Doctoral Thesis

Self-Rated Health and Emotion Regulation in Pathological Aging: Adaptive Mechanisms for Managing Severe Health Decline in Late Life

March 2025

Graduate Course of Clinical Thanatology and Geriatric Behavioral Science

Department of Human Sciences

Graduate School of Human Sciences

Osaka University

Mio Shinozaki

Contents

Abstract

As individuals age, they face various losses, including declining health. Yet many older adults maintain psychological well-being—a phenomenon called the “aging paradox” that suggests high psychological adaptability. Since primary control over declining health is often difficult in late life, secondary control through emotion regulation is considered crucial for psychological adaptation. While research on normal aging with gradual functional decline is extensive, it remains unclear how older adults with pathological aging, which involves rapid decline and dramatic suffering, regulate their emotions and achieve psychological adaptation when facing health losses. Through three studies of older patients, this research aimed to clarify the psychological adaptation mechanisms specific to pathological aging.

Study 1 investigated the impact of physical vulnerability on psychological adaptation, focusing on depressive mood among post-acute care inpatients. The results showed that patients of more advanced ages are better able to mitigate depressive mood through optimistic health perceptions despite physical decline, suggesting that the advanced emotion regulation abilities described in socioemotional selectivity theory persist even in pathological aging. However, depressive mood remains higher than that in normal aging and worsens among end-of-life patients regardless of age, supporting the assertion of the strength and vulnerability integration model that increased vulnerability diminishes the effectiveness of emotion regulation.

Study 2 examined how cognitive decline influences self-rated mobility, depressive mood, and fall incidence to clarify the impact of cognitive vulnerability on psychological adaptation. The results showed that patients with moderate cognitive decline tend to maintain optimistic self-rated mobility even when their actual mobility is limited and this optimistic self-rating helps reduce their depressive mood. However, the self-rated mobility of individuals with severe cognitive decline is optimistically biased (i.e., more closely linked to their superior pre-hospitalization mobility than their current condition). Follow-up analysis revealed that in the severely impaired group, this

optimistic self-rating leads to an increased risk of falls within three months of discharge. These findings suggested that optimism serves as an adaptive emotion regulation strategy in patients with moderate cognitive decline, while those with severe cognitive decline may show optimism based on anosognosia, potentially leading to maladaptive outcomes such as an increased risk of falls.

Study 3 examined the influence of controllability on psychological adaptation strategies among older adults attending memory clinics. The findings revealed that patients, even those experiencing pathological aging, are more likely to be highly sensitive to subtle pathological changes rather than showing optimistic attitudes toward their health condition in the early stages of illness when primary control through treatment remains viable.

The findings of these three studies demonstrated that disease controllability and the degree of vulnerability play crucial roles in determining the selection and effectiveness of adaptation strategies in pathological aging. In the early stages of illness, the possibility of primary control through treatment leads older adults to become highly sensitive to subtle pathological changes. However, as the disease progresses and primary control becomes more difficult, older adults shift to emotion regulation strategies, perceiving their health status more optimistically than the actual situation to maintain positive emotions. This ability to flexibly select adaptation strategies according to the situation appears to increase survival rates and help maintain psychological well-being in late life. Additionally, older adults with extreme vulnerability may experience decreased psychological adaptation capacities, suggesting the need for support to bolster their inherent abilities.

Chapter 1
Introduction

Discrepancies between older adults' self-rated health and objective health status are commonly observed in clinical settings. For example, I frequently encounter relatively independent older adults stating, "I can't do anything anymore" or "My memory is so terrible that I forget things immediately." By contrast, bedridden older adults with severe frailty or advanced dementia often respond, "There's nothing wrong with me," "My health is excellent," or "I don't have any memory problems."

Why is there such a discrepancy between older adults' self-rated health and their objective health status? I wondered whether this divergence holds critical significance for happy and adaptive living in the face of increasing losses during later life. This question served as the starting point and inspiration for this study.

1.1 Health Decline and the Aging Paradox in Later Life

Human developmental changes involve repeated cycles of gains and losses throughout life, which continue until death (Baltes, 1987; Baltes & Goulet, 1970; Baltes et al., 1980). While gains and losses occur at every stage of life, their balance shifts with age; in later life, losses outweigh gains (Baltes, 1987). Age-related health decline is a typical loss experienced by everyone in later life and represents a critical issue that directly affects functional ability and life.

Despite the increasing prevalence of health decline, older adults tend to maintain optimistic self-assessments of their health (Idler, 1993; Maddox & Douglass, 1973). Studies have consistently reported that the correlation between subjective and objective health assessments weakens with age (French et al., 2012; Henchoz et al., 2008; Idler & Benyamini, 1997; Kivinen et al., 1998; Pinquart, 2001; Schnittker, 2005b). This optimistic tendency has also been observed in centenarians with multiple illnesses and functional limitations (Araujo et al., 2018; Gondo et al., 2013).

It is easy to assume that later life, characterized by an increasing proportion of losses, would inevitably be a time of great distress. However, the reality seems more complex. Many older adults maintain high levels of subjective well-being and satisfaction (Baltes & Baltes, 1990; Brandtstädter & Greve, 1994; Charles & Carstensen, 2007; Jopp et al., 2016; Mroczek & Kolarz, 1998; Scheibe & Carstensen, 2010; Smith et al., 1999), and their prevalence of depression has been reported to be lower than that in younger populations (Blazer et al., 1987).

This apparent contradiction—the increase in losses during later life coupled with well-maintained positive emotions—has been termed the “aging paradox” (Charles & Carstensen, 2010; Kunzmann et al., 2000; Mather, 2012; Mroczek & Kolarz, 1998). This phenomenon, characterized by the gap between losses and maintained well-being, has attracted significant attention from researchers. However, several aspects of these mechanisms remain unclear.

1.1.1 Three Types of Aging and Their Characteristics

Aging in later life shows varying patterns and is classified into three types: normal, pathological, and terminal aging (Atchley, 1989; Birren & Cunningham, 1985; Franceschi et al., 2018). The characteristics of each are as follows.

Normal Aging

Normal aging refers to the natural aging process that occurs in the absence of disease or disability. While there is some decline in physiological and cognitive functions, the progression is gradual, allowing individuals to maintain age-appropriate abilities and lifestyles with minimal disruption.

Pathological Aging

Pathological aging describes the aging process characterized by the presence of medical conditions or impairments that lead to declines that exceed those expected during normal aging. These impairments often result in significant challenges in daily life and require external support or intervention.

Terminal Aging

Terminal aging refers to the rapid decline observed in the final years of life (Gerstorf et al., 2013; Siegler, 1975). This period is marked by a significant reduction in resilience and repair mechanisms, with accelerated deterioration across multiple functional domains.

Although these three classifications are not strictly distinct, they provide a valuable framework for clinical practice related to older adults. The distinction between normal aging and the other two forms of aging is particularly crucial, with the primary criterion being whether functional decline aligns with age-appropriate expectations.

1.1.2 Redefining Successful Aging from a Psychological Perspective

Rowe and Kahn defined “successful aging” as a state free from disease and functional decline characterized by high levels of physical and cognitive functioning and active social engagement (Rowe & Kahn, 1997). This definition, rooted in medical and biological perspectives, presents an idealized view of late life and establishes stricter criteria than those for normal aging. While this framework offers important insights, only about 26–30% of individuals aged 65 years and older and only 9% of those aged 80 years and older meet these criteria in practice (Plugge, 2021). For many older adults, progression to pathological or terminal aging is inevitable.

By contrast, older adults tend to perceive their aging as successful even when facing health-related limitations (Plugge, 2021). They often emphasize the importance of accepting and adapting to physical and cognitive constraints (von Faber et al., 2001).

This perspective is crucial for older adults. Declines in health and function are often unavoidable with aging and maintaining health is not always feasible through individual efforts alone. Instead, from a psychological standpoint, successful aging can be understood as the ability to flexibly cope with adversity, live as oneself, and be happy, even when health deteriorates, function declines, and active social engagement becomes challenging (Gondo et al., 2013). Such an adaptive approach to aging may also be considered “successful.”

To elucidate why many older adults can maintain positive emotions despite declining health, it is essential to first clarify how they perceive, understand, and adapt to their own health conditions.

1.2 Emotion Regulation as a Core Mechanism of Psychological Adaptation

1.2.1 Defining Psychological Adaptation and Emotion Regulation in Later Life

Psychological adaptation in later life refers to the ability to select optimal adaptive strategies according to one's resources and circumstances when faced with unavoidable age-related losses (Isaacowitz & Blanchard-Fields, 2012). This enables older adults to maintain their psychological health and well-being, even as losses accumulate later in life (Brandtstädter & Greve, 1994; Dunne et al., 2011; Heckhausen, 1997).

The central mechanism supporting psychological adaptation is emotion regulation. Emotion regulation refers to the capacity to adjust the type, timing, and intensity of the emotions experienced (Charles, 2010; Gross & Levenson, 1997; Urry & Gross, 2010). This capacity is thought to develop as a trade-off for developmental losses and plays a crucial role in maintaining physical and psychological health later in life (Urry & Gross, 2010).

Moreover, when self-rated health remains positive despite a decline in actual health, it reflects the ability to positively reframe negative situations through emotion regulation (Araujo et al., 2018; Mather et al., 2004; Mather & Carstensen, 2005). Such positive self-rated health is regarded as an indicator that psychological adaptation is functioning effectively (Mather & Carstensen, 2005).

1.2.2 Age-Related Changes in the Perception of Health Decline

How do older adults perceive their health decline? Research suggests that the perceptions of and psychological responses to health decline vary with age. For instance, experiencing the same illness or disability earlier in life induces more depressive symptoms than experiencing them later in life (Schnittker, 2005a). Several factors are thought to underlie the adaptive responses of older adults to health decline.

Typicality

Illnesses and functional declines in later life are often accepted as natural aspects of aging. Among younger and middle-aged adults, individuals with physical disabilities have a three to four times higher risk of major depression than their non-disabled peers. However, this relationship is not significant in older adults (Turner & McLean, 1989). This may be because older adults interpret changes in their health as a natural aspect of aging, which then mitigates their psychological distress (Hoeymans et al., 1997; Idler et al., 1999; Kunzmann et al., 2000; Turner & McLean, 1989).

Predictability

Health decline in later life is often perceived as a predictable phenomenon, unlike illnesses or accidents in younger years (Heckhausen et al., 1989; Schnittker, 2005a). For example, studies have shown that older patients with cancer report better emotional states than younger patients (Hart & Charles, 2013). This predictability may allow older adults to prepare psychologically, enabling them to adapt more flexibly to health decline.

Familiarity

Older adults may become accustomed to chronic ailments and disabilities (Leinonen et al., 2002). During the early stages of illness or disability, psychological distress tends to be more pronounced, but individuals adapt to chronic conditions over time, a phenomenon referred to as the "adaptive weakening of this impact with ongoing loss" (Schilling et al., 2011). This process helps older adults maintain a calmer psychological response to their health decline.

Life Experience

Older adults have accumulated years of experience, which enables them to develop flexible and effective coping strategies for difficult situations (Blanchard-Fields, 2007). This experience may make psychological adaptation to health decline easier for older adults than for younger individuals.

1.2.3 Socioemotional Selectivity Theory (SST)

Motivation significantly shifts later in life. According to SST, emotional control and emotion regulation are closely linked to the perception of time and their importance increases as one approaches the end of life (Carstensen et al., 1999).

Young adults who perceive their future as expansive prioritize future-oriented goals such as knowledge acquisition and the pursuit of new information. However, as people enter late life and become more aware of their limited time remaining, their motivational priorities shift from acquiring knowledge for the future to pursuing emotionally meaningful experiences and present-day well-being. Research suggests that along with this motivational shift, older adults tend to exhibit a cognitive style characterized by increased attention to positive information and decreased attention to negative information (Isaacowitz & Blanchard-Fields, 2012).

