CHAPTER II
LITERATURE REVIEW

A. The Concept of the Elderly

1. Definition

An elderly person is someone who has reached the age of ≥60 years (Candraningtyas et al., 2024). Aging is the final stage in the life cycle characterized by biological, physical, psychological, and social changes (Maula, 2024). Aging is an inevitable process and will always have an impact on every individual (Arham et al., 2024).

It can be concluded that the elderly are individuals ≥60 years old who enter the final stages of the life cycle, where biological, physical, psychological, and social changes occur that affect various aspects of life, including health. This process is inevitable and affects every individual.

2. Age Restrictions

According to Ministry of Health of the Republic of Indonesia (2023)), the age limit for the elderly is classified into three categories:

a. Pre-Elderly: Age 60-69 years old
b. Elderly: Age 70-79 years old
c. Late Elderly: Age 80 years and above

3. Features

In old age, it is usually characterized by various physical and physiological changes, so there are a number of characteristics that generally appear in the elderly:

a. Physical Characteristics

1) Sarcopenia (decrease in muscle mass and strength)

The elderly experience a loss of muscle mass of 1-2% per year after the age of 50. This condition results in shrinking muscles, reduced strength, decreased stamina, and daily activities such as Walking or getting up from a chair becomes more difficult. Sarcopenia is also a major risk factor for falls and fractures in the elderly (Damanti et al., 2025).

2) Changes in body composition

As we age, muscle tissue decreases while fat tissue increases, especially visceral fat (fat around organs). This decreases physical strength, increases insulin resistance, and contributes to metabolic diseases. Elderly people with unbalanced body composition tend to have limited mobility (Palmer & Jensen, 2022).

3) Decreased bone density (osteopenia/osteoporosis)

Elderly bones become more fragile due to reduced mineralization and bone mass. This process increases the risk of fractures even if only from a light fall. Postmenopausal women are more susceptible due to a decrease in the hormone estrogen. Osteoporosis also affects posture by causing kyphosis (hunchback) (Guo et al., 2022).

4) Sensory disorders (vision, hearing, balance)

Decreased retinal function leads to blurred vision, cataracts, and difficulty adapting to light. Hearing loss (*presbycusis*) reduces communication skills, while decreased vestibular function impacts balance, increasing the risk of falling (Asejeje & Ogunro, 2024).

b. Physiological characteristics

1) Cardiovascular System

Aging reduces the elasticity of blood vessels and increases arterial stiffness, so systolic blood pressure tends to rise. Heart function also decreases, characterized by decreased *cardiac output* during strenuous activity. This condition makes the elderly tired quickly when doing physical activity.

2) Respiratory System

The elderly experience a decrease in the elasticity of lung tissue and stiffness of the chest wall. This decreases the vital capacity of the lungs as well as increases the remaining air left after expiration. As a result, tolerance to physical activity is reduced and it is easier to experience tightness during activities.

3) Nervous System

The speed of transmission of nerve impulses slows down, reflexes weaken, and motor coordination decreases. In addition, cognitive processes such as short-term memory, attention, and thinking speed also decrease. These changes increase the risk of falls and decrease the quality of life due to difficulties in daily cognitive activities.

4) Endocrine System and Metabolism

Insulin sensitivity is reduced, so the elderly are more at risk of developing type 2 diabetes. In addition, basal metabolism slows down so that fat accumulation is easy to occur. The production of growth hormones, testosterone, and estrogen also decreases, which accelerates sarcopenia and osteoporosis.

5) Musculoskeletal System

In addition to losing muscle mass, joints experience degeneration (osteoarthritis) which causes pain, stiffness, and limited movement. This leads to reduced flexibility, walking speed, and the ability to maintain balance. As a result, the risk of falling in the elderly is getting higher.

4. The Theory of the Aging Process

Aging is a slow process, in which changes accumulate over time, increasing susceptibility to disease and death. This process occurs in all living things and is influenced by genetic and environmental factors. Both factors determine the speed and pattern of aging experienced. At the cellular level, aging occurs when cells undergo a decline in function until eventually, they die. There are two main theories about the causes of aging, namely the theory of programmed aging and the theory of accumulated damage. The programmed aging theory states that aging is a natural process that has been genetically programmed, while the damage accumulation theory argues that aging occurs as a result of the build-up of damage in cells over time (Nital & Attar, 2024).

a. Programmed Aging Theory

Programmed aging, or also known as adaptive aging, is the concept that humans and other complex organisms have innate biological mechanisms that limit their lifespan. This concept calls into question Darwin's principle of "*Survival of the Fittest*," since aging does not support survival or reproduction. Although it was rejected, recent research has begun to provide support for this theory, making it an important focus in the study of aging.

1) *Telomeres Shortening Theory*

The telomere theory of aging explains that cells age because telomeres, which are the protective parts at the ends of chromosomes, shorten each time the cell divides. This theory adds that *Deoxyribonucleic Acid* (DNA) around telomeres also plays a role in the aging process. Research shows that aging is associated with genetic changes, damage due to stress, inflammation, and telomere protection.

2) *Hormonal Theory*

Hormonal Theory explains that as we age, the body has more difficulty regulating hormones because the hypothalamus works poorly due to high levels of stress hormones (cortisol). Research shows hormones play a role in aging.

3) *The Immunological Theory*

The immunological theory of aging states that the weakening of the immune system is not only due to aging, but is also the cause of various age-related health problems. After reaching its peak at puberty, immune function gradually declines, leading to an increased risk of infections, chronic diseases, as well as contributing to the aging process and death.

b. Damage Accumulation Theory

The damage-based theory of aging states that aging occurs as a result of the gradual accumulation of damage to the body's systems over time, which even begins before birth. This buildup of damage eventually leads to the malfunction of organs or even the entire body. Some researchers

argue that aging is the result of different types of damage occurring simultaneously, so the aging process is influenced by a combination of different mechanisms.

1) *Free Radical Theory*

   As we age, damage to cells, especially cells that do not divide, accumulates. Mitochondria, which are responsible for producing Adenosine Triphosphate (ATP), have a lower DNA repair ability than the cell nucleus. This condition leads to a decrease in energy production and an increase in harmful molecules called *Reactive Oxygen Species* (ROS). Damaged mitochondria produce more ROS, forming a cycle of damage that drains energy and accelerates aging.

