

BSc Health and Social Care
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a) Introduction

Diabetes mellitus is defined as a chronic metabolic problem marked by the presence of hyperglycemia due to defects in insulin secretion, decreased response to insulin, or the combination thereof. Among various types of diabetes mellitus, Type 2 diabetic mellitus (T2DM) is the most prevalent form that accounts for more than 90% of the estimated incidents in the population globally. Thus, it becomes an important issue within the field of public health (NICE, 2022). Type 2 diabetic mellitus is marked by progressive complications that are closely related to insulin resistance. Insulin resistance in the body means that the body's organs do not respond effectively to insulin.

There is an alarming prevalence of T2DM in recent years, largely because of the rising incidence of obesity, physically inactive lifestyles, and poor dietary habits (World Health Organization, 2023). Major risk factors for the condition are being overweight or obese, particularly if it is Visceral obesity, physically inactive lifestyles, hypertension, hyperlipidemia, smoking, the progressive process of growing older, and having first-degree relatives with the condition. It is also observed that people of African, South Asian, or Caribbean ethnicity are more vulnerable (Sagastume et al., 2022).

Complications related to Type 2 DM affect various aspects of patients' health. These complications may comprise cardiovascular complications, neuropathy, retinopathy, nephropathy, among others. Patient education in the primary care clinic is also very crucial because many people do not recognize the relationship between their lifestyles and how they affect their blood glucose levels. Enhancing patient awareness also helps patients in the self-management process related to blood glucose checking, dietary adjustments, and exercises (Zhang et al., 2023).

b) Explain how blood sugar levels are maintained at a safe and effective level for the body's needs.

The maintenance of the concentration of glucose in the bloodstream is an essential biological process achieved through the synergy of major hormones, namely insulin and glucagon. These hormones help regulate the concentration of glucose in the bloodstream, keeping it within safe margins and ensuring the proper functioning of vital organs, especially the brain. With the consumption of a meal, there is the digestion of carbohydrates, resulting in the release of glucose, hence an increase in the concentration of glucose in the bloodstream. This increase triggers a response in the pancreatic beta-

cells in the islets of Langerhans in the pancreas to release insulin (NICE, 2022). The release of insulin from the pancreas triggers a response in the skeletal muscle fibers and fat cells in the body, hence an increase in their glucose uptake. The uptake of glucose by the skeletal muscle fibers and fat cells in the body occurs through the translocation of glucose transporter type 4 proteins in the cells. The glucose transporter type 4 proteins act as “gatekeepers” in the process. In addition to promoting glucose uptake in cells, insulin also triggers the process of glycogenesis in the liver, where excess glucose is converted to glycogen, thereby reducing the problem of hyperglycemia. Moreover, insulin inhibits the release of glucose from the liver.

Glucagon, on the other hand, has an opposite but equally vital role in glucose regulation. Produced in the pancreatic α -cells, glucagon is released in conditions where lower levels of blood glucose are present, such as in fasting, during prolonged periods of muscular exercise, and in conditions of illness. The primary functions include the increase in blood glucose concentrations through the process of glycogenolysis, the breakdown of glycogen in the liver into glucose, and gluconeogenesis, the formation of glucose from non-carbohydrate sources like amino acids. The combined role of insulin and glucagon forms the basis of a negative feedback system that works all the time in a regulated manner, keeping the levels of glucose in the desired range. The brain, their primary source, relies heavily on glucose.

In the case of Type 2 diabetic patients, there is an impairment in this precisely regulated process. The primary disruption in the process has been observed in insulin resistance, where the muscle, liver, and fatty tissues become less responsive to the action of insulin. The effect on the cells would be the reduced uptake of glucose, leading to an increase in glucose levels in the bloodstream. The pancreas, in response to the resistance, increases the secretion of insulin in an attempt to counter the effect. Eventually, the pancreas becomes exhausted, and its ability to produce insulin becomes defective, resulting in the lack thereof. Hyperglycemia perpetuates complications, such as neuropathy, retinopathy, nephropathy, and cardiovascular disease. These complications develop because excessive glucose concentrations in the blood have toxic effects on the vasculature and nerves. Thus, the role of insulin and glucagon in the glucose-insulin and glucose-glucagon

systems, respectively, would help in understanding why the treatment and management of T2DM are needed.

c) Show how oxygen and glucose are used to produce energy through cell metabolism.

Energy production in the body is mainly the function of cellular respiration, the process by which glucose and oxygen are converted into ATP. This is achieved through various steps.

Glycolysis is the initial stage, occurring in the cytoplasm. Pyruvate forms from glucose along with low levels of ATP. However, if oxygen is present, the process continues in the mitochondria during the tricarboxylic acid cycle along with oxidative phosphorylation. Approximately 30-36 molecules of ATP are generated from one molecule of glucose. Oxygen serves as the electron acceptor in the electron transport chain.

Mitochondria have an especially important function in energy production. Dysfunction of mitochondria is being increasingly recognized as an important contributing factor to the development of T2DM. Insulin resistance alters the entry of glucose into the cell, causing decreased production of energy in the form of ATP. This manifests as sugar accumulation in the blood (chronic hyperglycemia), damage to mitochondria, elevated production of ROS.

d) Briefly examine how recording and tracking blood sugar levels helps individuals with Type 2 diabetes to safely manage their condition.

