weight. Dietary calories should be 60-70 per cent from carbohydrate 15-20 per cent from protein and 15-25 percent from fat.

Carbohydrate

High carbohydrate high fibre diet is given as it improves insulin binding. Complex carbohydrate found in cereals and pulses are recommended. These are then broken down into simple sugars before they are absorbed from the gut. Refined carbohydrates such as sugar, honey, jaggery and jam contain simple sugars which are directly absorbed are not recommended for diabetics, as they cause a rapid rise in blood sugar.

Protein

It is recommended that 15-20% of total calories be derived from proteins. Proteins supply essential amino acids needed for tissue repair. Proteins do not raise blood sugar during absorption and do not supply as many calories as fats. In patients with NIDDM, (Non-insulin-dependent diabetes mellitus). consumption of protein along with carbohydrate will lower the blood glucose concentration. One gram of protein per kilogram body weight is adequate.

Fat

Low fat diet increases insulin binding and also reduces LDL and VLDL levels and reduces the incidence of atherosclerosis which is more common in


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diabetics. Fat content should be 15-25% of total calories and higher in polyunsaturated fatty acids.

Vitamins and Minerals

These are protective factors which are essential for the body. They are present in fruits and vegetables.

Dietary fibre

Intake of 25g of dietary fibre per 1000 calories is considered optimum for a diabetic. High fibre foods have a low caloric value and low glycemic index and therefore diabetics should consume such foods liberally. Fibre present in vegetables, fruits, legumes and fenugreek seed is soluble in nature and more effective in controlling blood sugar and serum lipid than insoluble fibre present in cereals. High-fiber diet promotes weight loss, lower insulin requirements, Decrease serum cholesterol and triglyceride values and lower blood pressure.

Dietary guidelines for diabetes

- 1) Timely intake of in between meal and snacks should be stressed to avoid hypoglycemia.
- 2) Patients should avoid fasting and feasting.
- 3) The diabetes should avoid alcohol.
- 4) Take small but frequent meal.
- 5) Take plenty of fluids.
- 6) Diet should be balanced.

The purpose of a glycemic index (GI) diet is to eat carbohydrate-containing foods that are less likely to cause large increases in blood sugar levels. The diet could be a means to lose weight and prevent chronic diseases related to obesity such as diabetes and cardiovascular disease.

Complications associated with diabetes

High blood sugar damages organs and tissues throughout your body. The higher your blood sugar is and the longer you live with it, the greater your risk for complications.

A. Acute complications

A diabetic is likely to develop acute complications as a result of sudden decrease or increase in blood sugar levels.

- 1) **Hypoglycemia:** The rapid lowering of blood sugar (below 40 - 50 mg/dl) is known as hypoglycemia. The person may experience increased appetite, weakness, sweating, restlessness, palpitation and giddiness. The diabetic who develops hypoglycemia should immediately be given sugar or glucose.
- 2) **Ketoacidosis:** When the body cannot utilize carbohydrates to provide energy, it burns fats and certain amino acids. This results in increased formation of ketones, which accumulate in the blood resulting in ketoacidosis. This is a serious condition and the patient can go into a coma.
- 3) **Infections:** In diabetics, cuts and wounds heal slowly. They are prone to infections of the skin, urinary tract and foot.

B. Long term complications

- 1) **Heart disease, heart attack and stroke:** Increased predisposition of the diabetic for atherosclerosis (hardening of blood vessels due to deposition of fatty substances) because they generally have high levels of blood lipids as cholesterol and triglycerides, which make them susceptible to heart disease and stroke.
- 2) **Microangiopathy:** Lesions that affect the small blood vessels of the eyes and kidneys.
- 3) **Retinopathy:** Lesions of the eye results in rapid deterioration of eye sight.
- 4) **Nephropathy:** Lesions of the kidney result in the excretion of protein in the urine. Neglect may lead to kidney failure.
- 5) **Neuropathy:** Diabetics can develop lesions of the peripheral nervous system. Patients with neuropathy experience tingling, numbness and it is a degenerative condition of sensory nerves resulting in pain and absence of reflexes.

Conclusion

Diabetes mellitus is growing to epidemic proportions, leading to devastating complications in the developing countries. The major reasons for this is due to sedentary life style, lack of exercise, lack of awareness on balanced diet, selection of foods on low glycemic index foods. There are many challenges in the successful treatment of diabetes mellitus because of personal and economic costs incurred in diabetes therapy. The long-term consequences lead into enormous human suffering and economic costs. Individuals affected with diabetes in the family must take care of this


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condition and must educate the other members in the family to follow precautionary steps to prevent this as the saying goes Prevention is better than Cure.

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