2) *Wear and Tear Theory*

   The theory of aging wear and tear from Dr. August Wiesmann (1882) states that aging occurs due to damage to cells and tissues due to stress, radiation, toxins, and daily use, such as worn out machines. Research shows that stress and illness can accelerate aging.

3) *Somatic Mutation Theory*

   The somatic mutation theory explains that aging occurs due to random mutations that accumulate in the DNA of body cells (somatic cells) over time. These mutations can disable important genes so that cells work less effectively, eventually leading to organ damage and death. This mutation is considered one of the main causes of aging and age-related diseases.

4) *Rate of Living Theory*

   The aging life rate theory states that organisms age due to rapid energy use, primarily through oxygen metabolism.

5) *Cross Linking Theory*

   The cross-linking theory of aging explains that cross-linking is a process of binding large molecules that cause body tissues to become less elastic, stiffer, and brittle. This process reduces the tissue's ability to function properly and increases resistance to enzymes. This buildup

creates stagnant metabolic conditions, so that changes in aging due to cross-linking become inevitable.

5. Changes that occur in the elderly

According to Manurung, et al. (2023)), in the book entitled "The Basic Science of Gerontic Nursing", the changes that occur in the elderly can be explained as follows:

a. Physiological/Physical Changes

The body's system undergoes various changes with age, such as dry skin, sagging, wrinkles, thinning of hair, changes in hair color, decreased hearing, weakened cough reflex, reduced mucus production, and decreased cardiac output. Although these changes are not diseases, the elderly are becoming more susceptible to a number of health disorders. These physical changes are influenced by health, lifestyle, stress, and environmental factors.

b. Cognitive Changes

A decrease in the number of brain cells and changes in neurotransmitter levels cause cognitive changes in the elderly. However, severe cognitive impairments such as disorientation, loss of language and numeracy skills.

c. Functional Changes

The severity of the disease affects the functional abilities of the elderly, especially in carrying out ADLs which are important for maintaining independence. Sudden changes in ADL usually indicate the presence of an acute illness or worsening health condition.

d. Psychosocial Changes

The aging process also involves various transitions and losses in life. The older a person is, the more social and psychological changes must be faced.

6. Problems that often occur in the elderly

The elderly group is the most vulnerable group after the age group of toddlers. In this age range, the risk of degenerative diseases such as

hypertension, coronary heart disease, cancer, diabetes mellitus, osteoporosis, and joint diseases increases. In general, the frequency of these diseases tends to increase with age, so that they are more experienced by the elderly (Nisak et al., 2021). According to Fauziah, et al (2021), explaining that as the elderly age, it will have an impact on body conditions, such as decreased muscle strength, reduced range of motion, and decreased function of the vestibular organs and vision, which can ultimately lead to a decrease in balance. This condition is the main risk factor for falls in the elderly.

B. The Concept of Falling in the Elderly

1. Definition

   A fall in the elderly is defined as an unexpected event in which the elderly suddenly lose their balance and fall to the floor or lower surface without the ability to control the situation, for example as a result of slipping or tripping (Christina, Utantyo, et al., 2025). Falls are included in one of the major health problems in the elderly which is often referred to as *Geriatric Giant*. The main causes of falls in the elderly come from internal factors, such as disorders in the sensory, cognitive, and central nervous systems that result in decreased balance, muscle strength, and muscle flexibility. In addition, dangerous home environmental conditions, such as old or unstable household appliances, slippery or uneven floors, also contribute to the risk of falls in the elderly (Ariyanti et al., 2024).

2. Consequences of Falls

   The impact of falls on the elderly can be very serious, ranging from minor injuries to permanent disabilities that limit independence. Injuries due to falls are also the main causes of pain, loss of independence, and premature death in the elderly. Falls can cause broken bones, head injuries, bruises, and serious injuries that interfere with the quality of life of the elderly (Christina, Utantyo, et al., 2025).

3. Factors That Affect the Risk of Falls in The Elderly

   According to Julianti, et al (2021), the risk of falls in the elderly is influenced by intrinsic factors and extrinsic factors:

a. Intrinsic Factors

1) Elderly

Based on research Novianti and Naufal (2023), there is a link between increasing age and the risk of falls in the elderly. This is caused by the degeneration process which as we age leads to a decrease in the ability to carry out daily life activities. As a result, the body's flexibility also decreases, increasing the likelihood of falling risks in the elderly.

2) Gender

Women tend to be more at risk of falling than men, this is in line with research Novianti and Naufal, (2023), which explains that there is a significant relationship between sex and the risk of falls in the elderly. Hormonal and physiological differences in aging between men and women are a differentiating factor in falling. In elderly women, menopause affects physical conditions, increasing the risk of falling. In contrast, in elderly men who experience andropause slowly, the effect is not significant on physical condition. Estrogen deficiency in women causes a decrease in osteoclastogenesis which results in loss of bone mass, affects posture and increases the risk of falling.

3) Previous fall history

A history of previous falls affects the risk of falls in the elderly because previous fall experiences can lead to anxiety and fear of falling again, which can ultimately affect balance and walking patterns. In addition, the elderly who have fallen have functional damage or decreased physical abilities that have not fully recovered, making them more susceptible to falling back. Studies show that the elderly with a history of falls have a four-fold greater chance of experiencing recurrent falls than those with no history of falls, due to the presence of physical and psychological factors that magnify the risk (Setiawati et al., 2025).

4) Physical activity

Although the elderly with high physical activity tend to be actively moving, the decline in function in the movement system, muscle

strength, postural control, and balance keeps them at risk of falling. When performing activities, physiological limitations and decreased movement regulation cause balance to be prone to being disturbed, thus increasing the likelihood of falling (Christina, Utantyo, et al., 2025).

5) Balance disorders

Balance disorders in the elderly are often caused by a decrease in physical ability which includes weakening muscle strength, changes in posture, and a decline in overall health. These factors contribute to instability in maintaining position and movement, so that the elderly are more prone to having difficulty maintaining balance which ultimately leads to falls (Ahmad et al., 2024).

