CHAPTER II
LITERATURE REVIEW

A. Theoretical Concept of Diabetes Mellitus (DM)

1. Definition of Diabetes Mellitus

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by elevated blood glucose levels, which, over time, can impair the function of vital organs, including the heart, blood vessels, kidneys, eyes, and nerves (WHO, 2024). According to *Perkumpulan Endokrinologi Indonesia*, DM is a metabolic disease characterized by elevated blood glucose levels resulting from inadequate insulin production, impaired insulin utilization, or a combination of both. (PERKENI, 2021).

Based on the foregoing explanations, it can be concluded that DM is a chronic metabolic disease characterized by elevated blood glucose levels resulting from impaired insulin production, impaired insulin action, or both. This condition not only disrupts normal metabolic processes but also contributes to progressive damage to vital organs, including the heart, blood vessels, kidneys, eyes, and nerves.

2. DM Classification

According to the American Diabetes Association, (2025) DM can be classified into the following categories:

a. Type 1 Diabetes Mellitus (T1DM)

T1DM is characterized by autoimmune destruction of the pancreatic β-cells, resulting in absolute insulin deficiency and the inability of the body to produce sufficient insulin.

b. Type 2 Diabetes Mellitus (T2DM)

T2DM is the most common form of diabetes. It is characterized by elevated blood glucose levels resulting from progressive pancreatic β-cell dysfunction accompanied by insulin resistance.

c. Gestational Diabetes Mellitus (GDM)

GDM is a type of diabetes that develops during pregnancy, typically in the second or third trimester, in individuals with no previous diagnosis of diabetes.

d. Specific Types of Diabetes Due to Other Causes

This category includes diabetes resulting from specific underlying causes, such as monogenic diabetes syndromes (e.g., neonatal diabetes and maturity onset diabetes of the young), diseases of the exocrine pancreas (e.g., cystic fibrosis and pancreatitis), and drug- or chemical-induced diabetes, including that associated with glucocorticoids and antiretroviral therapy.

3. Risk factors

Risk factors for DM are broadly classified into two categories: non-modifiable risk factors and modifiable risk factors (Friska et al., 2025).

a. Non-modifiable risk factors

Several non-modifiable risk factors for DM have been identified, including age over 45 years (although DM may also occur in individuals younger than 40 years), female sex, and a family history of DM. In addition, a history of gestational diabetes mellitus (GDM), polycystic ovary syndrome (PCOS), and low birth weight (< 2.500 g) are also recognized as non-modifiable risk factors.

b. Modifiable risk factors

Modifiable risk factors for DM include overweight or obesity, physical inactivity, hypertension, abnormal blood lipid levels (dyslipidemia), smoking, unhealthy dietary habits, sleep disturbances, and prediabetes or metabolic syndrome.

4. Pathophysiology

People with DM are prone to hyperglycemia due to the interaction of various complex factors. High blood sugar levels can damage pancreatic beta cells and inhibit insulin production, leading to recurrent

metabolic disorders. Although thresholds vary, hyperglycemia generally occurs when blood glucose exceeds 180 mg/dL. When these levels exceed 250 mg/dL, the kidneys will fail to reabsorb glucose, which then leads to frequent urination symptoms (polyuria) and excessive thirst (polydipsia) (Sapra & Bhandari, 2023).

Insulin resistance occurs due to the formation of fatty acids and inflammatory substances in the body, which inhibit the absorption of glucose by cells and promote fat breakdown. When insulin production or response is insufficient, the body increases the level of the hormone glucagon inappropriately, so that blood sugar levels increase. In T2DM, the condition develops more severe when insulin production is no longer able to balance the resistance that occurs (Sapra & Bhandari, 2023).

Chronic hyperglycemia causes sugar to stick to the body's proteins, a process called non-enzymatic glycation that can be monitored through an HbA1c test. This process slowly damages delicate blood vessels and triggers typical complications such as retinopathy, nephropathy, and diabetic neuropathy. Without proper control, this condition can lead to serious impacts in the form of blindness, kidney failure, and amputation (Sapra & Bhandari, 2023).

5. Clinical Manifestations

According to the American Institute for Preventive Medicine (Suryanti et al., 2025), several signs and symptoms may indicate the presence of DM, including the following:

a. Overweight or obesity, which may increase the risk of developing metabolic disorders.
b. Frequent drowsiness, particularly after meals or during light physical activity.
c. Feeling tired or weak easily, even after adequate rest.
d. Blood glucose levels exceeding the normal range.
e. Excessive itching, particularly around the genital area.

f. Frequent urination (polyuria), especially at night. Excessive thirst (polydipsia) and increased hunger (polyphagia) despite having eaten.

g. Unintentional weight loss occurs because the body's cells are deprived of energy when glucose cannot be utilized effectively. As a result, the body breaks down fat and protein as alternative energy sources, while some calories are also lost through the urine. Consequently, muscle mass decreases, leading to significant weight loss.

