

CHAPTER II

THEORETICAL OVERVIEW

A. Diabetes Melitus

1. Definition

Diabetes mellitus or diabetes is a chronic disease that can be suffered for a lifetime. Diabetes mellitus (DM) is caused by metabolic disorders that occur in the pancreas which is characterized by an increase in blood sugar or often referred to as a hyperglycemia condition caused by a decrease in the amount of insulin from the pancreas. DM disease can cause various complications, both macrovascular and microvascular. DM disease can cause cardiovascular disorders which is a fairly serious disease if not treated as soon as possible so that it can increase hypertension and heart infarction.

There is one study that shows that DM is a very important degenerative disease because it is included in the top four non-communicable diseases that are increasing every year and become a global health threat in modern times, DM is caused by a lack of eating vegetables and fruits, as well as consuming too much sweet and salty foods and drinks as well as fast food. This condition is increasingly worrying with the increase in DM cases in the young age group of approximately 15 years old (Kelas et al., 2025).

One of the previous researchers stated that Indonesia is the country that ranks fourth in the number of people with diabetes after the United States, China and India. In addition, DM sufferers in Indonesia are expected to increase rapidly by 2-3 times by 2030 compared to 2000. Added to the explanation of WHO data that, the world is currently inhabited by 171 million people with DM and will increase 2 times,

366 million by 2030. The Data and Information Center of the Ministry of Health of the Republic of Indonesia also states that the IDF's latest estimate that by 2035 there will be 592 million people living with diabetes in the world (Lestari et al., 2021)

2. Etiology

The habit of consuming artificially sweetened drinks and *junk food* in adolescents can have an impact on increasing blood glucose levels. The risk of hyperglycemia in adolescence is multifactorial and is influenced by various lifestyle factors, but the most dominant is the consumption pattern of foods and drinks high in sugar and high calories which can affect glucose metabolism in the body. High consumption of artificially sweetened beverages can lead to an increase in simple sugar intake so that it triggers a spike in blood glucose levels. In addition, the consumption of *junk food*, which is generally high in fat, sugar, and salt and low in fiber, can also disrupt the body's metabolic balance and increase the risk of insulin resistance. These factors, if they occur continuously, can increase the likelihood of hyperglycemia in adolescents.

The causes of diabetes mellitus can vary, which are as follows:

- a. Gender: The prevalence of Type 2 DM in women is higher than in men (Ministry of Health of the Republic of Indonesia BKPK, 2023). Women suffer more from diabetes because physically, women have a higher risk of experiencing an increase in body mass index. Premenstrual and postmenopausal syndrome, which causes the distribution of body fat to easily accumulate due to hormonal processes, makes women more susceptible to suffering from type 2 diabetes mellitus.
- b. Age: Age < 45 years is the group with a lower risk of developing Type 2 DM. The risk in this group was 72 percent lower than those aged 45. There are

significant association between age and the incidence of DM. The age group that suffers the most from DM is the 45-52 year old age group (47.5%). The increased risk of diabetes with age, especially after the age of 40, is caused by an increase in glucose intolerance at that age. The aging process leads to a decrease in the ability of cells β the inner pancreas to produce insulin. As we age, mitochondrial activity in muscle cells decreases by up to 35%. This has to do with a 30% increase in muscle fat content, which triggers insulin resistance.

- c. Body mass index (BMI): Obese individuals have a 2.7 times greater risk of developing diabetes mellitus. This is due to a lack of physical activity and high consumption of carbohydrates, proteins, and fats, which are risk factors for obesity. This leads to an increase in free fatty acids (FFA) in the cells. This increase in FFA will reduce the translocation of glucose transporters to the plasma membrane, leading to insulin resistance in muscles and adipose tissue. Individuals with a BMI of ≥ 23 kg/m² are at risk of developing type 2 DM.
- d. History of hypertension: There is a significant association between blood pressure and DM. The results showed that people with hypertension had a greater risk of developing diabetes, with a 6.85 times higher chance compared to those who did not have hypertension. Some literature links hypertension to insulin resistance. The effect of hypertension on the incidence of DM is caused by the thickening of the walls of arterial blood vessels, which narrows the diameter of the blood vessels. This interferes with the process of transporting glucose from the blood.