6) Diseases of the nervous system

Diseases that attack the nervous system can increase the likelihood of falls in the elderly because the disorders that occur affect the ability to control movement, balance, and body coordination. Conditions such as stroke, Parkinson's, and peripheral neuropathy cause decreased mobility function, weakened posture regulation, and sensory and motor disorders that are essential in maintaining body balance. In addition, damage to nerve pathways inhibits communication between the brain and limbs, so the elderly have difficulty in regulating fast and precise movements as an effort to prevent falls. Therefore, the elderly who suffer from diseases of the nervous system become more susceptible to loss of balance and the incidence of falls (Ahmad et al., 2024).

7) Muscle and bone disorders

Disorders in muscles and bones can increase the risk of falls in the elderly because muscle weakness and decreased bone function affect the body's ability to maintain balance and perform normal movements. As we age, muscles experience a decrease in mass and strength, making it difficult to support posture and balance when standing or moving. In addition, bone conditions such as osteoporosis cause bones to become more fragile and easily broken in the event of a fall, making the elderly

more susceptible to falls due to imbalance or weak supporting muscles. This decline in muscle and bone function is often exacerbated by a lack of physical activity and various diseases that attack the musculoskeletal system, which as a whole contributes to an increased risk of falls in the elderly (Ahmad et al., 2024).

b. Extrinsic Factors

1) Slippery floors or uneven footing surfaces

Slippery floor conditions and uneven footing surfaces are important environmental factors that increase the risk of falls in the elderly. Elderly people with balance disorders and decreased muscle strength are more likely to slip or lose their footing when walking on these surfaces (Muladi et al., 2023).

2) Tripping over objects

Tripping occurs due to sudden changes in the stride path, such as obstacles that cause the swing phase of the foot to become shorter or change. Elderly people who have short steps and limitations in lifting their legs are more prone to getting stuck. Interactions between the body and objects in the home environment, such as furniture, wires, or folded carpets, are often the main cause of falls (Shishov et al., 2024).

3) Less lighting

Decreased vision function in the elderly, such as presbyopia, cataracts, and decreased contrast sensitivity, cause them to rely more on adequate lighting. Dim lighting conditions hinder the ability to detect changes in surfaces, stairs or thresholds, as well as obstacles, thus slowing down reactions and step adjustments that put the elderly at risk of falling (Emad et al., 2024).

4) Slippery footwear

Footwear that has a smooth or worn sole reduces the coefficient of friction between the foot and the floor, so that when performing torque movements or stopping suddenly, the resulting frictional force is insufficient to hold the body, potentially leading to slipping. Elderly

people with proprioception disorders and decreased muscle strength in the ankle rely heavily on the traction provided by the footwear (Kim & Hegazy, 2024).

C. The Concept of Body Balance in the Elderly

1. Definition

Balance in the elderly is the body's ability to maintain stability, which can be interpreted as the ability of the elderly to maintain the position of the center of gravity and the body's supporting plane (Wijayani et al., 2022). Balance is the ability to maintain body position in various positions. Equilibrium is divided into two types, namely static equilibrium and dynamic equilibrium (Fauziah et al., 2021).

Imbalance (*Imbalance*) in the elderly is one of the consequences of the decline in the functioning of the physiological and morphological systems in the elderly. This condition increases the risk of falls in the elderly group. Falls in the elderly are one of the leading causes of death and injury in these populations (Candraningtyas et al., 2024).

2. Benefits of balance training in the elderly

Balance exercises are special exercises in the form of physical activity that are carried out with the aim of improving the vestibular system, or body balance, and strengthening the muscles of the lower body. Through muscle stretching and muscle strengthening, balance exercises seek to improve functional balance by increasing static and dynamic balance activities (Nofita et al., 2023). Systematic physical exercise can improve the condition of fitness in the elderly. Regular exercises are able to strengthen muscles, increase agility, train balance, prevent falls, and support the independence of the elderly in carrying out daily activities (Shalahuddin et al., 2022).

Balance exercises in the elderly play an important role in maintaining body stability, increasing speed, agility, and coordination between the legs, hands, and eyes so as to reduce the risk of falling. The implementation of this exercise regularly can also optimize the physical abilities of the elderly, strengthen the muscles in the lower limbs, improve static and dynamic

balance, and reduce the risk of falling. In addition, balance training contributes to an overall improvement in quality of life and has the potential to improve cognitive function, while preventing negative impacts due to the physical disability of the elderly (Pertiwi & Sastrini, 2025).

3. Types of balance in the elderly

According to Fauziah, et al (2021), explaining that balance has two main types, namely:

a. Static Balance

Static Balance is the ability to maintain body stability while standing in one fixed position.

b. Dynamic Balance

Dynamic Balance is the ability to maintain balance during activities or movements.

4. Factors that affect balance in the elderly

According to Melda, et al (2022), factors that affect balance include the center of gravity, the line of gravity, and the focus plane. These three factors are interconnected and together determine a person's ability to maintain a stable body position. The explanation of each factor is as follows:

a. Center of Gravity *(COG)*

The center of gravity is the point at which the force of gravity acts on all objects, both living and inanimate, and is located at the center point of the object. The function of the center of gravity is to distribute the mass of the object evenly. In humans, the body's weight is supported by this point so that the body is in a state of balance. When there is a change in posture, the position of the center of gravity also changes, which can lead to imbalance (instability). The center of gravity moves automatically following the direction or change in body weight. If the center of gravity is right in the middle of the body, then the body will be in a state of balance, but if it is outside the body, then the body will become unstable. In an upright standing position, the human center of gravity is about 1 inch in front of the second vertebra sacrum.

b. Line *of Gravity (LOG)*

A gravitational line is an imaginary line that runs vertically through the center of gravity. The level of stability of the body is determined by the relationship between the line of gravity, the center of gravity, and the field of support that together affect the balance and postural stability of the body as a whole.

c. Base *of Support (BOS)*

The base plane refers to the area of the body that comes into contact with the surface of the ridge. The body will be in a state of balance if the line of gravity is right inside the plane of the pile. Body stability is better if the area of the support field is larger, for example, standing with both legs provides more stability than standing with one leg. In addition, the closer the position of the support plane to the center of gravity, the higher the level of stability of the body.