h. Blurred vision. Elevated blood glucose levels also affect the blood vessels in the eyes. Thickening of these blood vessels may impair vision and, if left untreated, can lead to serious complications, including blindness.

i. Loss of foot sensation, such as numbness or tingling in the lower extremities or feet. Tingling commonly occurs in the hands and feet due to elevated blood glucose levels that damage the blood vessels. This damage impairs blood flow to the nerves, causing certain parts of the body to feel numb or as though they are being pricked with needles.

j. Recurrent skin infections, particularly in the feet, due to delayed wound healing. When blood glucose levels exceed 200 mg/dL, the body's ability to fight infection declines. As a result, wounds become more difficult to heal and are at greater risk of developing severe infections. If left untreated, these wounds may progressively worsen and eventually require lower-extremity amputation.

6. Complications

Complications of DM can occur in all types of DM and include disorders of small blood vessels (microvascular), large blood vessels (macroscular), as well as nerve damage (neuropathic) (Sapra & Bhandari, 2023). The severity and duration of uncontrolled blood sugar levels greatly affect the appearance of the following complications:

a. Acute Complications (Diabetic Ketoacidosis and HHS)

Insulin deficiency in type 1 diabetes triggers Diabetic Ketoacidosis (DKA) due to fat burning that produces ketone toxins. Meanwhile, people with type 2 diabetes are more susceptible to Hyperoglycemic Hyperomorphic Syndrome (HHS), which is an extreme spike in blood sugar without ketosis. Despite the different mechanisms, the treatment protocols of the two remain the same: fluid rehydration, insulin therapy, and electrolyte balancing.

b. Atherosclerotic Cardiovascular Disease (ASCVD)

Cardiovascular disease is the leading cause of death among people with DM, accounting for approximately two-thirds of all deaths. In T2DM, this risk increases when fasting blood glucose levels exceed 100 mg/dL, even before marked hyperglycemia develops.

c. Visual Impairment (Diabetic Retinopathy)

DM is the leading cause of blindness at the age of 20 – 74 years. Regular eye exams are crucial because this risk arises from the beginning of diagnosis in type 2, in contrast to type 1 which usually takes five years to complete. Retinal damage can be inhibited through disciplined control of blood pressure and blood sugar.

d. Kidney Disease (Diabetic Nephropathy)

Severe kidney damage often progresses to end-stage renal disease (ESRD). This life-threatening condition typically begins with microalbuminuria (30 – 300 mg/day), which, if left untreated, may progress to macroalbuminuria (> 300 mg/day).

e. Nerve Damage and Delayed Wound Healing (Diabetic Neuropathy)

Persistent hyperglycemia can lead to diabetic neuropathy, a form of nerve damage that results in the loss of protective sensation in the feet. Consequently, patients often fail to recognize minor injuries until they progress to severe infections. Routine foot

examinations are essential for preventing these complications, which are among the leading causes of lower-extremity amputation.

7. Diagnosis of DM

The recommended blood glucose test is carried out enzymatically using plasma from venous blood. Treatment results can be monitored with a glucometer (PERKENI, 2024).

Table 2. 1 Diagnostic Criteria for DM

Kriteria	Information
1	Fasting plasma glucose (FPG) ≥ 126 mg/dL, following at least 8 hours of no caloric intake (fasting).
2	Two-hour plasma glucose ≥ 200 mg/dL during an Oral Glucose Tolerance Test (OGTT) using a 75-g glucose load.
3	Random plasma glucose ≥ 200 mg/dL in the presence of classic symptoms of hyperglycemia or hyperglycemic crisis.
4	Hemoglobin A1c (HbA1c) ≥ 6.5%, measured using a method standardized by the National Glycohemoglobin Standardization Program (NGSP) and certified as traceable to the Diabetes Control and Complications Trial (DCCT) reference assay.

Source : PERKENI, (2024)

8. DM Management

The management of DM can be done as follows: (Haryati et al., 2023).

a. Pharmacological therapy

Pharmacological blood glucose control is carried out through the administration of Oral Hypoglycemic Drugs and insulin. Oral Hypoglycemic Drugs plays a role in increasing tissue sensitivity and stimulating insulin secretion, while recombinant insulin is responsible for suppressing the formation of new glucose and helping its absorption into the body's cells.

b. Non-pharmacological therapy

1) Education

Education aims to encourage patients to adopt a healthy lifestyle as a measure to prevent and control DM.

2) Food Planning

This therapy focuses on controlling blood glucose levels, blood lipid levels, and blood pressure through adherence to a healthy dietary regimen. Patients are required to follow the principles of appropriate quantity, food type, and meal timing.