This cognitive style of attending to positive information while avoiding negative information, known as the “age-related positivity effect,” is considered a crucial factor in psychological stability in late life. As this cognitive style becomes the default mode of daily information processing, it gradually enhances older adults’ emotion regulation abilities (Mather, 2012), which are thought to support their adaptation to age-related losses (Carstensen et al., 2003).

1.2.4 Age-Related Positivity Effect

To understand the adaptive significance of this positivity effect in late life, understanding negative bias is crucial, namely, the general cognitive characteristic of paying more attention to negative information than to positive information (Isaacowitz

& Riediger, 2011; Vaish et al., 2008). This bias is thought to have evolved because while ignoring positive information may not pose significant risks, overlooking negative information could expose us to danger (Baumeister et al., 2001; Taylor, 1991; Vaish et al., 2008).

However, this tendency reverses in older adults, who often show the above-described age-related positivity effect (Carstensen et al., 2003; Charles et al., 2003; Isaacowitz, 2022; Mather & Carstensen, 2003, 2005; Reed et al., 2014). This effect, which can be explained through the SST framework, suggests that older adults have increased motivation to prioritize emotionally meaningful experiences (Mather & Knight, 2005).

The significance of this effect observed in older adults is evident at both the individual and the group levels. At the individual level, it protects against age-related losses and supports adaptation by preventing depression and reducing mortality risk (Fiske et al., 2009). At the group level, emotionally stable older adults who focus on positive information serve an evolutionarily adaptive function by contributing to the psychological stability of the entire group, including younger members, thereby increasing survival rates and prosperity (Carstensen & DeLiema, 2018).

1.2.5 Neural Basis of Emotion Regulation

Initially, age-related neural decline was thought to be the cause of the age-related positivity effect. This aging brain principle suggested that decreased amygdala arousal in emotion processing made it difficult to process negative information, resulting in the positivity effect (Cacioppo et al., 2011).

However, studies have shown that healthy older adults maintain relatively well-functioning brain regions involved in emotion regulation, including the amygdala and prefrontal cortex (Mather, 2012, 2016; Samanez-Larkin & Carstensen, 2011). Furthermore, it has been clarified that reduced amygdala activity is not a result of deterioration but that it rather stems from cognitive efforts to downregulate negative emotional responses. Increased prefrontal cortex activity in older adults enables their

sophisticated cognitive control, leading to the age-related positivity effect (Mather et al., 2004; Nashiro et al., 2011).

1.3 Adaptive Strategies for Coping with Health Decline in Late Life

As discussed earlier, late life is marked by several factors that promote adaptation to health decline, including shifts in the perception of one's declining health, motivational changes associated with aging, and neural foundations that enable advanced emotion regulation. However, mitigating the emotional impact of illness and functional decline is challenging. Late life is characterized by increased vulnerability due to aging, which is accompanied by reduced resources available to adapt to developmental and everyday challenges (Baltes, 1997). Nevertheless, older adults often manage to maintain high levels of positive emotions. This section explores the primary control strategies employed to cope with health decline in later life and their adaptive significance.

1.3.1 Controllability of Health Decline and Selection of Adaptive Strategies

When facing and adapting to various challenges in the developmental process, two strategies play crucial roles: primary and secondary control (Heckhausen et al., 2010). Primary control aims to achieve goals by actively engaging with the environment and circumstances, whereas secondary control seeks adaptation by adjusting one's internal state to match one's environment (Heckhausen & Schulz, 1993).

Generally, the selection of adaptive strategies varies according to age. As people grow older and their available resources decrease, secondary control tends to be selected (Heckhausen & Schulz, 1995). Moreover, in situations involving health and functional decline, not only age but also controllability through treatment influences the selection of adaptive strategies. For example, in the early stages of an illness, primary control strategies are selected when improvements through treatment can be expected. However, in situations in which the illness has already progressed and improvement through treatment cannot be expected, secondary control strategies are selected and play a major role as one's health declines (Heckhausen & Schulz, 1995; Rothbaum et al., 1982; Schulz et al., 1991; Wrosch et al., 2000). Thus, the selection of adaptive strategies is closely related not only to age but also to the available resources and controllability.

1.3.2 Selection, Optimization, and Compensation with Emotion Regulation (SOC-ER)

According to Selective Optimization with Compensation (SOC) theory proposed by Baltes and colleagues (Baltes & Baltes, 1990), as resources decline in late life, individuals achieve their goals by employing three strategies: “selection,” which involves narrowing down important goals; “optimization,” which focuses on enhancing the means and resources to achieve those goals; and “compensation,” which uses alternative methods to address limitations (Freund, 2008).

Building on SOC theory, Urry and Gross (2010) proposed the SOC-ER model, which applies these principles to emotion regulation. This model suggests that individuals use both internal (e.g., predictive abilities and cognitive control) and external resources (e.g., social relationships and environmental support) to select and optimize emotion regulation strategies according to the situational demands.

For example, older adults with reduced cognitive function often adapt effectively by choosing strategies with lower cognitive demands such as focusing on positive information rather than employing resource-intensive strategies such as reappraisal. This allows them to maximize their emotional well-being within the constraints of their available resources (Urry & Gross, 2010).

1.3.3 Social Comparison

Social comparison is a commonly used emotion regulation strategy in late life. This is a typical secondary control strategy employed to regulate emotions in situations in which primary control is difficult (Heckhausen & Schulz, 1995). Social comparison has three functions: self-evaluation, self-improvement, and self-enhancement. Which of these functions becomes central varies depending on the availability of resources and expectations of primary control (Heckhausen & Krueger, 1993).

In younger adulthood, when resources are abundant and primary control can be expected, there is a tendency to engage in upward comparison with others who are in better condition, primarily for self-improvement (Guyer & Vaughan-Johnston, 2018). However, as resources become scarcer with age, downward comparison with less fortunate others becomes the central control strategy aimed at maintaining self-esteem and self-enhancement (Gibbons & Gerrard, 1991; Heckhausen & Krueger, 1993; Henchoz et al., 2008; Mehlsen et al., 2019; Taylor & Lobel, 1989; Wood, 1989).

Particularly for the oldest-old, downward comparison with peers becomes an important adaptation strategy. An awareness of peers in less fortunate circumstances can trigger response shifts such as changes in values and internal standards, which can bring about positive changes to self-perception and self-evaluation (Gibbons, 1999; Sprangers & Schwartz, 1999).

This type of social comparison also influences how older adults evaluate their health status. Through downward comparisons with peers who face similar health decline, older adults can mitigate feelings of inferiority and maintain an optimistic view of their own health status (Cheng et al., 2007; Henchoz et al., 2008; Pinquart, 2001; Rakowski & Cryan, 1990; Tornstam, 1975). Moreover, this process does not necessarily need to be based on facts (Taylor, 1983; Taylor & Brown, 1988). The mere possession of positive illusions that “I am better off than others my age” is considered beneficial for maintaining self-esteem and improving psychological well-being.

1.3.4 Goal Disengagement and Reengagement

Goal disengagement and reengagement represent secondary control strategies aimed at minimizing the impact of failure or setbacks and maintaining psychological stability by either abandoning unattainable goals or adjusting them to align with reality (Heckhausen, 1997; Heckhausen & Schulz, 1993).

In later life, when losses become more prominent than gains, developmental goals often shift from acquisition to loss avoidance (Freund, 2008; Heckhausen, 1997). In situations characterized by diminishing resources and a reduced feasibility of primary

control, goal disengagement and reengagement strategies play a crucial role (Heckhausen & Schulz, 1993).

Particularly in advanced old age, when health deteriorates or functional decline makes goal attainment difficult, appropriately exercising goal disengagement and reengagement rather than continuing to pursue unattainable goals is effective in preventing depression and maintaining well-being (Boerner, 2004; Brandtstädter & Greve, 1994; Dunne et al., 2011).

1.3.5 Gerotranscendence

The concept of "gerotranscendence," proposed by Tornstam, offers an important perspective of how older adults adapt to the fear of death. According to this theory, later life involves a shift from materialistic and rational perspectives to a more inward, cosmic, and transcendent viewpoint. This transition fosters an internal transformation that emphasizes the broader flow of life, reducing the fear of death and increasing overall life satisfaction (Tornstam, 1989, 1997).

Throughout this chapter, theories and findings regarding adaptive strategies for coping with health decline during normal aging have been reviewed. In the next subsection, theories and findings related to pathological and terminal aging are introduced.

1.4 Characteristics of Self-Rated Health and Emotion Regulation in Pathological Aging

As previously discussed, while normal aging is characterized by gradual functional decline, pathological aging exhibits distinct features such as dramatic deterioration and accelerated progression (Franceschi et al., 2018). The patterns of psychological adaptation to health decline in pathological aging may differ substantially from those observed in normal aging discussed above. Indeed, empirical evidence regarding psychological adaptation in pathological aging has yielded mixed findings, particularly in terms of self-rated health and emotion regulation.

Some studies have reported that even in pathological aging, individuals' self-rated health remains optimistic and they demonstrate high emotion regulation capabilities. For example, reports indicate that even after hospitalization for serious conditions such as stroke, myocardial infarction, and femoral fractures, over 75% of patients rate their health status as "good" or "fairly good" (Wilcox et al., 1996). Reports suggest that even terminally ill patients maintain positive perceptions of life (Taylor & Brown, 1988). Furthermore, studies suggest that emotion regulation strategies such as downward comparison and goal readjustment function effectively even in cancer patients and severely frail older adults (Affleck & Tennen, 1991; Buunk et al., 1990; Frieswijk et al., 2004; Wood et al., 1985; Wurm et al., 2008).

However, some studies have suggested that pathological aging leads to a deterioration in self-rated health and decreased emotion regulation abilities. For instance, while downward comparison is frequently used in situations in which control is difficult, it has only limited efficacy in enhancing happiness and psychological well-being in cases of pathological aging (Mehlsen et al., 2019). Additionally, studies have reported that when health conditions deteriorate beyond a certain level, self-rated health and well-being decline (Paul et al., 2007), with one study finding that 11.5% of older hospitalized patients exhibit major depressive symptoms and 23% show depressive symptoms (Koenig et al., 1988). Moreover, in very old age, chronic functional limitations such as a decline in vision, hearing, and mobility are suggested to exacerbate

depression and negatively impact subjective well-being and life satisfaction (Smith et al., 2002; Wettstein et al., 2015).

These mixed findings may reflect the diversity of pathological aging, suggesting that models based on developmental changes during normal aging may not be directly applicable. Charles's (2010) strength and vulnerability integration (SAVI) model presents an interesting theoretical framework to explain these seemingly contradictory findings.

1.4.1 Strength and Vulnerability Integration (SAVI) Model

The SAVI model proposed by Charles (Charles, 2010) explains age-related changes in emotion regulation later in life through the interaction of strengths and vulnerabilities. This model points out that while emotion regulation skills (strengths) improve with age, physiological vulnerability also increases. Consequently, the ability to quickly recover from strong physiological arousal decreases, making it more likely that physical and mental stress will persist. Under such circumstances, it has been suggested that age-related strengths in emotion regulation may be offset, potentially making emotion regulation even more difficult than for younger adults (Charles, 2010; Charles & Luong, 2013). Hence, although the SAVI model was originally developed to focus on the progression of age-related vulnerability, it also provides useful insights for understanding the characteristics of pathological aging as described below.

1.4.2 Impact of Physical Vulnerability

Pathological aging shares common characteristics with age-related vulnerability; physical vulnerability increases with the progression of illness, disability, and frailty, leading to exposure to chronic stress.

From this model's perspective, in situations in which illness and disability progress, treatment control reaches its limits, and individuals are exposed to persistent pain, older adults' emotion regulation skills may cease to function effectively. Consequently,

deterioration in health status may directly affect self-assessment and negatively impact emotional well-being.