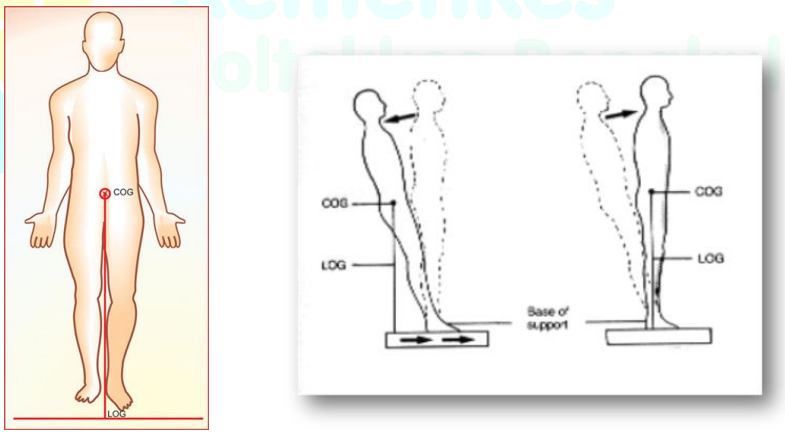

Figure 2. 1
Center of Gravity (COG), Line of Gravity (LOG) and Base of Support (BOS)

Sources: Lakshmi (2022)

5. The impact of balance disorders on the elderly

   Balance disorders are often a problem in the elderly resulting in muscle weakness, especially in the lower extremities, which can further degrade functional abilities such as weakened motor function, loss of balance, and increased chances of falling. Such loss of balance can directly lead to falls and serious injuries such as fractures (Irliani et al., 2021).

6. Measurement of balance in the elderly

   a. Measuring instruments

      Berg Balance Scale (BBS) is a balance measurement instrument that has high validity and reliability. The BBS was created by Katherine Berg in 1989, this scale aims to evaluate the ability to balance in the elderly population. The assessment was carried out through observation of the elderly with 14 tasks that measured static and dynamic balance related to mobility which included daily functional movements, such as how to stand, sit, turn their heads, reach, and maintain their body position (Miyata et al., 2022).

      The results of the measurement were classified into three levels, namely, low fall risk with a score of 41-56, moderate fall risk with a score of 21-40, and high fall risk with a score of 0-20. This scale is useful for predicting the risk of falls in the elderly. This BBS is a short test that can be done relatively quickly in different environments (Miranda & Tiu, 2023).

   b. Indications

      This test is indicated in the elderly, as well as in neurological conditions such as stroke, multiple sclerosis, traumatic brain injury, Parkinson's disease, peripheral neuropathy, and other conditions that have the potential to affect gait, including amputation of the lower extremities (Miranda & Tiu, 2023).

c. BBS Procedure

Table 2. 1 ***Berg Balance Scale (BBS)***

No.	Balance Items	Score (0-4)
1.	Sit to stand Instructions: Please stand without using your hands	4: Can stand stably without hand assistance 3: Can stand stable with the help of hands 2: Can stand up with hand assistance after several attempts 1: Requires minimal assistance to stand steady 0: Requires moderate to maximum assistance to be able to stand for 30 seconds without assistance
2.	Stand without support Instructions: Stand for 2 minutes without holding on Ket: if the respondent is able to stand without a support for 2 minutes, then a full score is given on item 3 and proceeded to item 4	4: Can stand safely for 2 minutes 3: Can stand for 2 minutes with supervision 2: Can stand for 30 seconds without support 1: Takes a few tries to stand 30 seconds without a support 0: Unable to stand for 30 seconds without assistance
3.	Sitting without support (in a chair without armrests) Instructions: Sit with your hands folded for 2 minutes	4: Can sit safely for 2 minutes 3: Can sit for 2 minutes with supervision 2: Can sit for 30 seconds 1: Can sit for 10 seconds 0: Unable to sit without a support for 10 seconds
4.	Move from standing to sitting Instructions: Please sit down	4: Sit safely with minimal hand assistance 3: Controlling sitting movements with the help of hands 2: Control the movement of sitting with the hamstrings as support in the chair 1: Able to sit independently, the movement is unstable 0: Need help sitting

5.	Transfer Instructions: Adjust the distance between seats, then have the respondent move from a seat with armrests to a chair without armrests or from bed to chair	4: Can move safely with minimal hand help 3: Can move safely using hand help 2: Can move with direction or under supervision 1: Requires the help of one person 0: Requires more than one person assistance
6.	Standing without support with your eyes closed Instructions: Close your eyes and stand for 10 seconds	4: Can stand comfortably for 10 seconds 3: Can stand for 10 seconds with supervision 2: Can stand for 3 seconds 1: Unable to keep eyes closed for 3 seconds 0: Needs help to prevent falls
7.	Standing without support with legs closed Instructions: Close both legs together and hold without assistance	4: Can position the legs independently and stand for 1 minute 3: Can position the legs independently and stand 1 minute with supervision 2: Can position the legs independently and stand for 30 seconds 1: Requires help to adjust the position of the legs and is able to stand for 15 seconds 0: Needs help to adjust the position of the legs and is unable to stand for 15 seconds
8.	Reach forward with full straight arms Instructions: Raise your arms forward to 90 degrees, straighten your fingers, and reach forward. (The researcher placed a ruler and asked respondents to reach as far as possible while reaching. Record the distance reached, the rotation of the body is allowed to obtain the maximum range.	4: Mamu reaches well >25 cm (10 inches) 3: Able to reach >12.5 cm (5 inches) safely 2: Able to reach >5 cm (2 inches) safely 1: Able to reach but need supervision 0: Loss of balance when trying