3) Physical exercise

Physical activity plays an important role in lowering blood sugar levels and reducing the risk of heart disease. Exercises are carried out according to the body's ability and adjusted to food intake. It is recommended to exercise at least 30 minutes per day or 150 minutes per week at moderate intensity, about 50 – 70% of the maximum heart rate. However, the duration and type of exercise must still be adjusted to the physical ability and energy intake of each individual.

B. Concept of Foot Sensitivity

1. Definition of Foot Sensitivity

Chronic hyperglycemia or persistently elevated blood glucose levels, triggers peripheral nerve damage through multiple pathogenic mechanisms, ranging from chronic inflammation to the accumulation of advanced glycation end products (AGEs). This condition is further aggravated by damage to the small blood vessels that supply nutrients to the nerves, ultimately leading to the gradual loss of sensory function in the feet (Khudhur, 2026).

Foot sensitivity is the ability of peripheral sensory nerves, especially small and large nerve fibers on the soles of the feet, to respond to various stimuli such as pressure, touch, temperature, and pain. Leg sensitivity is caused by peripheral neuropathy, where peripheral nerve damage occurs that interferes with sensory, motor, and autonomic nerve function in the lower extremities. Damage to peripheral nerves generally occurs due to metabolic and vascular disorders that reduce the supply of oxygen and nutrients to the nerves, which then triggers degeneration of

nerve fibers and decreased impulse conduction speed. As a result, the sensory response of the feet is impaired in sensing various stimuli such as light touch, pressure, temperature, and vibration. This condition causes symptoms in the form of tingling, numbness, burning pain, and weakness of the leg muscles due to impaired function of nerve fibers which play a role in the perception of pain sensations and temperature. As a result of the loss of protective sensations, people become susceptible to repeated trauma unknowingly, which has the potential to cause injuries to the foot (Bodman et al., 2024; Yang et al., 2025).

2. Mechanism of Hyperglycemia in People with DM

In people with DM, this sensitivity often decreases due to diabetic peripheral neuropathy, which is progressive damage to nerve fibers (both large and small nerve fibers) due to exposure to chronic hyperglycemia, oxidative stress, and microcirculatory disorders that cause axonal dysfunction and demyelination. This decrease in foot sensitivity decreases the individual's ability to detect trauma or temperature changes, thereby increasing the risk of wounds, infections, and diabetic ulcers (Bodman et al., 2024; Sloan, 2021). Foot sensitivity check in people with DM can use a 10-gram monofilament test on several points of the foot. This tool is used as a simple and effective tool in detecting decreased sensitivity due to diabetic peripheral neuropathy (Malik, 2023).

3. Factors that affect the sensitivity of the foot

a. Blood Sugar Levels

According to the criteria of PERKENI, (2024), Random blood glucose (RBG) ≥ 200 mg/dL, fasting plasma glucose (FPG) ≥ 126 mg/dL, or 2-hour postprandial blood glucose (2hPPBG) ≥ 200 mg/dL indicates hyperglycemia. When persistent, hyperglycemia impairs the ability of blood vessels to constrict and dilate appropriately, thereby compromising blood flow, particularly to the lower extremities. Consequently, foot sensation gradually declines,

leading to symptoms such as leg pain, muscle cramps, tingling, and discomfort while standing or walking (Kim, 2023).

b. Age

Complications of DM in the form of neuropathy can occur in various age groups. However, the risk increases with a longer duration of diabetes due to progressive degenerative changes that impair physiological function, including the ability of pancreatic β-cells to produce insulin. Peripheral neuropathy is most commonly observed in individuals over the age of 50 years. According to Tofure et al., (2021), the majority of individuals with diabetic peripheral neuropathy were over 55 years of age (71.43%). In older adults, reduced blood flow to the peripheral nerves further impairs nerve function. However, this condition may also occur in younger individuals with DM.

c. Duration of DM

Individuals with DM who experience chronic hyperglycemia for one year or longer are at increased risk of developing impaired blood circulation and nerve dysfunction in the feet, which may progress to peripheral neuropathy (Kamalarathnam & Varadarajan, 2022). This prolonged condition damages the capillary blood vessels supplying the peripheral nerves, thereby disrupting nerve signal transmission and reducing foot sensitivity to physical stimuli. Peripheral nerve damage associated with a longer duration of diabetes leads to slower nerve conduction velocity, which clinically increases the prevalence of peripheral neuropathy and decreases foot sensation (Sabanayagam, 2023; Simanjuntak & Simamora, 2020). Another study reported that the majority of individuals who had lived with DM for more than five years (75%) developed diabetic peripheral neuropathy. This condition is often associated with inadequate glycemic control and limited knowledge regarding appropriate dietary management (Tofure et al., 2021).

d. Gender

Gender influences the risk of peripheral neuropathy among individuals with DM. Women are more susceptible to reduced foot sensation than men, particularly due to the decline in estrogen levels after menopause. Estrogen deficiency may impair glucose metabolism and peripheral nerve function, reducing the body's ability to regulate blood glucose levels and protect peripheral nerves from damage. Consequently, women are at a higher risk of developing diabetic peripheral neuropathy than men (Elliott et al., 2024).