Frequent blood glucose tracking is crucial for persons living with T2DM. Self-monitoring of blood glucose (SMBG) helps the individual check their results on a daily basis. By analyzing the results, one is able to note the trends in their blood glucose. Since one is aware of how their food, stress levels, medicines, and exercises affect their blood glucose levels, they are better placed to make the relevant adjustments.

Continuous glucose monitoring (CGM) is now much more widely available and very beneficial. CGM systems allow the measurement of the glucose levels throughout both daytime hours and nocturnal periods. Present studies clearly indicate the efficacy of the use of CGM in the better control of the glucose levels in patients having Type 2 DM by reducing the risk of life-threatening hypoglycemic episodes. Recent studies from systematic review also implicate the positive effect of the use of CGM in the better control of glucose levels in diabetic patients irrespective of the use of insulin.

Such tracking of glucose levels helps primary care physicians in the process of adjusting the levels of medications taken by the patient. Additionally, it also promotes patient engagement in the process of controlling their glucose levels, giving them confidence in their ability to manage their condition.

e) Include evidence-based recommendations on how lifestyle changes could help improve their condition.

Lifestyle interventions play an essential part in the control of individuals with T2DM. There is adequate supporting evidence for the diet and activity interventions along with weight control measures.

Dietary changes: Nutrient-dense dietary patterns like the Mediterranean diet, composed of lots of fruits, vegetables, whole grains, legumes, fish, and olive oil, have been proven to enhance glycaemic control. Low glycaemic index meals work by delaying the digestion process of carbohydrates in order to prevent peak glucose levels.

Physical Activity: Exercise promotes the sensitivity of insulin in the body by increasing the use of glucose in skeletal muscles. At least 150 minutes of moderate-intensity aerobic activity per week, along with resistance exercises twice a week, is recommended. Exercise improves the function of mitochondria in the body by decreasing visceral fat and lowering HbA1c.

Weight Management: Reducing body weight by 5-10% helps in reducing blood sugar levels and improving insulin sensitivity. Recent studies also suggest that remission of T2DM is achieved in the majority of people through intensive lifestyle modification programs.

Cessation of smoking: Smokers are known to develop insulin resistance, inflammation, endothelial damage, and higher risks of cardiovascular diseases. From recent researches, there is conclusive evidence proving that people who smoke are at higher risks of having Type 2 DM than those who do not smoke.

Sleep and stress regulation: Poor sleep hygiene habits and persisting stress in the body increase the secretion of the stress hormone cortisol. Cortisol works to increase blood glucose levels in the body by decreasing the effect of insulin.

f) Conclusion

The management of Type 2 diabetes mellitus heavily depends on the patient's understanding about the disease and the involved pathophysiology. Without proper

understanding, the patient cannot make appropriate choices on issues related to lifestyle, management, and personal care measures. Type 2 diabetes mellitus has a perpetual problem in the management of glucose, mostly because of the intricate impact of insulin resistance and pancreatic beta-cell dysfunction. Understanding the pathophysiology related to the disease process would help a patient comprehend the need for monitoring and lifestyle changes in the management of the disease.

Glycemic control requires the integrated action of the following two major hormones: insulin and glucagon. While insulin reduces postprandial glucose levels in the bloodstream by stimulating glucose uptake and its uptake in the liver, glucagon, on the other hand, regulates the occurrence of hypoglycemia between the meals through the release of glucose from the liver. In a normal individual, the actions of these hormones are regulated in an intricate manner by a negative feedback process and keep glucose levels in the bloodstream in a narrow range. In the event of T2DM, the bodies lose the delicately balanced regulatory process. While there is increased resistance in the uptake of glucose in the muscular and adipose tissue, the release of insulin in the body becomes defective.

The other important element in the management of diabetes is the role of glucose and oxygen in the production of energy within cells. Glucose would work as the fuel source in the body, and sufficient oxygen would be needed in the process of producing energy in the form of ATP. In the condition called diabetes, the problem in glucose uptake in the cells resulting from insulin resistance could potentially lead to problems in the process of energy production. Examples of problems include weakness, decreased physical strength, poor wound healing, and increased vulnerability to infections. Individuals who understand the role would better appreciate the need to maintain constant glucose levels in the body.

Glycemic monitoring represents an essential part of safe and proper diabetic management. Self-monitoring of blood glucose concentrations provides spot values, allowing the patient to evaluate the relationship between diet, psychological stress, exercise, and antidiabetic treatment. The role of Continuous Glucose Monitoring Systems goes even further, since they offer moment-to-moment information and trends over time, making it possible to detect variations that remain undetected through SMBG. These

systems allow the patient to recognize harmful trends, like postprandial spikes and nocturnal events, in order to make changes in lifestyle, consult the doctor in due time, and make appropriate adjustments under the supervision of the medical team. There exists a strong, evidence-supported basis for various lifestyle changes, all of which make a significant contribution to the better management and prevention of complications in T2DM. Eating healthy, leading an active lifestyle, and obtaining some measure of weight reduction make important contributions to increased insulin sensitivity and reduced blood glucose. Quitting smoking decreases the risk of cardiovascular events, and the risk of developing cardiovascular disease has long existed in the diabetic patient. Good sleeping habits and proper management of stress factors also make an important contribution to the increased risk of high blood glucose, resulting from the disruption in the hormone levels in the bloodstream.

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