9.	Picking up objects from the floor in a standing position Instructions: Take the Shoes or Sandals that are in front of your feet	4: Can take safely and easily 3: Can take, but requires supervision 2: Unable to pick, but able to approach a shoe 2-5 cm (1-2 inches) balanced and independent 1: Can't pick up, try several times with supervision 0: Unable to pick up and need help not to fall
10.	Turning to look back Instructions: In a standing position, rotate your body to look back to the left and right (you can use the object as a reference).	4: Can look back on one side 3: Can look back well on one side, but the other side lacks 2: Only able to look sideways while staying balanced 1: Requires supervision when turning 0: Needs help to keep your balance from falling
11.	360-degree rotation Instructions: Please do a full 360-degree rotation	4: Can rotate 360 degrees safely in 4 seconds 3: Can rotate 360 degrees safely in one direction in 4 seconds or less 2: Can rotate 360 degrees safely but slowly 1: Requires supervision and instruction 0: Requires help to rotate
12.	Placing the legs alternately on a small bench in a standing position without support Instructions: Place your feet alternately on the *step stool*, then move on to the next step	4: Can be self-guided and safe, do 8 steps in 20 seconds 3: Can stand independently and safely, complete 8 steps within >20 seconds 2: Can perform 4 steps without aids with supervision 1: Can do more than 2 steps, but requires minimal assistance 0: Needs help to prevent falls
13.	Stand with one foot in front of the other Instructions: (Show it to respondents). Place one foot in front of the other. If it feels difficult, start with a wider distance	4: Can position easily, autonomously, and lasts 30 seconds 3: Can position easily and independently for 30 seconds 2: Can position with small steps, self-sustaining for 30 seconds 1: Requires assistance to position, but can last for 15 seconds 0: Loss of balance when positioning and standing

14.	Standing on one leg Instructions: Lift one leg and hold the position for as long as possible	4: Can stand on one leg for >10 seconds 3: Can stand on one leg for 5-10 seconds 2: Can stand ≥ 3 seconds independently 1: Tries to stand on its own but doesn't reach 3 seconds 0: Unable to afford and need help so as not to fall

Overall score (minimum score of 0 and maximum score of 56)

Sources: Miyata, et al (2022)

Interpretation:

41-56 = Low fall risk

21-40 = Moderate fall risk

0-20 = High risk of falling

D. The Concept *of Cawthorne-Cooksey Exercises*

1. Definition

   Cawthorne-Cooksey exercises is a therapeutic method that aims to help compensate the vestibular system with a focus on the main mechanisms of neuroplasticity, such as habituation and structural and functional reorganization (Keerthana et al., 2024). By stimulating neuroplasticity and central compensation, *Cawthorne-Cooksey Exercises* help patients cope with vestibular disorders as well as restore spatial awareness and mobility abilities. *Cawthorne-Cooksey exercises* show significant improvements in balance ability, spatial orientation, and overall quality of life. In the early stages, *Cawthorne Cooksey-Exercises* includes a variety of eye movements, head movements, and balance exercises that patients perform systematically and progressively (Roy et al., 2024).

2. Indications

   a. Elderly with balance disorders or a risk of falls

   b. Proprioceptive disorders and postural coordination

   c. Mild post-stroke balance disorder or stable neurological condition

   d. Rehabilitation after surgery of the inner ear or vestibular nerve

e. Complaints of mild dizziness, instability when moving, or difficulty adapting to changes in head/body position

3. Contraindications
   a. Acute/unstable medical conditions
   b. Severe acute neurological disorders
   c. Musculoskeletal or orthopedic injuries
   d. Acute and severe vision or vestibular disorders
   e. Patients with severe cognitive impairment
4. Physiological mechanisms

Cawthorne-Cooksey exercises designed to facilitate a variety of mechanisms that contribute to improved vestibular function as well as balance optimization (Roy et al., 2024). Here is an explanation of how this activity works to improve the balance of the body, namely:

a. *Sensory re-weighting*

Cawthorne-Cooksey exercises involve head, body, and eye movements that provide direct stimulation to the vestibular system. This movement demands a *re-weighting* of sensory information from the visual, vestibular, and proprioceptive systems.

b. *Proprioceptive system*

Through the *re-weighting* mechanism, the brain becomes more skilled in processing and integrating sensory inputs, including from the proprioceptive system. This process results in improved balance and spatial orientation, so that individuals are better able to maintain body stability.

c. *Vestibular compensation*

This exercise encourages vestibular compensation, which is the brain's adaptation process to the disorder of one of the vestibular organs, especially in unilateral cases. Through reorganization and readjustment of nerve connections, a healthy vestibular side can take over the role of the disturbed side, so that symptoms such as vertigo and dizziness are reduced and postural stability is improved.

d. *Habituation*

Habituation occurs when sensitivity to repetitive stimuli gradually decreases. Repeated exposure to head or body movements that initially cause symptoms of vertigo makes the brain get used to it, so the response to these triggers is weakened. This mechanism supports increased tolerance to movement, lowers the intensity of symptoms and improves daily functional abilities.

e. *Adaptation*

Adaptation is the ability of the vestibular system to adjust its response to sensory inputs based on previous experiences. In *Cawthorne-Cooksey exercises*, repetitive and controlled head and eye movements challenge the vestibular system to adapt to new stimuli. Through this mechanism, the brain learns to adapt responses to different positions and head movements, which ultimately improves coordination and balance control.

f. *Compensation*

Compensation refers to the brain's ability to reset its neural connections and internal processes in order to restore or improve impaired function. In the context of this exercise program, compensation occurs when the brain utilizes still-healthy vestibular inputs and proprioceptive signals to replace impaired vestibular function. Thus, postural stability is maintained and the impact of vestibular dysfunction can be minimized.

5. Procedure
   a. Have a blood pressure check before exercising.
   b. Warm up by sitting still while taking a deep breath, then rotate your shoulders back and forth for 2 minutes.
   c. Give each set of exercises a 1-minute break.
   d. After warm-up, perform the exercises in several sets in order:
      1) Eye and head movements, in a sitting position, start slowly, then increase the speed:
         a) Look up and down (10x)

b) Look left and right (10x)
c) Bring your fingers closer together and keep them away while staying focused on seeing them (10x)
d) Turn the head left and right (start slowly then faster) with your eyes open (10x)
e) Move the head up and down (start slowly then faster) with your eyes open (10x)

2) Head and body movements, in a sitting position:
a) Take an object on the floor, lift it over your head, and then place it back on the floor (keep looking at it during the exercise) (5x)
b) Perform rotational movements from the shoulder joint (10x)
c) Bend forward, then pick up the object that is placed on the floor between your knees (5x)

3) Standing exercises (do exercises near chairs or tables for handrails)
a) Repeat exercises 1) and 2)
b) Changing from a sitting position to standing with your eyes open and closed (5x) respectively
c) Changing from sitting to standing and rotating between them (5x)
d) Throwing small balls from hand-to-hand above eye level while eyes focused on the ball (10x)
e) Throwing a small ball from hand to hand below the knee with your eyes focused on the ball (10x)

e. Stop the exercise if the respondent feels shortness of breath or blood pressure rises
f. Resume with the rest of the exercises that have been determined, after the respondent has rested and the respondent's condition has improved
g. The exercise is closed with cooling for 2 minutes

6. Benefits

According to Jehaman, et al (2025), explaining that *Cawthorne-Cooksey Exercises* It involves changes in body position that aim to improve balance, coordination between muscle and eye movements, relieve symptoms

of vertigo, and improve walking patterns so that overall can reduce the risk of falls in the elderly. This method has been proven to be effective in overcoming balance disorders, both related to the vestibular system and non-vestibular in the elderly. In addition to reducing the risk of falling, this exercise also plays a role in improving the quality of life of the elderly and can be applied as a preventive and rehabilitation measure for individuals who experience balance disorders (Asif et al., 2022).