e. Obesity and Dyslipidemia

Obesity and dyslipidemia are metabolic risk factors that contribute to the development of peripheral neuropathy. An increased body mass index (BMI) and abnormalities in the lipid profile may lead to insulin resistance and metabolic dysfunction, ultimately impairing blood circulation to the feet (Yang et al., 2025). Individuals with a BMI of ≥ 23 kg/m^2 for women and ≥ 25 kg/m^2 for men are at greater risk of reduced foot sensation due to impaired blood flow and peripheral nerve damage. (Nugraha et al., 2022).

f. Other Factors

Other factors that may influence foot sensation include the presence of comorbidities, such as hypertension or peripheral vascular disease, smoking, excessive alcohol consumption, and genetic factors, including a positive HLA-DR3/DR4 genotype. (Bodman et al., 2024).

4. Clinical Manifestations of Impaired Foot Sensation

The most common clinical manifestations of diabetic neuropathy include (Hammi & Yeung, 2022):

a. Tingling (paresthesia) or a sensation like a needle pricking in the legs and hands.

b. Burning, sharp pain, or like being electrocuted, especially at night. Sufferers often feel generalized pain that worsens at night. This pain usually appears in the form of a throbbing sensation that greatly interferes with rest.
c. Numbness or loss of sensation in the distal extremities, usually starting from the toes. Patients often experience a thick sensation in the soles of the feet. This condition makes the foot feel like stepping on a soft mattress, so the patient does not notice if the footwear comes off when walking.
d. Decreased ability to sense temperature, touch, and vibration, which often leads to unconscious wounds.
e. Muscle weakness or coordination disorders due to motor nerve damage. When there is damage to many peripheral nerves known as diabetic polyneuropathy, patients can experience walking disorders (lameness) as well as leg muscle reduction or atrophy.
f. Autonomic symptoms, such as orthostatic hypotension, indigestion, erectile dysfunction, and sweating disorders.

5. Foot Sensitivity Screening Using Monofilament Test

The Semmes-Weinstein Monofilament Test (SWMT) is a simple, non-invasive, and reliable method used to detect loss of protective sensation (LOPS) due to diabetic peripheral neuropathy. The examination was performed using nylon monofilament that applied 10 grams of pressure at several points in the patient's leg to assess sensory nerve function (Hazari et al., 2024).

According to research conducted by Aithal & Bhat (2024), in showing that the 10-gram Semmes-Weinstein monofilament test has high accuracy in detecting diabetic peripheral neuropathy. Approximately 80% of cases can be identified through this test, with specificity reaching 100% in distinguishing individuals without neuropathy. These results confirm that SWMT is an effective, practical, and reliable screening method, especially for health facilities with

limited resources. The American Diabetes Association (ADA) recommends this tool as the primary screening method for detecting peripheral neuropathy in people with DM due to its degree of accuracy and ease.

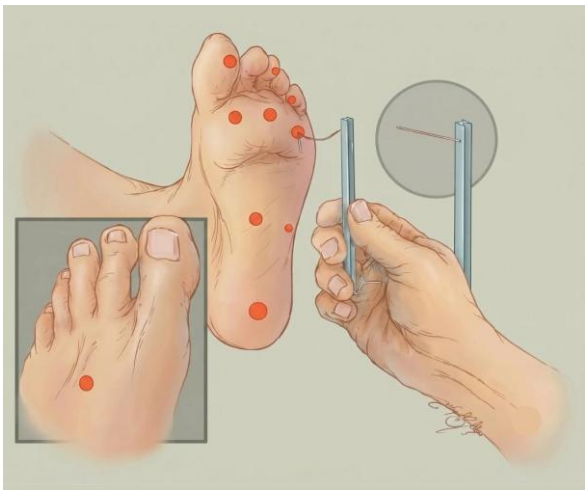

Figure 2. 1 Monofilament test uses (Artha, 2021)

The monofilament examination in this study was carried out based on a procedure developed by the South West Regional Wound Care Program in 2020, namely :

a. Asking the patient to take off his socks and shoes.
b. Explain the procedure to the patient and show the patient the monofilament.
c. Before performing an examination on the participant's legs, the monofilament is tested on the sternum or hand with the aim that the patient can recognize the sensation of taste from the touch of the monofilament.
d. Perform an examination on one of the limbs with both participants' eyes closed.
e. The monofilament is placed perpendicular to the examined skin, the pressure is carried out for 2 seconds, then immediately withdrawn.
f. Use monofilament at 10 location points on the left or right leg as shown in figure 2.1.