1.4.3 Impact of Psychological Vulnerability

With increasing age, the self-assessment of physical health becomes increasingly susceptible to the influence of depression (French et al., 2012; Schnittker, 2005b). In older adults with psychological vulnerabilities such as depression, emotion regulation adaptation strategies may not function effectively. Depression tends to lead to a pessimistic evaluation of one's physical health status, which can create a vicious cycle of worsening depression (French et al., 2012; Levkoff et al., 1987; Pinquart, 2001).

1.4.4 Impact of Cognitive Vulnerability

As emotion regulation requires sufficient cognitive resources (Charles & Luong, 2013; Mather & Knight, 2005), increased cognitive vulnerability may make it difficult to properly execute emotion regulation strategies, potentially leading to emotional deterioration (Mather & Knight, 2005).

Furthermore, patients with dementia and anosognosia show poor awareness of their condition, behavioral changes, and declines in physical and cognitive functions, with a tendency to evaluate their instrumental activities of daily living more positively than their actual state (Steward et al., 2019). However, such positive self-evaluations may not necessarily represent adaptive emotion regulation or contribute to emotional improvement. Instead, previous studies have suggested that these self-evaluations may be associated with maladaptive outcomes such as decreased treatment adherence (Bertrand et al., 2016; Morese et al., 2018) and an increased risk of accidents and fraud victimization (Sunderaraman & Cosentino, 2017).

1.5 Characteristics of Self-Rated Health and Emotion Regulation in Terminal Aging

In the terminal stages of life, characteristics that differ from those observed during normal or pathological aging emerge. Approximately three to seven years before death, physiological repair mechanisms begin to fail and an accelerated decline in physical and cognitive functions as well as physiological reserves—referred to as terminal decline—can be observed (Cohen-Mansfield et al., 2017; Gerstorf et al., 2010, 2013; Stolz et al., 2021).

This phenomenon affects not only physical and cognitive functions but also emotional functioning. Around four years before death, positive emotions tend to decrease, while negative emotions increase. Furthermore, life satisfaction and well-being have been reported to decline sharply during this period (Gerstorf, Ram, et al., 2008a).

Regarding the mechanisms underlying terminal decline in emotional functioning, some studies suggest that worsening health conditions are the primary factor (Diegelmann et al., 2016; Schilling et al., 2018), whereas others report that this decline occurs independently of health status (Gerstorf, Ram, Rocke, et al., 2008), resulting in inconsistent findings.

Notably, terminal decline is characterized by its association with time-to-death rather than chronological age (Cohen-Mansfield et al., 2017; Scheibe & Carstensen, 2010). This means that terminal decline is not age-specific but is instead a universal phenomenon observed even in younger terminally ill patients (Gerstorf et al., 2010).

1.6 What Does Self-Rated Health Reflect in Older Adults?

The self-rated health of older adults tends to deviate from objective health assessments with age. Nevertheless, self-rated health is a stronger predictor of future health outcomes and mortality risk than objective health indicators (Idler & Benyamini, 1997; Idler & Kasl, 1995; Idler et al., 1990; Miller & Wolinsky, 2007; Mossey & Shapiro, 1982; Schoenfeld et al., 1994; Singer et al., 1976). This seemingly paradoxical relationship raises an intriguing question: why does self-rated health maintain such strong predictive power despite its weak correlation with objective health measures and what exactly does it reflect? The high predictive power of self-rated health suggests that it does not merely reflect physical health or momentary mood more than objective health assessments do.

1.6.1 Reflection of Overall Vulnerability

One possibility is that self-rated health reflects overall vulnerability, including physical health status, psychological and cognitive vulnerabilities, and proximity to death. According to the SAVI model and findings on terminal decline, as death approaches, increased vulnerability limits psychological functioning, making emotion regulation more difficult (Charles, 2010). This makes maintaining an optimistic self-evaluation of health challenging. Thus, the strong predictive power of self-rated health may be due to its reflection of overall vulnerability, including physical, psychological, and cognitive frailty as well as proximity to death.

1.6.2 Reflection of Mental Health

Another possibility is that self-rated health in older adults tends to be influenced by mental health conditions (French et al., 2012; Levkoff et al., 1987; Pinquart, 2001). Depression, in particular, can lead to a pessimistic outlook, reducing self-rated health regardless of actual health status (Mulsant et al., 1997).

Depression in later life increases the risk of physical functional decline, creating a vicious cycle between physical and mental health (Lenze et al., 2001). Moreover, comorbid depression during pathological aging has been reported to negatively affect life expectancy (Blazer, 2003; Bruce, 2001; Evans et al., 2005; Fiske et al., 2009). On the contrary, optimism functions as a protective factor against depression (Fiske et al., 2009), promoting healthier lifestyles and reducing mortality risk (Kim et al., 2017). Thus, the strong predictive power of self-rated health for future health outcomes and mortality risk may be attributed to its reflection of psychological states such as depression and optimism.

1.6.3 Reflection of Interoception

A third possibility is that self-rated health in older adults represents a comprehensive evaluation that encompasses even interoception—various physiological signals within the body—reflecting not only visible symptoms and objective test results but also subclinical abnormalities and undiagnosed health issues. This includes patients' subjective sensations that "something feels wrong" or "different," even when these feelings seem vague. Because patients use these interoceptive signals as cues to evaluate their health status (Jylhä, 2009), their assessments often diverge from physicians' evaluations, which are based on objective measures (Stenback, 1964).

A notable example of this divergence is subjective cognitive impairment (SCI), where patients perceive cognitive decline despite normal objective test results (Jessen, 2014). While traditionally dismissed as excessive health anxiety, recent studies have shown that SCI is associated with an increased risk of dementia and brain pathology (Amariglio et al., 2012; Jessen et al., 2010; Mitchell et al., 2014).

1.7 Purpose and Significance of the Study

Recent advancements in medical care have extended healthy life expectancy. However, health decline in older adults remains inevitable and many face significant health challenges. In particular, approximately 60% of individuals aged 85 years and older require long-term care and the average duration between the onset of severe health deterioration and death is approximately 10 years. A critical challenge during this period is maintaining psychological well-being while adapting to these changes.

Traditional models of normal aging have primarily focused on age-related resource depletion as a key factor in how individuals select adaptive strategies. However, pathological aging is characterized by the dramatic manifestation and rapid progression of symptoms, which distinguishes it from the gradual decline observed in normal aging. These distinct progression patterns may influence how individuals psychologically adapt to health decline in the context of pathological aging.

Moreover, previous studies have often excluded older adults who are hospitalized, institutionalized, or have severe cognitive impairment owing to the practical challenges of their participation. Consequently, research has largely focused on relatively healthy older adults who could easily participate and it has been challenging to reflect on the experiences and circumstances of those with significant health or cognitive impairment. This selection bias has potentially led to an underestimation of the effects of end-stage decline and cognitive deterioration (Rabbitt et al., 2005), limiting our understanding of older adults experiencing severe health decline.

1.7.1 Purpose of the Study

This study aimed to elucidate the psychological adaptation mechanisms specific to health decline in pathological aging and provide insights into psychological support for older adults facing adaptation challenges. The research used data from older adults who were either hospitalized or receiving outpatient care, including individuals in the early stages of disease to those with severe conditions. The research focused on three key

factors in pathological aging—the aging process, vulnerability, and controllability—with particular attention to self-rated health and emotion regulation as essential components of psychological adaptation. The following three investigations were conducted:

Study 1: Examining the effects of physical vulnerability and aging on emotion regulation and self-rated health.

Study 2: Examining the impact of cognitive vulnerability on self-rated mobility, depressive mood, and maladaptive outcomes.

Study 3: Exploring the impact of controllability on illness self-awareness.

Through these investigations, the study examined the roles of self-rated health and emotion regulation as adaptation strategies in terms of their contribution to survival and psychological well-being.

1.7.2 Significance of the Study

The significance of this research lies in its use of data from clinical settings in which older adults receive medical care, including those patients with severe conditions who have often been excluded from previous research because of practical constraints. The use of clinical data not only elucidates the adaptation mechanisms specific to severe health decline in pathological aging but also provides findings applicable to psychological support for older adults in situations in which medical interventions alone may be insufficient.

Chapter 2

Moderating Effect of Age on the Relationship Between Physical Health Loss and Depressive Mood Post-Acute Care in Japanese Older Hospitalized Patients: Examining the Effects of Physical Vulnerability and Aging on Emotion Regulation and Self-Rated Health

2.1 Background

Generally, physical health decline is a major risk factor for depression (Evans et al., 2005; Katon et al., 2007; Turner & Noh, 1988). However, in older adults, this relationship does not always hold for older adults, as many studies have reported (Blazer, 2003; Fiske et al., 2009; Forsell & Winblad, 1999; Turner & McLean, 1989). Despite an increase in health decline, older adults tend to maintain optimistic self-assessments (Idler, 1993; G. L. Maddox & E. B. Douglass, 1973), and it has been consistently reported that the correlation between subjective and objective health assessments weakens with age (French et al., 2012; Henchoz et al., 2008; Idler & Benyamini, 1997; Kivinen et al., 1998; Pinquart, 2001; Schnittker, 2005b). Such an

optimistic tendency has also been observed in centenarians with multiple illnesses and functional limitations (Araujo et al., 2018; Gondo et al., 2013).

It has been suggested that experiencing the same level of illness or disability later in life is more predictable and psychologically manageable (Schnittker, 2005a; Turner & McLean, 1989; Verbrugge & Jette, 1994). Additionally, the ability to cope with illnesses may improve with life experience (Schnittker, 2005a). Studies on centenarians have reported high levels of psychological well-being and maintained psychological functions related to emotion regulation and psychological adjustment (Gondo et al., 2013; Jopp & Rott, 2006).

Furthermore, one explanation for older adults' ability to maintain positive emotions amidst health decline is the motivational shift that occurs with aging. According to the Socioemotional Selectivity Theory (SST) (Carstensen et al., 1999), awareness of limited time in life prompts older adults to prioritize emotionally meaningful goals and focus on the present, enhancing their emotion regulation abilities (Mather, 2012). Particularly in advanced old age, downward social comparison becomes an important adaptation strategy. Through downward comparison, older adults recognize the existence of peers in less fortunate circumstances, which can trigger response shifts, such as changes in values and internal standards. These shifts have been noted to bring positive changes in self-perception and self-evaluation (Gibbons, 1999; Sprangers & Schwartz, 1999).

Such secondary control strategies play a crucial role in psychological adaptation to health decline in late life, especially when primary control becomes challenging. The tendency to perceive one's health more optimistically than it objectively may indicate the presence of adaptive capacities and personal resources (Araujo et al., 2018). For older adults, adopting an optimistic perspective on health decline and maintaining emotional well-being may serve as an adaptive strategy to enhance survival rates during the frail stages of advanced old age.

Meanwhile, the progression of functional decline differs significantly between normal and pathological aging. In normal aging, physiological decline progresses gradually, whereas in pathological aging, diseases lead to dramatic and rapid deterioration (Franceschi et al., 2018). These differences in progression processes may

influence psychological adaptation to health decline in pathological aging. According to the Strength and Vulnerability Integration (SAVI) model (Charles, 2010), as physiological vulnerability increases, particularly in situations of sustained and severe distress, the strengths of emotion regulation associated with aging diminish, making emotion regulation more challenging. Consequently, the advantages of aging may diminish, leading to greater difficulties and reduced emotional well-being compared to younger adults (Charles, 2010).

Furthermore, approximately 3–7 years before death, rapid declines in physical function, cognitive function, and physiological reserves—referred to as terminal decline—occur inevitably, leading to the final stages of life (Cohen-Mansfield et al., 2017; Stolz et al., 2021). This terminal decline extends to emotional functioning (Gerstorf et al., 2010) and is reported to be particularly pronounced in individuals with severe health impairments and disabilities (Cohen-Mansfield et al., 2017; Diegelmann et al., 2016; Gerstorf et al., 2013; Schilling et al., 2018).