E. Concept *of Proprioceptive Exercises*

1. Definition

   Proprioceptive exercises is an intervention designed to improve the function of the proprioceptive system. This exercise focuses on the utilization of proprioceptive signals, which include kinesthetic and tactile-afferent senses, by eliminating additional information such as visual perception. Proprioception is the ability to be aware of the position and movement of the body in space, which plays a role in providing perception, both consciously and unconsciously, of the location and movement of limbs and other parts of the body (Valdes et al., 2024).

2. Indications
   a. Elderly with balance disorders or a risk of falls
   b. Post-joint injury patients
   c. Patients with mild-moderate neurological disorders
   d. Decreased muscle strength and coordination due to aging (sarcopenia)
   e. Balance rehabilitation program
3. Contraindications
   a. Acute injury or severe inflammation of the joints/muscles
   b. Severe pain when moving or standing
   c. Severe balance disorders with a high risk of falling unattended
4. Physiological mechanisms

   Mechanism on *proprioceptive exercises* Not only does it include increased muscle strength, but it also involves the activation of peripheral receptors, reflex modulation in the spinal cord, brain plasticity, as well as

multisensory integration that supports the control of body balance (Yılmaz et al., 2024). Here is a description of the underlying physiological processes:

a. Peripheral receptor stimulation (initial input)

   Proprioceptive exercises work by activating specific receptors found in muscles, tendons, joints, and skin. *Muscle spindle* plays a role in detecting changes in muscle length as well as stretching speed. When performing exercises such as *one-leg balance* or *Heel walking, muscle spindle* sends sensory signals to the central nervous system regarding small changes in the position of the knees and ankles. The Golgi Tendon Organ (GTO) functions as a muscle tension detector and helps regulate the contraction of the calf muscles during activities such as *Walking Again* to maintain stability and prevent excessive muscle fatigue. *Receiver Seal* located in the joint capsule plays a role in detecting the angle of the knee position, especially when the knee is bent or straightened during exercise. *Cutaneous receptors* which is on the sole of the foot detects pressure, such as the distribution of weight when standing with one foot. The activation of these receptors contributes to the increase *Sense Position Seal* (JPS), which is the body's ability to know the position of the joints without relying on visual information (Marasco & Nooij, 2023).

b. Reflex modulation at the spinal cord (spinal level)

   Reflex modulation in the spinal cord not only passively processes proprioceptive information, but also alters muscle reflex responses. One example is H-reflex modulation, which is a muscle monosynaptic reflex that plays a role in automatic posture control. *Proprioceptive exercises* makes the H-reflex more adaptive so that the body is able to respond to balance disturbances quickly. In addition, there has been an increase in *co-contraction* agonist and antagonistic muscles, such as the quadriceps and hamstrings, which improve the stability of the knee joint. Thus, *proprioceptive exercises* allows for a fast, automatic, and stable response when the body's center of gravity changes abruptly (Lin et al., 2025).

c. Plasticity at the brain level (supraspinal level)

Proprioceptive exercises It also stimulates adaptation to the motor control centers in the brain. The somatosensory cortex becomes more sensitive in processing proprioceptive signals, thereby increasing the accuracy of the perception of body position. The primary motor cortex improves muscle activation patterns, so corrective movements become faster and more effective. In addition, the cerape serves as a center for error correction by comparing the current position of the body with the desired posture, and then sending commands to correct that posture. Neurophysiological research shows that *proprioceptive exercises* can alter cortical activity, signaling the presence of neuroplasticity in the central nervous system (Parra et al., 2024).

d. Multisensory integration (visual, vestibular, and proprioceptive)

Balance does not only depend on proprioception, but also involves integration with the visual and vestibular systems. When the exercise is done with the eyes closed, the visual input is reduced so that the brain automatically increases the role of proprioceptive and vestibular signals through the mechanism *Sensory Re-Weighting*. This mechanism trains the body to maintain balance despite limited visual information, which is especially important for the elderly or patients with osteoarthritis of the knee who often experience stability disorders. Process *Re-weighting* has been shown to improve postural control abilities in the long term (Sluga & Kozinc, 2024).

e. Long-term adaptation through neuroplasticity

Proprioceptive exercises Carried out regularly, for example three times a week for 2 weeks causes structural and functional changes in the nervous system. This neuroplasticity improves the efficiency of sensorimotor pathways, reduces energy requirements in maintaining posture, and improves stabilizer muscle coordination such as *quadriceps, gluteus medius, gastrocnemius*, and *anterior tibialis*. The long-term impact of this

exercise includes improved static and dynamic balance, reduced risk of falls, and improved performance of daily activities (Yılmaz et al., 2024).

5. Procedure
   a. Have a blood pressure check before exercising.
   b. Warm up by sitting still while taking a deep breath, then rotate your ankles for 2 minutes.
   c. Give each set of exercises a 1-minute break.
   d. After warm-up, perform the exercises in several sets in order:
      1) *One-leg balance*
         a) Stand tall on a flat floor.
         b) Lift one of the legs ±5-10 cm off the floor.
         c) Hold a standing position with one leg for 15-30 seconds.
         d) Repeat on the other leg.
         e) Repetitions: 5 times per leg.
         f) Note: if it's difficult, use a wall or chair as a handle.
      2) *Toe walking*
         a) Stand up straight, lift your heels so that only the tips of your toes touch the floor.
         b) The knees are slightly bent.
         c) Walk forward for ±5-10 meters.
         d) Keep your back straight and steady steps.
         e) Repetitions: 5 times back and forth.
      3) *Heel walking*
         a) Standing up straight, lift the tips of the toes so that only the heels are on the floor.
         b) Keep balance, knees slightly bent.
         c) Walk forward for ±5-10 meters.
         d) Repetitions: 5 times back and forth.
      4) *Cross-body leg swings*
         a) Standing upright, one hand can be attached to the wall/chair for balance.

b) Swing one leg back and forth, then to the side cross past the body.
c) Slow movements, keep control of the direction of the swing.
d) Repetitions: 15-20 times for each leg.