1) If there are ulcers, calluses, or scars on the feet, apply monofilament to the adjacent area.
2) If the patient has had an amputation, the test is performed at the possible location point only.
3) It can also be done in people with DM without diabetic foot problems.

g. At each location, three examinations were carried out, if the patient was indicated not to feel monofilament.
h. Evaluation of the inspection results:
   1) Positive: can sense the pressure of the monofilament and can show the location precisely after the monofilament is lifted, at 2-3 times of inspection.
   2) Negative: unable to feel pressure or unable to pinpoint the location accurately, on 2 out of 3 examinations.
   3) Positive result score = 1, negative result score = 0. So the total score on one leg varies between 0-10.

C. Concept of Foot Reflexology using a Foot Reflection Board

1. Definition of Foot Reflexolgy using a Foot Reflection Board

Foot Reflexology is a complementary therapy method that provides stimulation or controlled pressure to the reflection points on the sole of the foot that are believed to be related to certain organs, body systems, and nerve pathways. Mechanical pressure at the point of reflection triggers the mechanoreceptor to send signals to the spinal cord, and then the body responds by relaxing the muscles, increasing blood flow, and reducing discomfort. The process aims to improve blood circulation, nerve function, and sensory response, so that it can affect the sensitivity of the feet, especially in individuals with sensory disorders such as DM (Cai et al., 2023; Toledo et al., 2022; Vindis et al., 2024).

Foot Reflection Board is a complementary therapy tool that combines a map of the soles of the reflection points and focused

mechanical pressure on specific points developed based on previous research by offering the method of foot reflexology therapy and the principle of suppression that resembles acupressure, especially for people with DM who experience neuropathy symptoms such as numbness in the feet. The design of this tool places a protrusion or dotted surface on the area of the sole of the foot that corresponds to the reflex map to provide local stimulation (Dewi et al., 2023; Suwannarat et al., 2025).

Based on some of the explanations above, it can be concluded that the Foot Reflexology using a Foot Reflection Board media, can be defined as a measured stimulation technique on the sole of the foot to stimulate the peripheral nervous system. This intervention serves as an adjunct therapy to re-optimize the sensitivity of the sensory nerves that have decreased.

Figure 2. 2 Palm Seed Insole tool innovations
(Suwannarat *et al*., 2025)

2. Reflection Points

The reflection point is a stimulation point to bring about a healthy balance of the body. Stimulation is done to reduce the symptoms of neuropathy by placing emphasis on the points so that it can stimulate the sensory receptors in the legs so that it affects the nerve conduction in the legs (Surya & Desnita, 2020). At this reflection point, there are 4

focus points targeting the numb area and 15 reflexology points that cover the entire sole of the foot (Suwannarat et al., 2025).

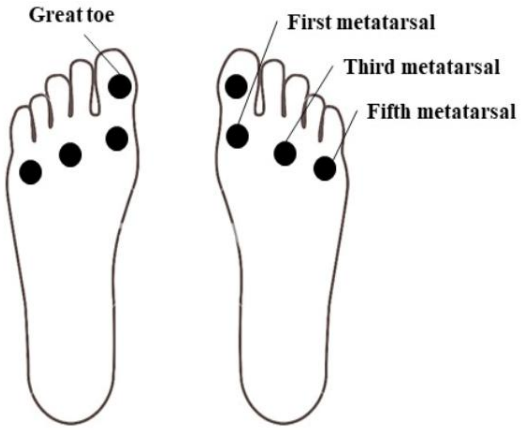

Figure 2. 3 Points associated with symptoms of foot neuropathy (Suwannarat et al., 2025)

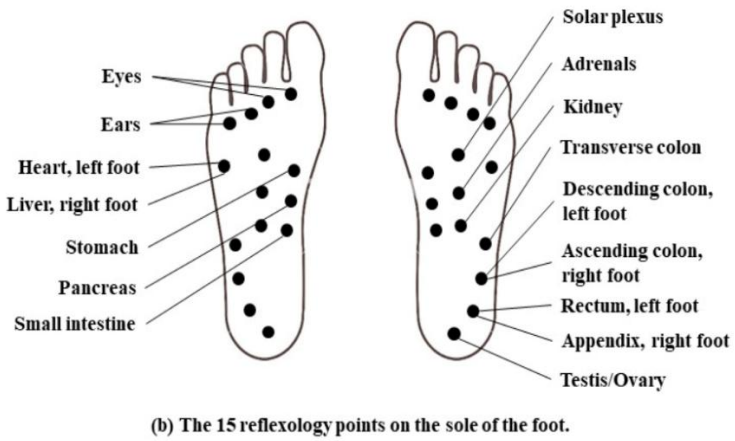

Figure 2. 4 15 reflection points on the soles of the foot (Suwannarat et al., 2025)

3. Mechanism of action of Foot Reflexology using a Foot Reflection Board on Foot Sensitivity of People with DM

The use of the Foot Reflection Board mechanically stimulates the sensory area on the sole of the foot through measured pressure. In people with DM 2, this routine intervention functions to activate plantar receptors, especially the Meissner and Pacini corpuscullum. This activity optimizes the transmission of nerve signals to the central

nervous system, so that it is able to improve conduction disorders due to neuropathy while increasing tactile sensitivity in the legs (Megda et al., 2020).