Supporting these findings, studies on pathological aging indicate high rates of depression and anxiety. For instance, 35% of hospitalized older patients and 12.4–42% of institutionalized older adults have been reported to exhibit depressive symptoms (Blazer, 2003; Djernes, 2006; Fiske et al., 2009; Koenig et al., 1988). Depression risk increases significantly in cases of severe disability (Koenig et al., 1988) or when individuals experience chronic pain and functional limitations that cause significant stress and distress (Turner & Noh, 1988).

In summary, in normal aging, the emotional advantages associated with aging allow older adults to maintain positive emotions even as their health declines. However, in pathological aging, where physical and mental vulnerabilities are heightened, these emotional strengths may diminish, potentially leading to worsening mental health. Nevertheless, the relationship between physical health and mental health in pathological aging remains insufficiently understood.

2.2 Purpose

This study aimed to investigate the moderating effect of age on the relationship between objective physical function, self-rated physical health, and depressive mood in older hospitalized patients with heightened physical and mental vulnerability following acute care. Specifically, this study aimed to determine whether the relationship between physical health decline and depressive mood differs by age.

If psychological functions related to emotion regulation, as observed in normal aging, are preserved even in pathological aging characterized by significantly increased vulnerability, it was hypothesized that older patients would demonstrate greater emotional control. Consequently, their self-rated health would be more positive than their actual health, and such positive self-assessments would be associated with lower levels of depressive mood.

Conversely, if, as suggested by the SAVI model, the emotional strengths associated with aging are diminished under conditions of heightened vulnerability following acute care, it was hypothesized that individuals with more severe physical health decline would rate their health more negatively and exhibit higher levels of depressive mood.

2.3 Methods

2.3.1 Participants

Between July 2015 and September 2020, participants were recruited from hospitalized patients aged 65 years or older who were transferred from an acute care ward to a community comprehensive care ward at the National Center for Geriatrics and Gerontology.

In this institution, patients requiring coordination of post-discharge care services (e.g., awaiting vacancies in care facilities), those with advanced frailty or comorbidities (e.g., diabetes or bone fractures), patients aged 80 years or older, and those with cognitive decline—particularly those with significantly increased vulnerability—were transferred to the community comprehensive care ward for continuous care until discharge.

Informed consent was obtained at the time of transfer to the community comprehensive care ward. Patients with terminal illness who died within three months, or those with severe conditions such as respiratory distress, intense pain, or decreased consciousness at the time of transfer, were excluded. Additionally, patients already taking antidepressants or mood stabilizers at the time of transfer were excluded due to the potential influence of these medications on the 15-item Geriatric Depression Scale (GDS-15) scores. However, patients who had previously used antidepressants or mood stabilizers but discontinued them before transfer, or those with symptoms of depression who were not taking such medications, were included.

A total of 711 patients consented to participate. Based on prior findings that GDS-15 is valid for assessing depression in older adults with Mini-Mental State Examination (MMSE) scores of 10 or higher (Conradsson et al., 2013), 82 patients with MMSE scores of 9 or lower were excluded. Eleven patients who began taking antidepressants or mood stabilizers before assessment were excluded. An additional 28 patients with missing data on primary variables were excluded. These 28 patients included 10 who were discharged before assessment, nine with disease aggravation, three with severe

behavioral and psychological symptoms of dementia, two with low arousal, and four with other conditions. Finally, 590 participants (187 males and 403 females) were included in the study (Figure 2.1).

2.3.2 Time Points of Data Collection

Informed consent was obtained immediately after the transfer from the acute care ward to the community comprehensive care ward. Data on pre-hospitalization conditions (T0) were collected when family members or their representatives visited the hospital because of admission procedures, meetings with patients, and consultations with physicians. Data at the time of transfer (T1) were collected upon admission to the community comprehensive care ward. Four-year survival status and causes of death were obtained from medical records.

2.3.3 Measurement Items

Sociodemographic characteristics:

Data on age, sex (male and female), marital status (married, widowed, and others), residence at prehospitalization (private home and institution), level of daily living independence at prehospitalization (independence, supervision/minimal assistance, moderate assistance, and maximal assistance), length of stay in the acute care unit, length of stay in the community comprehensive care ward, hospitalization-causing diseases, and comorbidities (yes/no) were collected through interviews with family members and medical records. Hospitalization-causing diseases were defined as the immediate causes of acute hospitalization. Comorbidities were defined as the presence of diseases other than the hospitalization-causing diseases.

Physical function at pre-hospitalization (T0):

Physical function data at pre-hospitalization were retrospectively collected from the family members of patients during acute care. To evaluate the patient's ability during prehospitalization, 18 activities of daily living, similar to those in the Functional Independence Measure (FIM) criteria, were examined. Each item was rated on a seven-point scale (7 = complete independence, 6 = modified independence, 5 = supervision, 4 = minimal assistance, 3 = moderate assistance, 2 = maximal assistance, 1 = total assistance) by family members. The total score for the 18 items ranged from 18 to 126, with higher scores indicating higher physical function pre-hospitalization. Cronbach's alpha in this study was .95.

Cognitive function at post-acute care (T1):

The participants' cognitive function after acute care was assessed using the MMSE (Folstein et al., 1975). Cronbach's alpha in this study was .87.

Physical function at post-acute care (T1):

Physical function was assessed using the Japanese version of FIM 3.0 (Liu et al., 1997; Tsuji et al., 1995). The FIM is an 18-item scale that evaluates abilities in activities of daily living, including self-care, sphincter control, transfer, and locomotion. Each item was rated on a seven-point scale (7 = complete independence, 6 = modified independence, 5 = supervision, 4 = minimal assistance, 3 = moderate assistance, 2 = maximal assistance, 1 = total assistance) based on therapist observation. The total score range of the FIM is 18–126, with higher scores indicating higher physical function after acute care. Cronbach's alpha in this study was .96.

Self-rated physical health at post-acute care (T1):

To evaluate participants' self-assessment of physical health after acute care, the Japanese version of the Medical Outcome Study 8-Item Short Form Health Survey (SF-

8) (Fukuhara & Suzukamo, 2004) was used. The SF-8 includes eight items related to physical and mental health, with two component scores: the Physical Component Summary (PCS-8) and the Mental Component Summary (MCS-8), calculated using the algorithm described in the Japanese SF-8 manual. In this study, the PCS-8 score was used as the self-rated physical health score. PCS-8 scores are normalized to a mean of 50 and a standard deviation (SD) of 10 for the general Japanese population, with higher scores indicating better self-perceived health.

Depressive mood at post-acute care (T1):

Depressive mood was assessed using the GDS-15 (Yesavage & Sheikh, 2008), a measure of psychological adjustment after acute care. Participants responded “yes” or “no” to each of the 15 items (score range: 0–15). The GDS-15 is used to assess depressive mood in older adults and is effective for individuals with MMSE scores of 10 or higher (Conradsson et al., 2013). Cronbach’s alpha in this study was .82.

Time-to-death:

Based on findings that emotional decline begins approximately four years before death (Gerstorf, Ram, et al., 2008b), participants at T1 were categorized based on whether their time-to-death was less than or equal to four years. Data on survival status and causes of death were collected from medical records four years after the initial assessment.

2.3.4 Statistical Analysis

The age quartiles of the participants were 78.75, 83.00, and 88.00 years, and people tended to understand age in five-year increments. Thus, the participants were divided into four age groups (65–79, 80–84, 85–89, and ≥90 years). Descriptive statistics for each group were calculated. Differences among the four age groups were examined

using one-way analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables. Associations among the key variables within the four age groups were examined using Pearson's product–moment correlation coefficient.

Hierarchical multiple regression analysis (forced entry method) was used to examine whether age had a moderating effect on the relationship between health-related variables (objective physical functioning and self-rated physical health) at post-acute care and depressive mood. In step 1, objective physical function at pre-hospitalization and cognitive function at post-acute care were included as control variables. In step 2, health-related variables (objective physical function and self-rated physical health) at post-acute care were treated as independent variables, and age was included as a moderating variable. In step 3, two interaction terms, constructed by combining the two independent variables with the moderating variable, were entered into the model. To reduce multicollinearity, mean-centering was applied (Cohen et al., 2003). Specifically, the mean was subtracted from each value of the two health-related variables and age before entering them into the regression equation. Multicollinearity in the hierarchical multiple regression analysis was examined using the variance inflation factor (VIF), with a value of 10 or more indicating multicollinearity. For significant interaction terms, simple slope analysis was conducted with age at −1 SD and +1 SD (Aiken & West, 1991; Cohen et al., 2003).

Additionally, the causes of death for participants who died within four years were aggregated for each of the four age groups. Two-way analysis of variance (ANOVA) was performed with age (< 85 years, ≥ 85 years) and time-to-death (≤ 4 years, > 4 years) as independent variables, and depressive mood score (T1) as the dependent variable. Missing values in Time-to-Death were imputed using a LightGBM classifier with a 0.5 threshold for binarization.

All analyses were conducted at a significance level of $p < .05$. Effect sizes were calculated using η^2 or Cramér's V where appropriate.

Hierarchical multiple regression analysis was performed using R version 4.1.3 (packages: "car" version 3.0-13, "carData" version 3.0-5, "pequod" version 0.0-5, "jtools" version 2.2.0, and "ggplot2" version 3.3.6). All other analyses were conducted

using IBM SPSS Statistics for Windows version 29. Additionally, Python (version 3.10.0) was used for data preprocessing and machine learning, utilizing the following packages: pandas (2.2.3), numpy (1.26.4), scikit-learn (1.6.1), imbalanced-learn (0.13.0), matplotlib (3.10.0), seaborn (0.13.2), and lightgbm (4.5.0).

2.3.5 Ethics Approval and Consent to Participate

Written informed consent was obtained from all the participants. In the case of patients who did not have sufficient capacity to provide consent due to cognitive decline or other reasons, informed consent was obtained from the patient and family. This study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of the National Center for Geriatrics and Gerontology (approval number: 830).

2.4 Results

2.4.1 Characteristics of the Participants

Table 2.1 summarizes the characteristics of participants across the four age groups. The mean age of participants was 82.81 ± 6.85 years (range: 65–100), and the mean cognitive function score (MMSE) was 21.91 ± 5.40. Before hospitalization, 48.81% of participants were independent in their daily living activities. Common causes of hospitalization were vertebral fractures, femoral fractures, and heart failure. The mean length of stay in the acute care ward was 28.08 ± 19.74 days, and in the community comprehensive care ward, it was also 28.08 ± 19.74 days. Notably, 97.97% of participants had comorbid conditions.

Table 2.2 presents differences in key variables across the four age groups. The mean score for objective physical function before hospitalization was 105.09 ± 22.10. After acute care, the mean score for objective physical function (FIM) was 83.04 ± 25.20, with an average score of 4.61 per item, suggesting that participants typically required minimal assistance. The mean score for self-rated physical health (PCS-8) was 35.26 ± 10.53, which was lower than the national average for the general Japanese population. The mean depressive mood score (GDS-15) was 6.71 ± 3.81; 41.69% of participants scored between 5 and 9, and 25.59% scored 10 or higher.

Differences across the four age groups in post-acute care objective physical function, self-rated physical health, and depressive mood were analyzed. Continuous variables were examined using one-way ANOVA, and categorical variables using chi-squared tests. Significant differences were found in post-acute care objective physical function ($F(3,586) = 8.90$, $p < .001$, $\eta^2 = .04$). Multiple comparisons using the Bonferroni method indicated that the 65–79 years group ($p < .001$) and the 80–84 years group ($p < .001$) scored significantly higher than the ≥90 years group. However, no significant differences were observed among the four age groups in self-rated physical health ($F(3,586) = 1.49$, $p = .22$, $\eta^2 = .01$) or depressive mood ($F(3,586) = 0.12$, $p = .95$, $\eta^2 = .00$).