5) *Blind advanced one-leg balance* (standing one leg with your eyes closed)
a) Stand up straight, lift one foot ±5-10 cm from the floor.
b) Close your eyes slowly, holding the position for 10-20 seconds.
c) Focus on calm breathing and body control.
d) Repetitions: 5 times per leg.
e) Note: do it near a wall/chair to be safe if you lose your balance

e. Stop exercise if respondents feel shortness of breath or blood pressure rises.
f. Continue with the rest of the exercises that have been determined, after the respondent has rested and the respondent's condition has improved.
g. The exercise is closed with cooling for 2 minutes.

6. Benefits

Proprioceptive exercises It is known as one of the effective interventions in musculoskeletal and neuromuscular rehabilitation due to its ability to improve postural control through stimulation of the sensorimotor system (Lin et al., 2025). This exercise involves different types of exercises such as *One-leg balance* (standing on one leg), *Toe walking* (walking with toes), *Very walking* (walking on heels), *Cross-body leg swings* (cross-leg swing), and *Blind advanced one-leg balance* (stand one foot with your eyes closed). The goal of this exercise is to improve balance through a mechanism of improving the function of the sensorimotor system, i.e. by optimizing the proprioceptive input from joint and muscle receptors to the central nervous system (Sluga & Kozinc, 2024).

F. Balance Exercises Concept

1. Definition

Balance exercises It is a physical activity that aims to increase body stability through strengthening the muscles of the lower extremities.

Intervention *Balance Exercises* which are done 3 times in 1 week for 2 weeks causes adaptation to the nervous system in the form of *Spatial summation* and *Temporal summation*. *Spatial summation* is the number of potential post synapses that occur simultaneously as a result of the activation of many nerve endings in a large area of neuronal membranes, whereas *Temporal summation* is an increase in the frequency of the release of presynaptic nerve impulses so as to strengthen the post synapse potential. This adaptation triggers the addition of multiple fibers, which is an increase in the number of motor units that contract simultaneously, thereby increasing muscle strength (Hadikusuma & Rossa, 2021).

Balance exercises It also improves biomechanical limitations by strengthening the gastrocnemius muscles, hamstrings, torso extensors, anterior tibialis, quadriceps, and abdominal muscles. These muscles support the structure of the body and support the stability of the body (*limit of stability*), thus allowing the center of gravity to move further in the direction of *anteroposterior* and *medialateral* while maintaining body stability. These adaptations ultimately improve balance in the elderly (Hadikusuma & Rossa, 2021).

2. Procedure
   a. Have a blood pressure check before exercising.
   b. Warm up by stretching your legs and arms for 2 minutes.
   c. Give each set of exercises a 1-minute break.
   d. After warm-up, perform the exercises in several sets in order:
      1) *Single limb stance*
         a) Stand tall on a flat floor.
         b) Lift one of the legs ±5-10 cm off the floor.
         c) Hold a standing position with one leg for 15-30 seconds.
         d) Repeat on the other leg.
         e) Repetitions: 5 times per leg.
         f) Note: if it's difficult, use a wall or chair as a handle.

2) *Clock reach*
   a) Stand up straight and imagine that there is a big clock in front of the body.
   b) Extend one hand forward as a clockworker.
   c) Reach a specific direction (e.g. 12, 3, 6, and 9 o'clock) while maintaining balance.
   d) Return to the starting position in each direction.
   e) Do 2-3 sets with 4 directions per set.
3) *Tandem stance*
   a) Stand with one foot in front of the other, so that the heel of the back foot touches the tip of the front toe (heel to toe position).
   b) Hold the stationary position for ±20 seconds per rep.
   c) Change the position of the legs (front legs to back).
   d) Repeat 3 times for each position.
4) *Single limb stance with arm movement*
   a) Do a basic position like *a Single limb stance.*
   b) When balancing your body, perform arm movements (sideways, forwards, or upwards).
   c) Hold the position for 10-20 seconds while moving your arms slowly.
   d) Switch legs and repeat.
   e) Do 3 reps per side.
5) *Knee marching*
   a) Stand up straight while holding on to a chair or without a handle if possible.
   b) Raise your right knee to hip height (if you can), then lower it.
   c) Replace it with a left knee, such as walking in place.
   d) Do 10-15 knee lifts on each side.
   e) Repeat 2-3 sets.
6) *Grapevine exercise*
   a) Stand up straight, then step to the side in a *cross-step* pattern:
      (1) The right foot steps to the right side.

(2) The left leg crosses in front of the right foot.
(3) The right leg returns to the right side.
(4) The left leg crosses behind the right leg.

b) Make a movement in one direction (right), then the other way (left).
c) Repeat 5-6 cross-step steps per direction.

e. Stop exercise if respondents feel shortness of breath or blood pressure rises.
f. Resume with the rest of the predetermined exercise after the respondent has rested, felt calm and his condition has improved.
g. The exercise is closed with cooling for 1 minute.

G. Effect of *Cawthorne-Cooksey Exercises* and *Proprioceptive Exercises* on Balance in Elderly at Risk of Falls

The aging process in the elderly often leads to a decrease in balance due to changes in the musculoskeletal and nervous systems. This imbalance increases the potential for falls that can have a significant impact on the quality of life of the elderly. Therefore, interventions that focus on improving balance are essential to prevent falls in this group. Two methods that have been widely researched are *cawthorne-cooksey exercises* and *proprioceptive exercises*. These two techniques provide benefits in the form of strengthening muscles, improving posture control, coordination between muscle and eye movements, and improving balance so that it can reduce the risk of falling.