Applying acupressure pressure to the points of reflection on the surface of the body using fingers, other parts of the body or blunt aids aims to improve blood flow, relieve pain, increase relaxation, and help regenerate body cells, including nerve cells that are weakened due to DM complications (Ling et al., 2025). In people with DM with peripheral neuropathy, acupressure point stimulation can activate sensory receptors and autonomic nerves, triggering the release of vasoactive neuropeptides such as Calcitonin Gene-Related Peptide (CGRP) and substance P (SP). These substances play a role in dilating blood vessels, increasing blood flow to the lower extremities, and improving nerve function (Surya & Desnita, 2020). In addition, emphasis on specific points such as acupressure can lower inflammation and oxidative stress that damages nerves, while also increasing neurotrophic factors that support nerve regeneration (Ge et al., 2024).

The application of the Foot Reflection Board makes a significant contribution to the improvement of peripheral hemodynamics through the dilation of blood vessels and activation of the parasympathetic nervous system. This increased tissue perfusion ensures that the distal nerves receive adequate oxygenation, so that the process of regeneration of sensory functions runs faster and neuropathy complaints are reduced. In addition, the systemic effects of this therapy include a decrease in stress levels and more stable glycemic regulation, both of which are essential to prevent further nerve damage (Cicek et al., 2021; Toledo et al., 2022).

4. Implementation of the use of Foot Reflection Board

The use of the Foot Reflection Board was carried out for 15 minutes 3 times a week for one month to see the effect of pressing the soles of the feet on the degree of neuropathy in people with DM (Suwannarat et al., 2025).

How to use the Foot Reflection Board is as follows:

a. Ask the patient to remove the footwear, shoes/sandals.
b. Patients are asked to stand up straight and hold on to a chair or wall.
c. Place the foot in position 1, hold for 30 seconds
d. Put your foot in position 2, do a gentle foot stamping for 60 seconds.
e. Repeat back from position 1 to position 2.
f. Do it for 15 minutes.

D. Buerger Allen Exercise Concept

1. Definition of Buerger Allen Exercise

Buerger Allen Exercise is a simple non-pharmacological exercise that aims to improve blood circulation in the lower limbs, especially for people with DM who experience circulation disorders and decreased sensitivity of the legs due to peripheral neuropathy (Radhika et al., 2020). This exercise is done through alternating changes in the position of the legs such as elevating, lowering, and resting the legs so that they help smooth blood flow and increase tissue oxygenation and prevent complications due to poor circulation (Sari et al., 2024).

2. Mechanism of Action of Buerger Allen Exercise on Foot Sensitivity of People with DM

Buerger Allen Exercise focuses on setting the position of the legs that utilize the laws of gravity and the function of the calf muscle pumps to improve the alternating circulation of arteries and veins. Buerger Allen Exercise movement creates a calf muscle pump effect that functions as a venous pump, thus helping blood return to the heart and encouraging perfusion to the tissues of the legs. This increase in perfusion causes an increase in skin perfusion pressure and stimulates

the release of vasodilator substances such as nitric oxide which helps to widen blood vessels, increase oxygenation and improve microblood flow in peripheral nerves (Hall & Hall, 2021). The increased blood flow ensures that the supply of oxygen and nutrients to the leg tissues becomes smoother. This condition is a crucial factor in minimizing ischemia in the sensory nerves, which is often the main etiology of the development of peripheral neuropathy (Radhika et al., 2020; Thakur et al., 2022).

The benefits of Buerger Allen Exercise are not only limited to improving tissue perfusion, but also include strengthening neurovascular function that contributes directly to the sensory sensitivity of the legs. More adequate microblood circulation creates physiological conditions that support peripheral nerve regeneration, making the transmission of sensory signals more effective. The consistent application of Buerger Allen Exercise has been able to reduce neuropathic complaints, such as numbness and paresthesia, while improving sensory response in people with type 2 DM. As a non-pharmacological modality, Buerger Allen Exercise has been shown to be a safe nursing intervention in inhibiting the progression of complications of diabetic neuropathy (R. Jannah *et al*., 2024).

3. Implementation of Buerger Allen Exercise

Based on research Mohammad et al., (2021), the Buerger Allen Exercise procedure developed by Buerger (1926) and Allen (1930) aims to stimulate blood circulation to the legs and legs. Buerger Allen Exercise is performed three times a week (Mukaromah et al., 2026). This exercise consists of three steps, which are as follows :

a. First step: elevation stage

The patient is in a supination position (sleeping on his back) with his lower extremities (legs) raised to an angle of 45-90º, supported by a board or several pillows in this position for ± 2-3 minutes until the skin is pale (appears white off).