2.4.2 Correlations Among Key Variables Across Age Groups

Table 2.3 presents the Pearson's product–moment correlation coefficients between the key variables across the four age groups. No significant correlation greater than .20 was observed between post-acute care objective physical function and self-rated physical health in any age group. In the two younger age groups (65–79 and 80–84 years), a significant negative correlation was found between post-acute care objective physical function and depressive mood. However, no significant correlation was observed between these variables in the two older age groups (85–89 and ≥90 years). Alternatively, the correlation between self-rated physical health and depressive mood tended to be stronger in the older age groups.

2.4.3 Moderating Effect of Age on the Relationship Between Health-Related Variables and Depressive Mood at T1

Hierarchical multiple regression analysis (forced entry method) was used to examine the moderating effect of age on the relationship between health-related variables (objective physical function and self-rated physical health) and depressive mood at T1 (Table 2.4). Pre-hospitalization physical function and cognitive function were entered as control variables in Step 1. In Step 2, health-related variables at post-acute care (objective physical function and self-rated physical health) were entered as independent variables, and age was entered as a moderating variable. Results showed a significant increase in the coefficient of determination from Step 1 to Step 2. After controlling for pre-hospitalization physical function and cognitive function, both health-related variables were significantly associated with depressive mood. Age was not directly associated with depressive mood.

In Step 3, interaction terms were created by multiplying the two independent variables by the moderating variable (age), and these terms were entered into the model. The increase in the coefficient of determination from Step 2 to Step 3 was significant. Both interaction terms (objective physical function × age and self-rated physical health

× age) were significant at Step 3. The overall model explained a significant portion of variance in depressive mood (R^2 = .14, adjusted R^2 = .13). Variance inflation factors (VIFs) were all below 3, indicating no multicollinearity issues.

Given the significance of the interaction terms, simple slope analyses were conducted. The mean age −1 SD and mean age +1 SD were substituted into the regression equation (Aiken & West, 1991; Cohen et al., 2003). Figure 2.2 illustrates the results of the simple slope analysis for the objective physical function × age interaction term. When age was the mean −1 SD years (75.96), an association was observed between objective physical function and depressive mood, with lower physical function predicting higher depressive mood (β = −.04, t(582) = −4.08, p < .001). Conversely, when age was the mean +1 SD years (89.66), no significant association was observed (β = −.01, t(582) = −1.01, p = .31).

Figure 2.3 depicts the results of the simple slope analysis for the self-rated physical health × age interaction term. Associations between self-rated physical health and depressive mood were significant both when age was the mean −1 SD years (β = −.04, t(582) = −1.99, p < .05) and when it was the mean +1 SD years (β = −.13, t(582) = −6.74, p < .001). Higher self-rated physical health was associated with lower depressive mood, with a stronger association observed when age was the mean +1 SD years.

2.4.4 Relationship Between Time-to-Death and Age with Depressive Mood at T1

Based on these results, there appeared to be differences in psychological adaptation between individuals aged <85 years and those aged ≥85 years. Furthermore, previous research has shown that emotional decline begins approximately four years before death (Gerstorf, Ram, et al., 2008b). To investigate this further, a two-way ANOVA was conducted using age (<85 years, ≥85 years) and time-to-death (≤4 years, >4 years) as independent variables and T1 depressive mood scores as the dependent variable.

Of the 590 participants, time-to-death data were missing for 210 individuals and were imputed using LightGBM (F1-score: .72). The analysis revealed a significant main

effect of time-to-death ($F(1, 586) = 6.36$, $p < .05$, $\eta^2 = .01$), with lower T1 depressive mood scores in the surviving group. However, neither the main effect of age ($F(1, 586) = 0.64$, $p = .42$, $\eta^2 = .00$) nor the interaction between time-to-death and age ($F(1, 586) = 1.60$, $p = .21$, $\eta^2 = .00$) was significant (Table 2.5).

Although the overall model reached statistical significance ($F(3, 586) = 2.91$, $p < .05$), its explanatory power was limited ($R^2 = .02$). To provide further context, Table 2.6 summarizes the causes of death within four years from T1.

2.5 Discussion

This study aimed to investigate the moderating effect of age on the relationship between objective physical function, self-rated physical health, and depressive mood in hospitalized older patients with increased vulnerability after acute care.

2.5.1 Effects of Age and Physical Vulnerability on Depressive Mood

Previous studies have suggested that in frail older adults with significantly declining health, overall frailty increases, leading to reduced psychological functioning and difficulties in emotion regulation (Baltes & Smith, 2003; Charles, 2010; Smith et al., 1999).

Interestingly, in this study, a one-way ANOVA revealed that patients aged ≥85 years, despite having poorer objective physical function, did not necessarily exhibit worse self-rated physical health or higher depressive mood compared to those aged ≤84 years. Correlation analysis further showed that while objective physical function was significantly associated with depressive mood in patients aged ≤84 years, this association was not significant in those aged ≥85 years, who instead showed an association between self-rated physical health and depressive mood. These results suggested that even with deteriorating objective health status, older patients may avoid increases in depressive mood if they maintained positive self-rated health.

These findings were further supported by hierarchical multiple regression and simple slope analyses, which demonstrated that age influenced the relationship between physical function and depressive mood. Specifically, older patients (mean +1 SD years) were less likely to show increased depressive mood even with lower physical function compared to younger patients (mean −1 SD years). Age also affected the relationship between self-rated physical health and depressive mood, suggesting that older adults (+1 SD) were more likely to reduced depressive mood when their self-rated health was positive.

That is, these results suggest that although physical vulnerability increased with advancing age, emotion regulation appeared to function better in older patients, confirming age-related mitigating effects in the relationships among objective physical function, self-rated physical health, and depressive mood.

However, in this study, 67.29% of older patients scored 5 or higher on the GDS-15, indicating the presence of depressive mood and emotional distress following health deterioration. This suggested that while emotion regulation abilities existed and functioned, the age-related strengths in emotion regulation may be diminished under conditions of increased physical vulnerability, such as in acute or chronic care, and thus may not be sufficient to fully alleviate depressive mood.

2.5.2 Changes in Perceptions of Health Decline Around the Mid-80s

The reason why these relationships change around the mid-80s cannot be determined from the findings alone, but may reflect psychosocial transitions occurring during this period. The data, collected from 2015 to 2020, correspond with a period when Japan's 2016 healthy life expectancy was 72.14 years for men and 74.79 years for women, with overall life expectancy at 80.98 years for men and 87.14 years for women. The mid-80s might represent a transition from the "third age" to the "fourth age" (Baltes & Smith, 2003), and survival beyond average life expectancy might be perceived as a "bonus" period of life. As previous research suggests, psychological mechanisms such as downward social comparison may help maintain mental health in older adults with increased vulnerability (Affleck & Tennen, 1991; Buunk et al., 1990; Frieswijk et al., 2004; Wood et al., 1985; Wurm et al., 2008) For instance, patients aged 85 and above may have compared themselves to peers facing greater health challenges or who had passed away, fostering a sense of gratitude for their longevity, which may have facilitated their psychological adaptation.

2.5.3 Impact of Terminal Decline on Depressive Mood

The two-way ANOVA results demonstrated a significant increase in depressive mood scores at T1 among patients with a time-to-death of four years or less. This finding is consistent with previous research (Gerstorf, Ram, et al., 2008a), which has documented a decline in emotional well-being as death approaches, independent of chronological age.

These results suggest that proximity to death, rather than aging itself, may be a stronger determinant of depressive mood. This aligns with the concept of terminal decline, where emotional functioning deteriorates in the final years of life. Even among the very old (≥85 years), the impact of approaching death appeared to outweigh the potential resilience associated with age-related emotional regulation.

However, the limited explanatory power of our model (R^2 = .02) indicates that terminal decline alone does not fully account for late-life depressive mood. Factors such as social support, pain level, and comorbidities need to be considered in understanding emotional well-being in older adults approaching end of life.

2.6 Limitations

This study has several limitations. First, depressive mood was assessed only once using the GDS-15 after acute treatment, and longitudinal changes were not examined. As a result, the depressive mood evaluated in this study may not meet the diagnostic criteria for clinical depression and may represent a temporary adjustment disorder associated with acute inpatient treatment. Moreover, some patients recovered from depressive mood as their physical health improved. The relationship between depression and physical health is bidirectional (Bruce, 2001; Evans et al., 2005; Lenze et al., 2001), and while poor physical health may lead to depression, depression can also negatively affect physical health. Previous studies have also suggested that individuals with more positive emotions tend to have greater survival rates (Fredrickson, 2001; Ostir et al., 2000). Therefore, the direction of causality in this study remains unclear—poor physical health following acute treatment might have contributed to depressive mood, or depressive mood could have hindered physical recovery.

Additionally, while patients on medication for depressive or bipolar disorders were excluded from this study, other conditions such as stroke, Parkinson's disease, or dementia may have independently elevated depressive symptoms due to their underlying disease processes (Blazer, 2003; Evans et al., 2005; Fiske et al., 2009). These unaccounted factors could have influenced the findings. Finally, as the participants were all Japanese, cultural factors—such as unique perspectives on life and death and specific religious beliefs—may have shaped the results. This cultural specificity limits the generalizability of the findings to other populations.

2.7 Conclusions

This study revealed that even in pathological aging with increased physical vulnerability, older patients could potentially reduce depressive mood by maintaining positive self-rated health despite deteriorating physical health, with this ability becoming more pronounced with advancing age.

These findings demonstrated that despite their increased physical vulnerability, older adults retained superior emotion regulation capabilities, confirming age-related mitigating effects in the relationships among objective physical function, self-rated physical health, and depressive mood.

However, while these emotion regulation abilities in older patients appeared to function to some extent, findings suggested that they were not sufficiently effective under conditions of increased vulnerability, such as following acute care treatment.

Furthermore, for older adults approaching the end of life, emotional functioning appeared to deteriorate due to terminal decline regardless of age, with the effects of time-to-death overriding age-related strengths in emotion regulation, leading to increased depressive mood.

These findings underscore the importance of providing targeted psychological support for older adults facing increased vulnerability or terminal stages, as their adaptive resources may be insufficient to maintain emotional well-being through inherent regulation mechanisms alone.

2.8 List of Tables

Table 2.1

Characteristics of Participants by Age Groups

Participant Characteristics, *Mean* ± *SD* or *n* (%)	Total (*N* = 590)	65–79 (*n* = 172)	80–84 (*n* = 166)	85–89 (*n* = 160)	90 + (*n* = 92)	*p*	Effect Size (η^2 / Cramér's V)
Age	82.81 ± 6.85						
Sex, Female	403 (68.31)	115 (66.86)	101 (60.84)	114 (71.25)	73 (79.35)	.016	.13
Residence at T0						.370	.07
Private	569 (96.44)	166 (96.51)	162 (97.59)	151 (94.38)	90 (97.83)		
Institution	21 (3.56)	6 (3.49)	4 (2.41)	9 (5.63)	2 (2.17)		
Daily living independence at T0						< .001	.15
Independence	288 (48.81)	86 (50.00)	103 (62.05)	72 (45.00)	27 (29.35)		
Supervision / Minimal assistance	238 (40.34)	60 (34.88)	46 (27.71)	75 (46.88)	57 (61.96)		
Moderate assistance	51 (8.64)	21 (12.21)	13 (7.83)	9 (5.63)	8 (8.70)		
Maximal assistance	13 (2.20)	5 (2.91)	4 (2.41)	4 (2.50)	0 (0.00)		
Main cause of hospitalization						.004	.16
Spinal fracture	193 (32.71)	41 (23.84)	56 (33.73)	61 (38.13)	35 (38.04)		
Other orthopedic disease	54 (9.15)	17 (9.88)	17 (10.24)	12 (7.50)	8 (8.70)		
Femoral Fracture	51 (8.64)	8 (4.65)	11 (6.63)	23 (14.37)	9 (9.78)		
Heart failure	48 (8.14)	12 (6.98)	10 (6.02)	13 (8.13)	13 (14.13)		
Other fracture	40 (6.78)	18 (10.47)	9 (5.42)	8 (5.00)	5 (5.43)		
Pneumonia	33 (5.59)	11 (6.40)	8 (4.82)	10 (6.25)	4 (4.35)		

Parkinson's disease / Parkinson's disease dementia	25 (4.24)	13 (7.56)	8 (4.82)	2 (1.25)	2 (2.17)		
Stroke	18 (3.05)	7 (4.07)	5 (3.01)	2 (1.25)	4 (4.35)		
Other	128 (21.69)	45 (26.16)	42 (25.30)	29 (18.13)	12 (13.04)		
Comorbidity, yes	578 (97.97)	169 (98.26)	160 (96.39)	157 (98.13)	92 (100.00)	.253	.08
Length of stay in acute care, days	28.08 ± 19.74	29.05 ± 19.06	28.11 ± 22.20	27.04 ± 17.12	28.02 ± 20.71	.835	.00
Length of stay in community comprehensive care ward, days	40.16 ± 14.18	38.23 ± 15.11	40.71 ± 14.50	41.41 ± 13.04	40.60 ± 13.55	.189	.01

Note. One-way ANOVA was used for continuous variables to examine differences across the four age groups, with η^2.