- e. Cholesterol levels: High cholesterol levels are at risk of developing type 2 DM. High cholesterol levels lead to an increase in free fatty acids, which results in apoptosis. This will damage the beta cells of the pancreas, leading to type 2 DM. Type 2 DM patients showed low HDL levels (37.3%) compared to high HDL levels (25.6%). High triglyceride levels (57.1%) significantly increase the risk of developing type 2 DM.
- f. Physical activity: An active body is beneficial for controlling blood sugar. This is important because when the body is active, sugar is burned and converted into energy, thereby reducing the amount of insulin. When a person does not get enough physical activity, nutrients that enter the body will accumulate and be stored as fat, thus increasing the risk of type 2 DM. There is a relationship between physical activity and the incidence of type 2 DM (Prasetyo, n.d.)

3. Pathophysiologists

According to (Maria, 2021) a person with type 2 DM, hyperglycemia persists throughout the night despite the presence of insulin produced naturally by the body. Insulin production can vary greatly in people with type 2 diabetes, and even if it is present, insulin usefulness is reduced due to insulin resistance in the peripheral nervous system. Insulin production can vary greatly in people with type 2 diabetes. As a consequence of abnormal carbohydrate metabolism of food, the pancreas secretes a very low amount of insulin, which in turn causes the liver to produce very high amounts of glucose.

The pathophysiology of type 2 diabetes is multifactorial and progressive, involving two main defects: insulin resistance and inadequate insulin secretion. Research shows that "for type 2 diabetes mellitus to occur, insulin resistance and inadequate insulin secretion must be present." Insulin resistance usually precedes the development of hyperglycemia. often years in advance. During this period, pancreatic beta cells compensate by increasing

insular secretion, maintaining relatively normal glucose levels despite reduced tissue sensitivity. However, this compensation mechanism eventually fails as the beta cells become dysfunctional and begin to experience a decrease in mass.

An important aspect of the pathophysiology of type 2 DM involves what has been described as "pancreatic islet paracryopathy" in which the reciprocal relationship between glucagon-secreting alpha cells and insulin-secreting beta cells is interrupted, leading to hyperglycemia, and consequently hyperglycemia". This disruption of alpha cell function results in improper glucagon secretion, which exacerbates hyperglycemia through increased liver glucose production. As the disease progresses, pancreatic atrophy can occur, which further interferes with the endocrine and exocrine function of the pancreas (Yameny, 2025)

4. Klasifikasi

According to the *American diabetes association 2020* , normal blood sugar in adolescents is classified as 100-140 mg/dL categorized as hyperglycemic risk, which means blood sugar levels are higher than normal so there is a risk of increased blood sugar (Yuliana Silvia et al., 2024)

Diabetes is conventionally classified into several clinical categories, although these categories are being reconsidered based on genetic, metabolomics and other characteristics as well as pathophysiology:

- a. Type 1 DM (caused by autoimmune b-cell damage, usually leading to absolute insulin deficiency, including latent autoimmune diabetes in adults).
- b. Type 2 DM (caused by a progressively non-autoimmune loss of adequate b-cell insulin secretion, often against the background of insulin resistance).
- c. Specific types of DM due to other causes, such as monogenic DM syndrome, exocrine pancreatic disease, and drug- or chemical-induced DM.