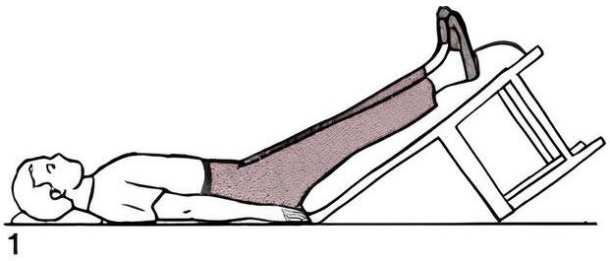

Figure 2. 5 Elevation stage 45-90º (Mohammad et al., 2021)

b. Second step: the stage of decline

The patient gets up and the sitting position is dangling or hanging. After the leg elevation stage, it is continued for the patient to hang the leg by sitting on the edge of the bed. The next step is to start doing flexion, extension, pronation, and supination for ± 3-5 minutes. Until the legs are pink.

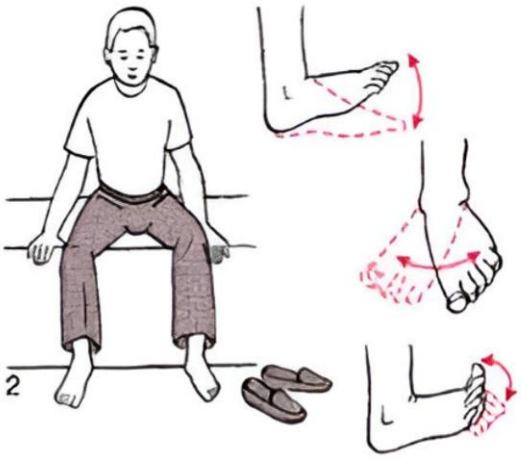

Figure 2. 6 Stage of descent by flexion, extension, pronation and supination (Mohammad et al., 2021)

c. Third step: horizontal stage or resting stage

The patient is in a lying position or the legs are laid flat on the bed for ± 3-5 minutes.

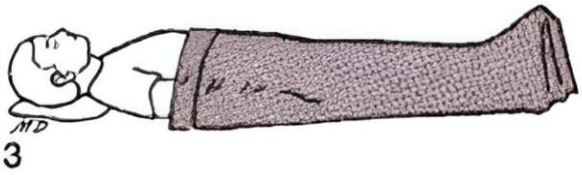

Figure 2. 7 Horizontal or resting stage (Mohammad et al., 2021)

E. The Effectiveness of Foot Reflexology using a Foot Reflection Board and Buerger Allen Exercise on Foot Sensitivity in People with DM

The administration of Foot Reflexology therapy with the Foot Reflection Board can be used to increase the sensitivity of the feet in people with DM. This occurs through pressure stimulation at the reflection points of the soles of the feet that are related to the nervous system and peripheral circulation. This stimulation can increase capillary blood flow, improve the oxygenation of nerve tissues, and improve the transmission of sensory impulses, so that the sensory perception of the legs becomes better (Megda et al., 2020). Increased peripheral perfusion also plays a role in the prevention of peripheral neuropathy and diabetic ulcers in people with DM (Toledo et al., 2022).

Research conducted by Dewi et al., (2023), at the Depok Health Center 3 on 30 respondents proved that therapy using the Foot Reflection Board for 10 minutes 3 times a week was able to significantly reduce the degree of peripheral neuropathy ($p < 0.001$). Similar research by Suwannarat et al., (2025) at Ban Klong Yai Hospital on 35 respondents showed that reflexology therapy using Palm Seed Insole for 15 minutes 3 times a week was proven to be effective in reducing numbness in people with DM with a *p-value* of < 0.001.

Buerger Allen Exercise can be used as a lower extremity exercise exercise that stimulates blood flow and increases tissue oxygenation through a change in leg position and calf muscle pump activation. This exercise utilizes the influence of gravity and calf muscle contraction to increase alternating arterial and venous circulation, so that tissue perfusion and peripheral nerve microcirculation are more optimal. The increase in peripheral blood flow contributes to improved oxygenation and nutrient distribution to nerve tissues, which further supports the sensory function of the legs in people with DM (Hall & Hall, 2021; Radhika et al., 2020; Thakur et al., 2022).