The chi-square test was used for categorical variables, with Cramér's V reported.

Table 2.2

Differences in Key Variables by Age Groups

Variables, *Mean* ± *SD* or *n* (%)	Total (*N* = 590)	65–79 (*n* = 172)	80–84 (*n* = 166)	85–89 (*n* = 160)	90 + (*n* = 92)	*p*	Effect Size (η^2)	Multiple Comparisons
Physical function at T0	105.09 ± 22.10	104.97 ± 24.71	108.92 ± 22.30	105.06 ± 19.74	98.47 ± 18.99	.004	.02	80–84 > 90+
Cognitive function (MMSE) at T1	21.91 ± 5.40	23.77 ± 5.16	22.43 ± 5.11	20.98 ± 5.16	19.09 ± 5.29	< .001	.09	65–79 > 85–89 > 90+, 80–84 > 90+
Physical function (FIM) at T1	83.04 ± 25.20	87.42 ± 25.71	86.53 ± 25.02	80.74 ± 23.77	72.55 ± 23.78	< .001	.04	65–79, 80–84 > 90+
Self-rated physical health (PCS-8) at T1	35.26 ± 10.53	34.26 ± 10.77	35.10 ± 9.79	36.66 ± 10.49	35.01 ± 11.31	.217	.01	–
Depressive mood (GDS-15) at T1	6.71 ± 3.81	6.85 ± 3.81	6.61 ± 3.88	6.67 ± 3.73	6.66 ± 3.84	.946	.00	–
≤ 4	193 (32.71)	50 (29.07)	52 (31.33)	57 (35.63)	34 (36.96)			
5 - 9	246 (41.69)	73 (42.44)	77 (46.39)	63 (39.38)	33 (35.87)			
≥ 10	151 (25.59)	49 (28.49)	37 (22.29)	40 (25.00)	25 (27.17)			

Note. One-way ANOVA was used for continuous variables to examine differences across the four age groups, with η^2.

Multiple comparisons were conducted using Tukey's or Tamhane's T2 tests based on Levene's test for equality of variances.

Table2.3

Correlations between Key Variables by Age Groups

Variables	1		2		3		4	
65-79 (*n* = 172)								
1 Physical function at T0								
2 Cognitive function (MMSE) at T1	.50	***						
3 Physical function (FIM) at T1	.68	***	.64	***				
4 Self-rated physical health (PCS-8) at T1	.18	*	-.16	*	.13			
5 Depressive mood (GDS-15) at T1	-.22	**	-.22	**	-.36	***	-.16	*
80-84 (*n* = 166)								
1 Physical function at T0								
2 Cognitive function (MMSE) at T1	.47	***						
3 Physical function (FIM) at T1	.64	***	.56	***				
4 Self-rated physical health (PCS-8) at T1	.15		.05		.19	*		
5 Depressive mood (GDS-15) at T1	-.20	**	-.25	**	-.28	***	-.24	**
85-89 (*n* = 160)								
1 Physical function at T0								
2 Cognitive function (MMSE) at T1	.54	***						
3 Physical function (FIM) at T1	.65	***	.65	***				
4 Self-rated physical health (PCS-8) at T1	.06		-.10		.07			
5 Depressive mood (GDS-15) at T1	-.17	*	.01		-.11		-.29	***
90 + (*n* = 92)								
1 Physical function at T0								
2 Cognitive function (MMSE) at T1	.41	***						
3 Physical function (FIM) at T1	.49	***	.46	***				
4 Self-rated physical health (PCS-8) at T1	.01		-.31	**	.02			
5 Depressive mood (GDS-15) at T1	-.07		.05		-.12		-.45	***

Note. Correlations are calculated using Pearson's correlation coefficient.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table2.4

Hierachical Regression Analysis of Depressive Mood at T1

Explanatory Variables	Step 1				Step 2				Step 3			
	B	*SE* (*B*)	*β*		*B*	*SE* (*B*)	*β*		*B*	*SE* (*B*)	*β*	
Physical function at T0	-.03	.01	-.16	***	-.01	.01	-.03		-.01	.01	-.03	
Cognitive function (MMSE) at T1	-.02	.03	-.03		-.03	.04	-.04		-.02	.04	-.03	
Age_c					-.02	.02	-.04		-.02	.02	-.04	
Physical function (FIM) at T1_c					-.03	.01	-.17	**	-.03	.01	-.18	**
Self-rated physical health (PCS-8) at T1_c					-.09	.02	-.25	***	-.09	.01	-.24	***
Physical function (FIM) at T1_c × Age_c									.00	.00	.11	**
Self-rated physical health (PCS-8) at T1_c × Age_c									-.01	.00	-.13	***
R^2 (R^2 *adj.*)	.03 (.03)				.12 (.11)				.14 (.13)			
ΔR^2	.03***				.08***				.03***			

Note. "_c" is the variable that was applied mean centering.

*p < .05, **p < .01, ***p < .001

Table 2.5

Two-Way ANOVA: Effects of Age and Time-to-Death on Depressive Mood (T1)

Independent Variables	SS	*df*	MS	*F*	*p*	Partial η^2
Age (< 85 years, ≥ 85 years)	9.25	1	9.25	0.64	.42	.00
Time-to-Death (≤ 4 Years vs. > 4 Years)	91.38	1	91.38	6.36	.01	.01
Age × Time-to-Death Interaction	22.90	1	22.90	1.60	.21	.00
Error	8415.34	586	14.36			
Total	35066.00	590				

Table 2.6

Causes of Death within 4 Years from T1 by Age Group

n (%)	Total (*N* = 147)	65–79 (*n* = 39)	80–84 (*n* = 40)	85–89 (*n* = 43)	90 + (*n* = 25)	*p*	Cramér's V
Cause of death						.657	.31
Heart failure	23 (15.65)	3 (7.69)	6 (15.00)	8 (18.60)	6 (24.00)		
Cancer	21 (14.29)	4 (10.26)	10 (25.00)	4 (9.30)	3 (12.00)		
Pneumonia	11 (7.48)	4 (10.26)	3 (7.50)	3 (6.98)	1 (4.00)		
Aspiration pneumonia	9 (6.12)	3 (7.69)	2 (5.00)	4 (9.30)	0 (0.00)		
Stroke	8 (5.44)	2 (5.13)	2 (5.00)	3 (6.98)	1 (4.00)		
Senility	8 (5.44)	1 (2.56)	1 (2.50)	4 (9.30)	2 (8.00)		
Parkinson's disease / Parkinson's disease dementia	6 (4.08)	4 (10.26)	2 (5.00)	0 (0.00)	0 (0.00)		
Other respiratory disease	5 (3.40)	3 (7.69)	1 (2.50)	0 (0.00)	1 (4.00)		
Myocardial infarction	4 (2.72)	2 (5.13)	2 (5.00)	0 (0.00)	0 (0.00)		
Renal failure	4 (2.72)	1 (2.56)	2 (5.00)	0 (0.00)	1 (4.00)		
Lewy body dementia	3 (2.04)	1 (2.56)	1 (2.50)	0 (0.00)	1 (4.00)		
Other heart disease	3 (2.04)	1 (2.56)	0 (0.00)	1 (2.33)	1 (4.00)		
Aortic valve stenosis	3 (2.04)	0 (0.00)	0 (0.00)	2 (4.65)	1 (4.00)		
Aortic aneurysm rupture	3 (2.04)	0 (0.00)	1 (2.50)	1 (2.33)	1 (4.00)		
Sepsis	3 (2.04)	1 (2.56)	1 (2.50)	0 (0.00)	1 (4.00)		
Other	6 (4.08)	3 (7.69)	1 (2.50)	1 (2.33)	1 (4.00)		

Unknown	27 (18.37)	6 (15.38)	5 (12.50)	12 (27.91)	4 (16.00)		
Time-to-Death (Post-T1 survival period)						< .001	.14
≤ 4 years	147 (24.92)	39 (22.67)	40 (24.10)	43 (26.88)	25 (27.17)		
> 4 years	233 (39.49)	87 (50.58)	70 (42.17)	54 (33.75)	22 (23.91)		
Unknown	210 (35.59)	46 (26.74)	56 (33.73)	63 (39.38)	45 (48.91)		

Note. The chi-square test was used for categorical variables, with Cramér's V reported as the measure of effect size.

The total $N = 147$ in the Cause of Death section represents individuals who died within 4 years only. The Time-to-Death section includes all participants (deceased + surviving + unknown, $N = 590$), hence the difference in total numbers.

2.9 List of Figures

Figure 2.1

Flowchart of the Selection Process of Analysis Participants

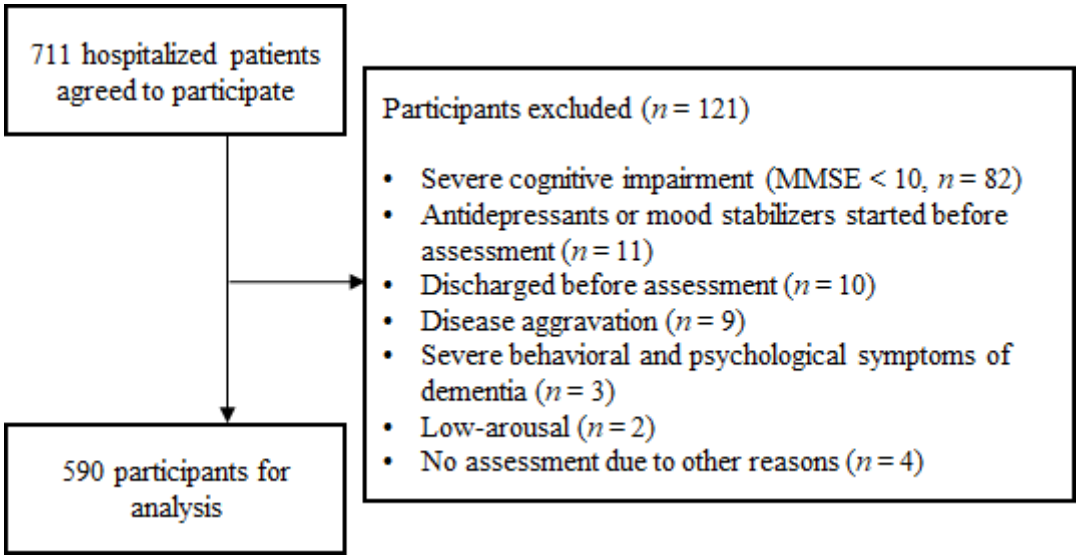


Figure 2.2

Moderating Effects of Aging on the Relationship between Physical Function and Depressive Mood at T1