5. Clinical manifestations

The signs and symptoms that DM patients will experience are as follows:

- a. Polyuria (frequent urination): a condition when a person excretes excessive amounts of urine.
- b. Polyphagia (feeling hungry quickly): a condition in which hunger increases excessively so that a person eats more often or in larger quantities than usual.
- c. Weight loss especially in type 1 dm patients
- d. Polydipsia (excessive thirst): a condition of excessive thirst that causes a person to drink much more than usual.
- e. Vision becomes blurred due to changes in osmolarity in the eye
- f. Tingling/numbness especially in the hands and feet (peripheral neuropathy)
- g. Wounds that are difficult to heal
- h. Recurrent infections
- i. Dry/itchy skin due to dehydration and fungal infections (Lestari et al., 2021) (Ceriello & Colagiuri, 2025)

6. Risk Factors

a. Age

Age is a major risk factor for diabetes. Screening should begin no later than age 35 for everyone. Screening should be considered in adults of any age who are overweight or obese and one or more risk factors for diabetes (Care & Suppl, 2025)

b. Obesity and fat distribution

Overweight and obesity are the drivers of the global diabetes epidemic. This condition affects most adults in most developed countries and is increasing rapidly in developing countries. If current global trends continue, the number of overweight people (BMI ≥ 25 kg/m²) is projected to increase from 1.3 billion in 2005 to nearly 2.0 billion by 2030.

c. Diet

Excessive calorie intake is a major driving factor behind the rising epidemic of obesity and type 2 diabetes worldwide, but the quality of diet also has independent effects. In the Nurse Health Study, we found that the quality of fats and carbohydrates plays an important role in the development of diabetes, regardless of BMI and other risk factors. In particular, a higher glycemic load of foods and trans fats was associated with an increased risk of diabetes, while greater consumption of cereal fiber and polyunsaturated fats was associated with a decreased risk. In a meta-analysis, we found that an increase in whole grain intake by 2 servings/day was associated with a 21% lower risk of diabetes.

d. Physical activity

A number of epidemiological studies show that increased physical activity reduces the risk of diabetes, while sedentary behaviors increase the risk. Every increase in time spent 2 hours/day increases the risk of diabetes by 14%. Every 2 hours/day increase in standing or walking at home was associated with a 12% reduction in risk. Every increase of 1 hour/day of brisk walking is associated with a 34% reduction in risk. These results suggest a continuum in the relationship between physical activity levels and diabetes risk. Among sedentary behaviors (watching TV, sitting at work, and other sedentary activities), watching TV for long periods of time was associated with the highest risk.

e. Smoking

Smoking is an independent risk factor for type 2 diabetes. A meta-analysis found that active smokers had a 45% higher risk of developing diabetes compared to non-smokers. In addition, there is a dose-response relationship between the number of cigarettes smoked and the risk of

diabetes (overweight or obesity and one or more diabetes risk factors (Care & Suppl, 2025)

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7. Complications

a. Acute complications

b. Diabetic ketoacidosis, and severe hypoglycemia occur if poor blood sugar control is sudden, can be life-threatening.

c. Microvascular complications

diabetic retinopathy (eye disorders to blindness), nephropathy (kidney), neuropathy (nerves). Damage to small blood vessels due to chronic hyperglycemia.

d. Macrovascular complications

Coronary heart disease, stroke, peripheral vascular disease. Complications of large blood vessels, increased risk of death.

8. Governance

The management of diabetes mellitus can be done by means of education and lifestyle modifications, such as education to understand diabetes, complications, and stable blood sugar targets, and for lifestyle, encourage patients to reduce their consumption of sugar and fast food and apply the principle of 3j (amount, type, hours), and encourage physical activity such as exercising at moderate intensity.

B. Consumption of artificial sweetened drinks and junk food

1. Definition of artificial sweeteners

It is a synthetic food additive that is used to give sweetness to food and drinks, generally does not provide nutritional or caloric value to the body. *The WHO* recommends limiting the consumption of free sugars to less than 5% of daily energy intake, Given that more than 23,000 products worldwide contain artificial sweeteners and their consumption is high and steadily increasing, the potential health impacts of these sweeteners have become an important but controversial topic that has attracted attention from health authorities such as the European Food Safety Authority and *the WHO*. Chen et al., 2024)

Impact mechanism:

- a. Stimulation of *Sweet Taste Receptors*: Artificial sweeteners (aspartame, sucralose, saccharin, acesulfam-K) activate sweet taste receptors in the mouth and intestines. Activation of these receptors can trigger a *cephalic insulin response*, which is the initial release of insulin in the absence of real glucose, which can eventually interfere with insulin sensitivity.
- b. Changes in the Gut Microbiota (Gut Microbiota Dysbiosis): The consumption of artificial sweeteners chronically changes the composition of the gut microbiota, especially lowering bacteria that play a role in maintaining glucose metabolism. This results in glucose intolerance and insulin resistance, which are major factors in diabetes.
- c. Disruption of Glucose Metabolism Regulation: Some artificial sweeteners can affect the release of the hormone *incretin*, which plays a role in regulating insulin secretion and gastric emptying. As a result, the body's response to glucose becomes unstable.

Some of the ingredients that are generally found in artificially sweetened drinks include the following:

1) Artificial sweeteners

Artificial sweeteners are substances used to give sweetness to foods or drinks with a very low number of calories. Some types of artificial sweeteners that are often used include:

- a) Aspartame
- b) Saccharin
- c) Sucralose
- d) Acesulfame potassium

This sweetener has a much higher level of sweetness than regular sugar so it is only used in small amounts.

2) Simple sugar

Some sweetened drinks also still contain simple sugars that can increase blood glucose levels, such as:

- a) Glucose
- b) Fructose
- c) Sucrose

3) Preservatives

Preservatives are used to extend the shelf life of the beverage and prevent the growth of microorganisms. Examples of preservatives that are often used include:

- a) Sodium benzoate
- b) Potassium sorbate

4) Food coloring

Dyes are added to give the drink a more attractive look. Dyes can come from natural or synthetic materials.

5) Flavors or flavor enhancers

Flavors are used to give a drink a certain aroma and flavor, for example the flavor of fruit such as orange, strawberry, or grape.

6) Carbonation (carbon dioxide)

In some drinks such as fizzy drinks, carbon dioxide gas is added to produce a bubbly sensation.

2. Definition of *junkfood*

It is a fast food that in recent times has been in great demand among teenagers, *junk food* is also known as a food that contains high calories, fat, sugar, and salt but has a very low vitamin content and also contains various food additives such as sweeteners, flavorings and preservatives that can cause health problems such as diabetes mellitus if consumed in excess (Junkfood, 2022)

Impact mechanism:

- a. Sugar and Moderate High Carb Content: Junk food is typically high in *refined carbohydrates* (sugar, white flour) and low in fiber. As a result, glucose is quickly absorbed causing a spike in blood glucose levels (hyperglycemia) and triggering excessive insulin secretion.
- b. High Saturated and Trans Fat Content: Saturated and trans fats cause oxidative stress and low-grade inflammation that interferes with insulin signaling which can lead to insulin resistance.
- c. High Calories & Large Energy Density: Excess energy intake from *junk food* increases the risk of obesity, which is a major risk factor for type 2 diabetes
- d. Low in Fiber and Micronutrients: Fiber helps slow down the absorption of glucose. *Junk food* that is low in fiber makes glucose rise quickly after eating (Chen et al., 2024)

Some of the ingredients that are generally found in *junk food* include the following:

1) Simple carbohydrates

Junk food often contains simple carbohydrates that are easily digested by the body so that they can increase blood glucose levels quickly.

Simple carbohydrates that are often found in *junk food* include:

- a) Glucose
- b) Fructose

c) Sucrose

2) Saturated fat

Saturated fat is widely found in fast food such as french fries, fried chicken, and burgers. Excessive consumption of saturated fat can increase the risk of obesity as well as metabolic disorders of the body.

3) Trans fats

Trans fats are usually formed during the food processing process, especially in foods that are fried using oil repeatedly. These fats can increase the risk of metabolic diseases and other health disorders.

4) High salt or sodium

Junk food generally has a high salt content to enhance the flavor of food and extend shelf life. High sodium can affect the body's fluid balance as well as increase the risk of cardiovascular disease.