Research conducted by Radhika et al., (2020) at Sri Ramachandra Hospital, Chennai, proved that administering Buerger Allen Exercise to 50 respondents for four consecutive days with a frequency of five times a day significantly improved lower extremity perfusion and reduced peripheral neuropathy symptoms with a $p < 0.001$. The research in Indonesia by Syah & Oktorina, (2022) reinforcing these findings, of the 80 respondents who were given Buerger Allen Exercise 2 times/day for 7 days, namely morning and evening, it was proven to increase the sensitivity value of the feet by $p < 0.001$. Other studies were also conducted by Hasaini et al., (2023), in the work area of the Martapura Health Center showed that of the 36 respondents who received Buerger Allen Exercise therapy for 6 consecutive days with the implementation 2 times a day (morning and evening) within 15 minutes, it was proven that there was an increase in foot sensitivity with a significance value of $p = 0.020$. Similar results were also found in a study conducted by Mukaromah et al., (2026), in the working area of the Pancur Health Center, Central Java, showed that the administration of Buerger Allen Exercise intervention to 82 respondents for 4 weeks with a frequency of 3 times a week was effective in significantly increasing the sensitivity of the feet of people with DM with a value of $p = 0.000$.

F. Theoretical Framework

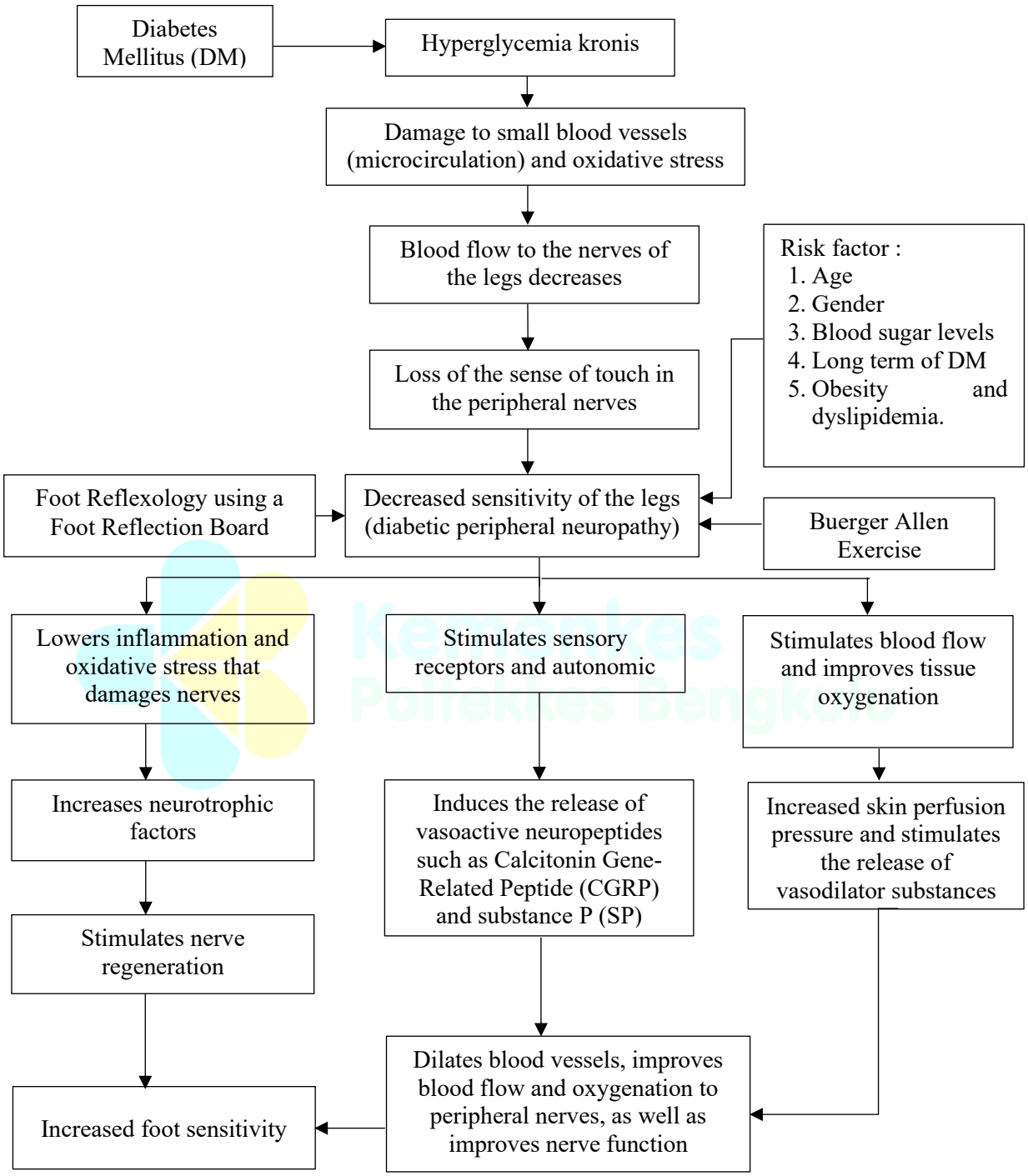

Chart 2. 1 Theoretical framework
(Bodman et al., 2024; Surya & Desnita, 2020; Ge *et al*., 2024; Radhika *et al*., 2020; Sari *et al*., 2024; Hall & Hall, 2021)