Cawthorne-Cooksey exercises involves changes in body position as well as eye and head movements. This exercise stimulates the onset of complaints which then trigger an adaptation mechanism in the vestibular system, so that the central nervous system can compensate for the imbalance experienced. Thus, this exercise helps the central nervous system to overcome balance disorders through visual and somatosensory stimulation gradually. Based on results *Literature Review* done by Noviana, et al (2023), it was found that this exercise has a positive impact on improving balance. In addition, *proprioceptive exercises* activates the proprioceptive system by channeling impulses from joint receptors

to the nervous system, thereby increasing the perception of body position and movement which ultimately improves balance (Sluga & Kozinc, 2024).

Based on the results of a study conducted by Ray, et al. (2023) in Nagpur, India, against 32 elderly people who are given the intervention *Cawthorne-Cooksey Exercises* to improve balance in the elderly. This study proves that *Cawthorne-Cooksey Exercises* affect the improvement of balance in the elderly (*p<0.0001).* In a study conducted by Seyedahmadi, et al (2023), in Zahedan, Iran, against 24 elderly people who were given intervention *Cawthorne-Cooksey Exercises* shows that *Cawthorne-Cooksey Exercises* has a significant effect on improving balance in the elderly (*p=0.001).* In a similar study, carried out by Keerthana, et al (2024), in Karnataka, India, against 30 elderly people who were given therapy *Cawthorne-Cooksey Exercises* shows that this therapy has a significant effect on improving balance and reducing the risk of falls in the elderly (*p<0.0001).*

In a study conducted by Antunez, et al. (2020), in Extremadura, Spain, in 42 elderly people who were given the intervention *proprioceptive exercises* shows that there is an increase in balance in the elderly (*p<0.0001). This research* It is carried out 3 times per week within 2 weeks. In a study conducted by Esposito, et al. (2021), in Italy, in 30 elderly people who were given therapy *proprioceptive exercises* shows that *proprioceptive exercises* has a significant effect on improving the balance of the elderly (*p=0.001).* A similar study conducted by Chalapud and Molano, (2023) in Popayan, Colombia, with 16 elderly people being given therapy *proprioceptive exercises*, indicating that *proprioceptive exercises* has a significant effect on improving balance and reducing the risk of falls in the elderly (*p=0.002).*

H. Theoretical Framework

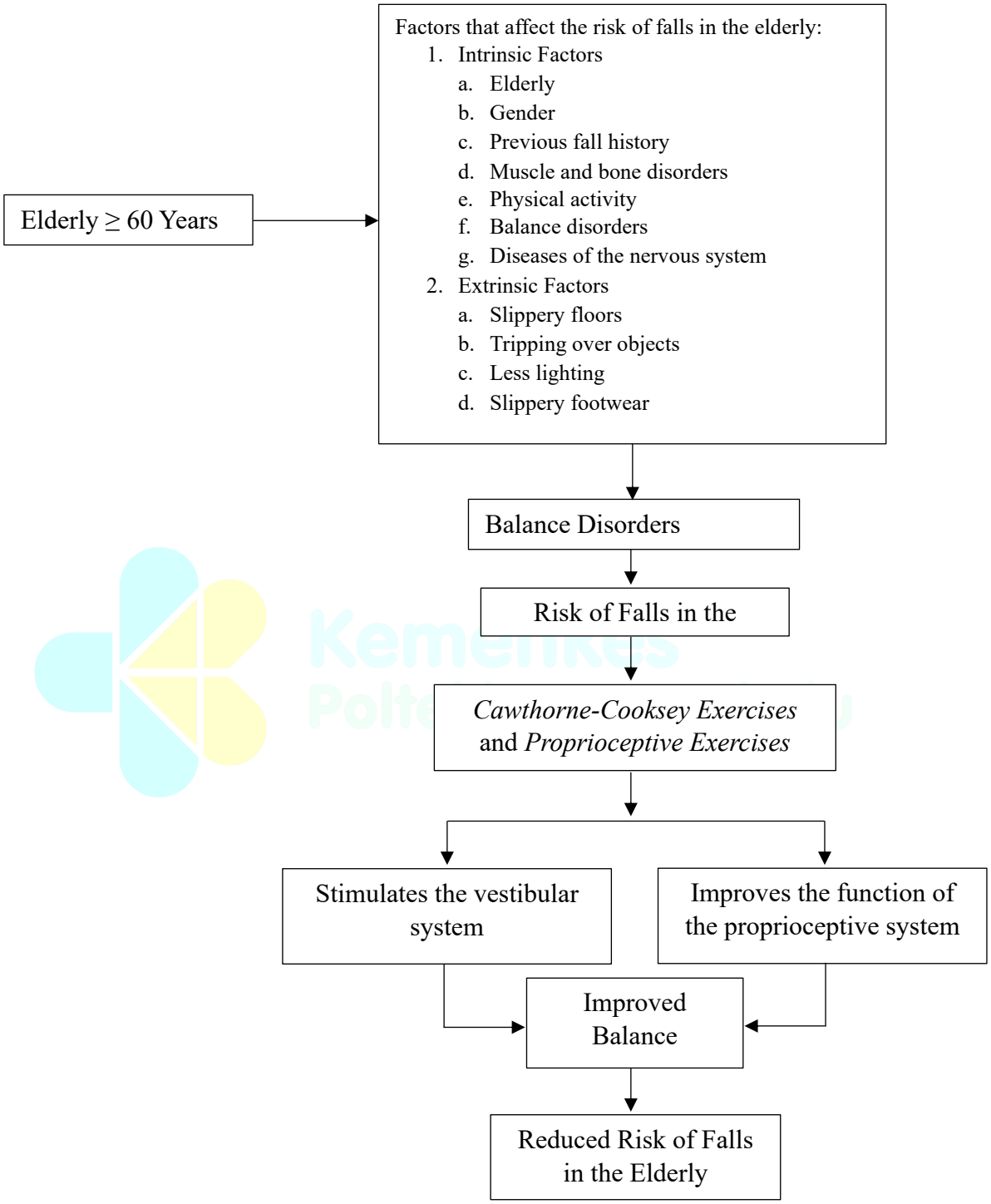

Diagram 2. 1 Theoretical Framework

Sources: (Candraningtyas et al., 2024), (Julianti et al., 2021), (Yılmaz et al., 2024) (Jehaman et al., 2025)