5) Food additives

Junk food also often contains various food additives, such as:

- a) Preservatives to extend the shelf life of food
- b) Food coloring to improve the appearance of food
- c) Flavorings to enhance the taste of food

B. Theoretical Framework

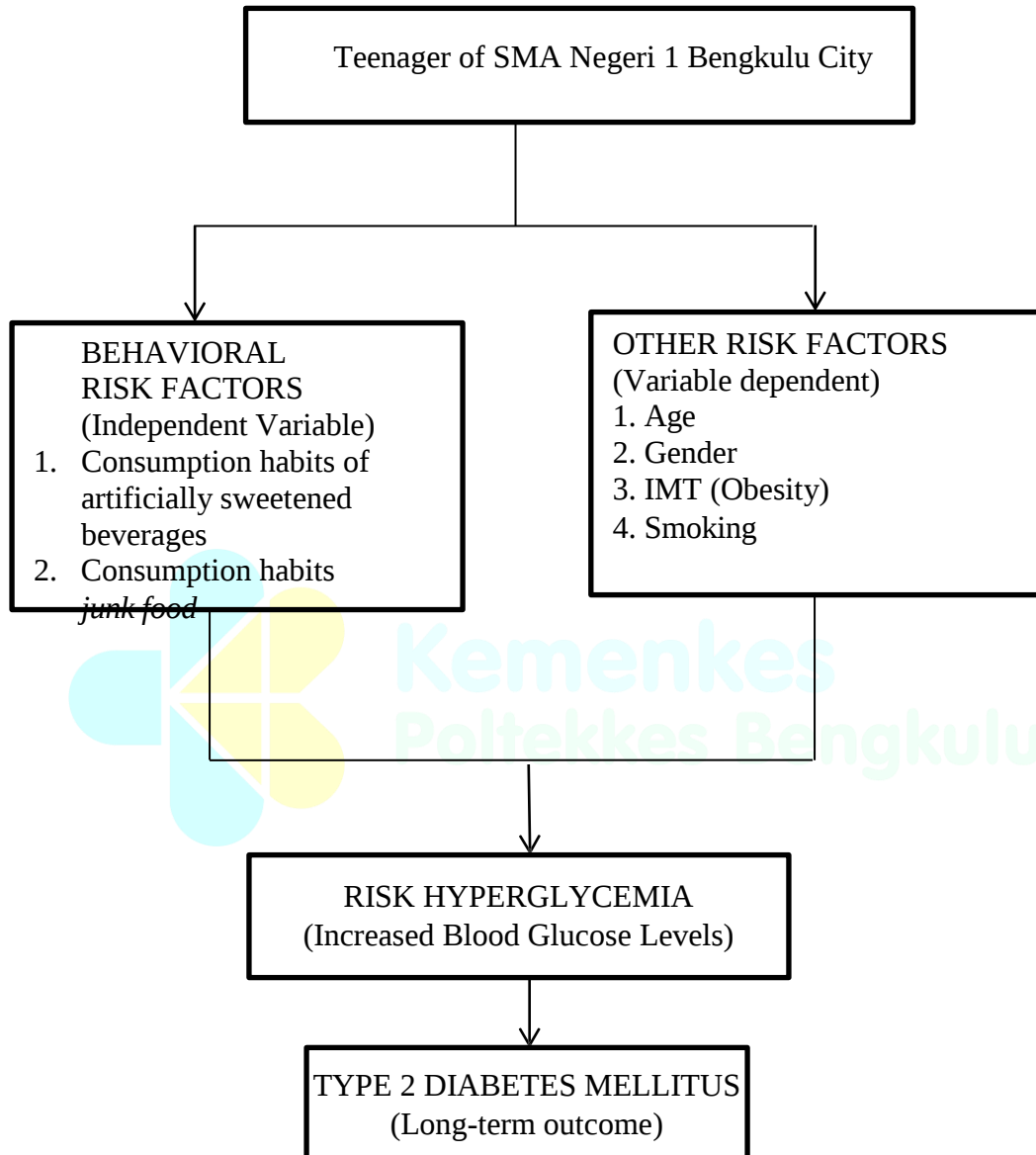


Chart 2. 1 Theoretical Framework

Source : (Han, 2023)