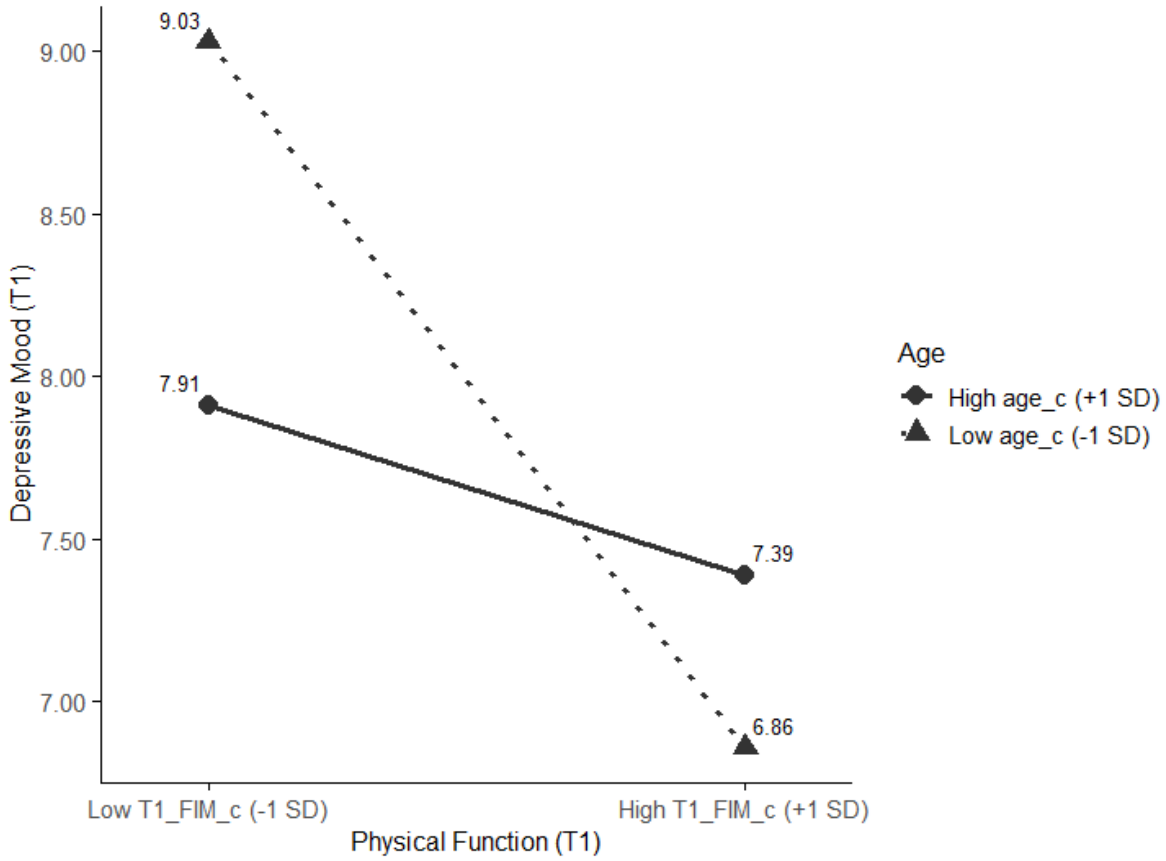
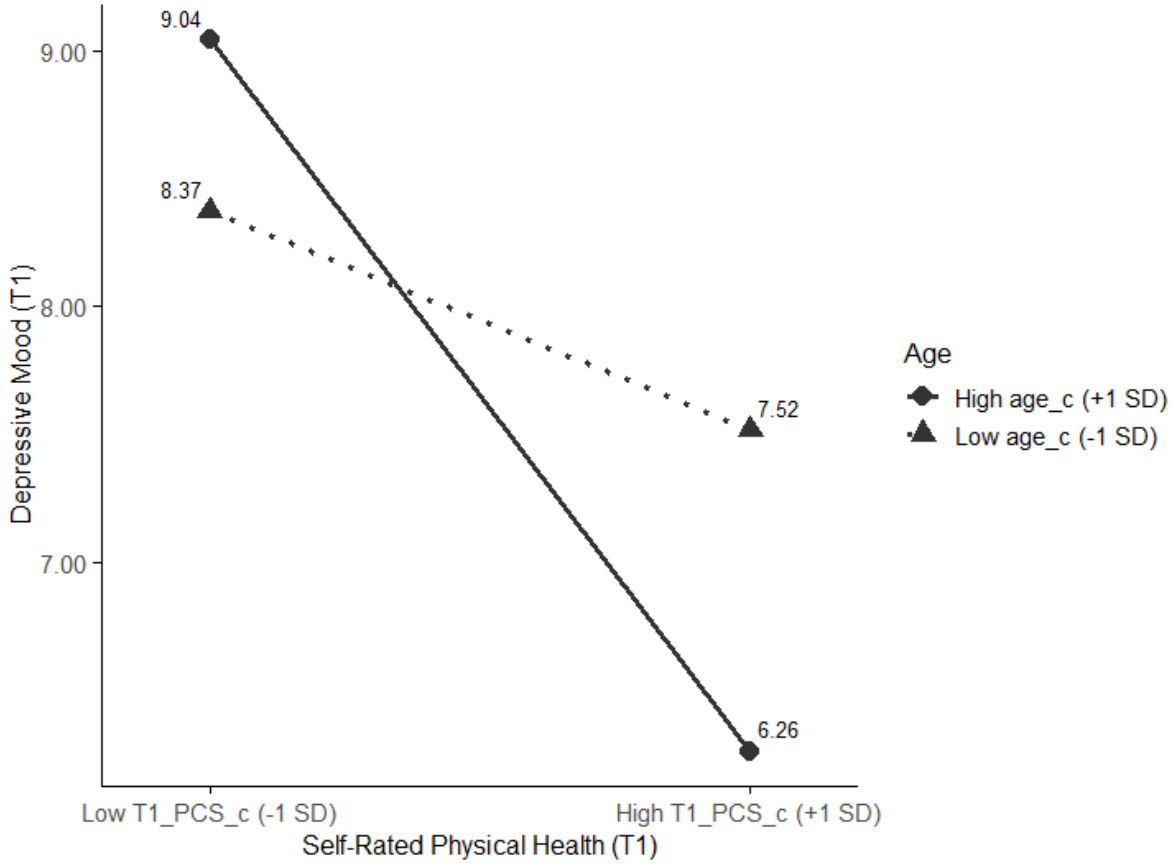


Figure 2.3

Moderating Effects of Aging on the Relationship between Self-Rated Physical Health and Depressive Mood at T1



Chapter 3
Examining the Impact of Cognitive Vulnerability on Self-Rated Mobility, Depressive Mood, and Maladaptive Outcomes

3.1 Background

Mobility is a crucial ability for older adults to maintain an independent lifestyle. It also significantly influences psychosocial aspects, such as preventing social isolation by enabling participation in social activities and interactions with friends, which support life satisfaction and well-being (Pantelaki et al., 2021).

However, when older adults are hospitalized due to acute illnesses, even a short period of approximately two weeks of bed rest can lead to rapid disuse syndrome and a sharp decline in mobility (Rejc et al., 2018). Particularly in older adults, once mobility declines, it is often difficult to recover to the previous level despite treatment or rehabilitation, which may result in substantial changes to their post-discharge lives. Thus, such pathological aging is characterized by dramatic and rapid functional decline (Franceschi et al., 2018), potentially making the psychological adaptation to health decline more challenging.

In later life, psychological adaptation refers to the ability to select optimal adaptive strategies based on one's resources and circumstances when facing unavoidable losses associated with aging (Isaacowitz & Blanchard-Fields, 2012). Through this process, older adults can maintain their psychological health and well-being despite the increasing losses (Brandtstädter & Greve, 1994; Dunne et al., 2011; Heckhausen, 1997). Emotion regulation is central to psychological adaptation, as it enables individuals to reinterpret negative situations positively, thereby achieving psychological adaptation. Consequently, when self-rated health is positive, emotion regulation and psychological adaptation are functioning effectively (Araujo et al., 2018; Mather et al., 2004; Mather & Carstensen, 2005).

However, in pathological aging, the dramatic and rapid increase in vulnerability can make it difficult to carry out effective emotion regulation, as suggested by the Strength and Vulnerability Integration (SAVI) model (Charles, 2010). Older adults undergoing acute treatment or hospitalization for severe illnesses experience not only heightened physical vulnerability but also increased risks of cognitive decline or dementia (Ehlenbach et al., 2010). Advanced adaptive strategies, such as emotion regulation, require sufficient cognitive resources (Charles & Luong, 2013; Mather & Knight, 2005), and cognitive vulnerability may hinder their effective use (Mather & Knight, 2005).

Moreover, patients with anosognosia, a symptom of cognitive impairment, often fail to accurately recognize their health status (Steward et al., 2019), exhibiting the tendency to rate their instrumental activities of daily living (IADL) more positively than warranted (Steward et al., 2019). However, such a positive self-assessment may not reflect emotion regulation or contribute to emotional improvement. Conversely, it may lead to maladaptive outcomes, such as decreased treatment adherence (Bertrand et al., 2016; Morese et al., 2018) or an increased risk of accidents and fraud (Sunderaraman & Cosentino, 2017).

In general, healthy older adults are reported to have a lower depressive mood prevalence compared to younger populations (Blazer et al., 1987). However, among hospitalized older patients, 11.5% are reported to experience major depression and 23% depressive mood (Koenig et al., 1988). One reason for the high prevalence of depressive

mood among hospitalized older adults may be that their heightened physical and cognitive vulnerabilities inhibit the advanced emotion regulation abilities typically present in healthy older adults.

Depressive mood in later life is known to negatively affect the recovery and maintenance of physical health (Bruce, 2001; Evans et al., 2005; Lenze et al., 2001) and life expectancy, even when excluding suicide as a factor (Blazer, 2003). Therefore, identifying the mechanisms of psychological adaptation to health decline in pathological aging and the psychological support strategies of older adults struggling with adaptation is important.

3.2 Objective

This study clarifies how cognitive vulnerability influences the psychological adaptation to health decline in older hospitalized patients under acute care. Specifically, it examines how differences in cognitive function levels affect the self-rated mobility, depressive mood, and post-discharge fall incidents in response to the mobility decline during hospitalization. Additionally, the study sought to provide clinical implications for supporting older adults with cognitive vulnerability.

3.3 Methods

3.3.1 Participants

Between July 2015 and September 2020, participants were recruited from patients aged 65 years and older who had been recently transferred from the acute care ward to the community comprehensive care ward at the National Center for Geriatrics and Gerontology. Patients with multiple hospitalizations during the study period, those expected to be hospitalized for less than two weeks, those with terminal conditions where death was anticipated during hospitalization, and patients with pacemakers were excluded.

In this facility, patients transferred to the community comprehensive care ward included those requiring post-discharge care coordination due to progressive functional decline (e.g., awaiting facility placement), those with severe frailty or comorbid conditions (e.g., diabetes, fractures), individuals aged 80 years and older, and patients with cognitive impairment. These categories of patients receive specialized care to address their heightened vulnerability.

All evaluations during hospitalization were conducted within the ward or hospital, considering each patient's condition. The maximum duration of hospitalization in the community comprehensive care ward was set at 60 days. In addition to treatment by the attending physician, the care team provided rehabilitation (two daily units on average) involving physical, occupational, and speech therapists. Nutritional assessments and advice were provided by the Nutrition Support Team for patients requiring nutritional improvements. However, no interventions specific to the study were implemented.

A total of 711 patients consented to participate in this study. Among them, three withdrew consent, while data for the major variables during hospitalization were missing for 17 patients due to issues such as reduced alertness (n = 4), severe dementia (n = 4), unexpected discharge before evaluation (n = 3), severe hearing loss (n = 2), and other reasons (n = 4). Additionally, follow-up data at three months post-discharge were

missing for 233 patients. Consequently, 250 patients were excluded, the final analysis included 461 participants (Figure 3.1).

3.3.2 Data Collection

Informed consent was obtained immediately after transferring from the acute care ward to the community comprehensive care ward. Data on pre-hospitalization status (T0) were collected through interviews with family members or proxies at the time of transfer (T1). The data at T1 were gathered by medical staff through patient interviews or observation immediately after the transfer to the community comprehensive care ward. A three-month post-discharge follow-up survey was conducted via mail.

3.3.3 Variable Measurement

Basic Characteristics: Age, gender, primary diagnosis, care level certification at T0 and at discharge, length of stay in the acute care ward, and length of stay in the community comprehensive care ward were recorded.

Cognitive Function at T1: Cognitive function at T1 was assessed by a psychologist using the Japanese version of the Mini-Mental State Examination (MMSE) (Folstein et al., 1975). The MMSE consists of 11 items (score range: 0–30), higher scores indicating better-preserved cognitive function. Cronbach's alpha for this study was .92.

Objective Mobility at T0: Pre-hospitalization mobility (approximately one month before acute care ward admission) was evaluated at T1 using Flow-FIM (Aoki et al., 2005), a flowchart-based version of the Functional Independence Measure (FIM). Family members assessed three sub-items related to transfer and mobility—"toilet transfer," "bed transfer," and "walking"—from the 18-item, seven-level ADL scale. The total score (range: 3–21) was used as the "objective mobility at T0." Items such as "bathtub transfer" and "stairs" were excluded due to their frequent difficulty in evaluation by the family. Cronbach's alpha for this scale was .93.

Objective Mobility at T1: At T1, physical therapists assessed mobility during rehabilitation using the Japanese version of FIM 3.0 (Liu et al., 1997; Tsuji et al., 1995). Consistent with the Flow-FIM, three sub-items ("toilet transfer," "bed transfer," and "walking") were scored (range: 3–21) as "objective mobility at T1." Cronbach's alpha was .88. The Flow-FIM and FIM scores were treated as equivalent in this study based on prior evidence of their high consistency (Aoki et al., 2005).

Difference in Objective Mobility (T0 - T1): This was calculated as the score at T0 minus the score at T1.

Self-Rated Mobility at T1: At T1, patients rated their mobility using a subscale from the Japanese version of the Medical Outcomes Study 8-item Short Form Health Survey (SF-8) (Fukuhara & Suzukamo, 2004). The responses to the five-point scale were reversed for analysis, with higher scores indicating more positive self-assessments (range: 1–5).

Depressive Mood at T1: At T1, depressive mood was assessed using the Geriatric Depression Scale-15 (GDS-15) (Yesavage & Sheikh, 2008). Participants responded "yes" or "no" to 15 items (score range: 0–15). A cutoff score of 4/5 indicated mild depression, while scores of 10 or higher indicated severe depression (Almeida & Almeida, 1999). Cronbach's alpha in this study was .81.

Fall Incidents Within Three Months Post-Discharge: Data on falls within three months post-discharge were collected via a mailed survey. The family members or patients indicated whether falls had occurred using a binary response ("yes" = 1, "no" = 0).

3.3.4 Statistical Analysis

Participants were divided into three groups—H, M, and L—based on their cognitive function scores at T1. Differences in basic characteristics and primary variables among the three groups were examined using one-way analysis of variance (ANOVA) or χ^2 tests. Additionally, Pearson's correlation coefficients were calculated for the primary variables within each group.

To investigate how differences in cognitive function levels influenced the relationships between T0 and T1 objective mobility, T1 self-rated mobility, and T1 depressive mood, multi-group structural equation modeling (SEM) was applied. Paths were established from T0 objective mobility to T1 objective mobility, from T0 and T1 objective mobility to T1 self-rated mobility, and from T1 objective mobility and T1 self-rated mobility to T1 depressive mood. The model without equality constraints was tested for significant differences in path coefficients among groups. Model fit indices, including the comparative fit index (CFI), root mean square error of approximation (RMSEA), and χ^2 values, were calculated. For path coefficients that showed significant differences between groups, a constrained model was tested, and fit indices were compared to evaluate whether the path relationships differed significantly among groups.

Finally, a binary logistic regression analysis was conducted to predict fall incidents within three months post-discharge (outcome variable: "fall occurred" = 1) using T1 objective mobility, the difference between T0 and T1 objective mobility (T0 - T1), and T1 self-rated mobility as explanatory variables. Variance inflation factors (VIFs) were first calculated to assess multicollinearity among explanatory variables, with VIFs below 5 indicating no multicollinearity concerns. Odds ratios and *p*-values for each explanatory variable were computed to evaluate their statistical significance. The Hosmer–Lemeshow goodness-of-fit test was used to assess model fit, a *p*-value greater than .05 indicating adequate fit.

All analyses were conducted at a significance level of $p < .05$ and effect sizes (η^2 or Cramér's V) were calculated. Statistical analyses were performed using IBM SPSS Statistics 29 and SPSS Amos 29. Binary logistic regression analysis was conducted using R version 4.3.2, employing libraries readxl (version 1.4.3), car (version 3.1.2), and ResourceSelection (version 0.3.6).

3.3.5 Ethical Considerations

This study was designed in accordance with the ethical guidelines outlined in the Declaration of Helsinki and the "Ethical Guidelines for Medical and Health Research

Involving Human Subjects" (revised February 28, 2017). The study received approval from the Ethics and Conflict of Interest Committee of the National Center for Geriatrics and Gerontology (Approval Number: 830).

At T1, participants were provided with a detailed explanation of the study, both written and verbally, and written informed consent was obtained. For patients with significant cognitive impairment who were unable to provide sufficient consent, participation was permitted with proxy consent. In such cases, informed assent was obtained from the patient, in addition to the written consent provided by the proxy following a thorough explanation of the study.

3.4 Results

A total of 461 participants (137 males, 324 females) were included in the analysis. The mean age was 82.48 ± 7.12 years (range: 65–100), and the mean MMSE score at T1 was 21.12 ± 6.77. Participants were divided into three groups based on their MMSE scores at T1: H Group (upper third, MMSE 26–30, n = 149), M Group (middle third, MMSE 19–25, n = 166), and L Group (lower third, MMSE 0–18, n = 146). The basic characteristics of participants by cognitive function group are shown in Table 3.1. The primary causes of hospitalization included conditions affecting mobility, such as vertebral and femoral fractures. Compared to T0, care level certification at discharge had generally worsened.

3.4.1 Differences in Key Variables by Cognitive Function Level

One-way ANOVA revealed significant differences among the three groups in terms of age (F(2, 458) = 24.72, p < .001, η^2 = .10), T0 objective mobility (F(2, 458) = 29.20, p < .001, η^2 = .11), T1 objective mobility (F(2, 458) = 69.93, p < .001, η^2 = .23), and the difference in objective mobility (T0 - T1) (F(2, 458) = 10.61, p < .001, η^2 = .04).

For T0 objective mobility, Levene's test indicated heterogeneity of variances; therefore, Tamhane's T2 test was used for post-hoc comparisons. For other variables, Tukey's HSD test was employed. The H Group was younger and had higher T0 and T1 objective mobility scores compared to the M and L Groups. Additionally, the H Group exhibited smaller differences in mobility (T0 - T1) compared to the other two groups.

No significant group differences were found for T1 self-rated mobility (F(2, 458) = 0.82, p = .441, η^2 = .00) or depressive mood (F(2, 458) = 2.47, p = .086, η^2 = .01). Notably, depressive mood exceeded the mild depression cutoff score of 4/5 (GDS-15) for all groups (Almeida & Almeida, 1999).

Regarding the incidence of falls within three months post-discharge, χ^2 tests revealed significant differences among groups (χ^2(2) = 13.42, p = .001, Cramér's V = .17).

Residual analysis indicated a significant excess of falls in the L Group (adjusted residual = 3.44) but fewer falls in the M Group (adjusted residual = -2.83). No significant deviations were observed in the H Group (adjusted residual = -0.52). The detailed results are presented in Table 3.2.

3.4.2 Differences in Structural Relationships Among Objective Mobility, Self-Rated Mobility, and Depressive Mood Based on Cognitive Function Levels

Pearson's correlation coefficients were calculated to examine the relationships among the primary variables by cognitive function level (Table 3.3). The analysis suggested differences in the relationships between variables among groups. Therefore, multi-group SEM was conducted to explore how cognitive function levels influenced the path coefficients in the model for self-rated mobility. Based on the correlation results, paths were established from T0 objective mobility to T1 objective mobility, from both T0 and T1 objective mobility to T1 self-rated mobility, and from T1 objective mobility and T1 self-rated mobility to T1 depressive mood.

The unconstrained model exhibited excellent fit indices: CFI = 1.000, RMSEA = .000, $\chi^2(3) = 0.168$ ($p = .983$) (Figure 3.2). Significant differences in path coefficients were found between the H and L groups for the path from T0 to T1 objective mobility. Additionally, significant differences in the path coefficients from T1 objective mobility to T1 self-rated mobility were observed between the H and M groups and between the H and L groups. Differences were also identified in the path from T1 objective mobility to T1 depressive mood between the M and L groups.

When these paths were constrained to equality across groups, the model fit indices deteriorated: CFI = .946, RMSEA = .062, $\chi^2(7) = 19.182$ ($p = .008$). This suggests that the path relationships differed across groups; thus, the unconstrained model was retained.

H Group (High Cognitive Function)

For the patients with high cognitive function, T1 objective mobility significantly influenced self-rated mobility (β = .47, p < .001) and depressive mood (β = -.23, p = .008). However, the impact of self-rated mobility on depressive mood was weaker (β = -.18, p = .034). The primary driver of depressive mood was the direct impact of changes in physical condition (β = -.23, p = .008). While the indirect effect of objective mobility on depressive mood via self-rated mobility was modest (β = .47 × -.18 = -.09), it still worsened the depressive mood. The total effect of declining objective mobility on depressive mood, including both direct and indirect effects, was β = -.23 + (-.09) = -.32.

M Group (Moderate Cognitive Function)

For the patients with moderate cognitive function, no significant relationship was observed between T1 objective mobility and self-rated mobility (β = .14, p = .105). However, self-rated mobility significantly correlated with depressive mood (β = -.24, p = .001). The direct effect of T1 objective mobility decline on depressive mood was also significant (β = -.29, p < .001), indicating that the primary pathway influencing depressive mood was the direct impact of objective mobility.

L Group (Low Cognitive Function)

For the patients with low cognitive function, T0 objective mobility significantly influenced T1 self-rated mobility (β = .20, p = .026). However, T1 objective mobility did not directly affect either self-rated mobility (β = .15, p = .107) or depressive mood (β = -.01, p = .948). Depressive mood was significantly influenced only by self-rated mobility (β = -.33, p < .001). The indirect effect of T0 physical condition on depressive mood via self-rated mobility was minimal (β = .20 × -.33 = -.07).

3.4.3 Association Between Anosognosia for Mobility Decline and Post-Discharge Fall Incidents

Based on the multi-group SEM results, in the L Group, self-rated mobility appeared influenced by T0 objective mobility. This finding suggests that anosognosia, characterized by poor awareness of current mobility decline, may cause these patients to act based on their pre-decline (T0) abilities rather than their current (T1) ones.

To test if this gap between previous and current mobility affects fall risk, binary logistic regression analysis was conducted using T1 objective mobility, the difference in objective mobility (T0 - T1), and T1 self-rated mobility as explanatory variables. The dependent variable was the occurrence of falls within three months post-discharge ("fall occurred" = 1).

In the L Group, the difference in objective mobility (T0 - T1) was significantly associated with post-discharge falls (OR = 1.15, 95% CI: 1.05–1.26, p = .003), indicating that larger differences increased fall risk. By contrast, no significant associations between explanatory variables and falls were found in the M or H groups (Table 3.4). Hosmer–Lemeshow tests indicated adequate model fit (p > .05 for all groups), and the VIF values below 5 confirmed no multicollinearity issues.

3.5 Discussion

Emotion regulation and psychological adaptation require sufficient cognitive resources (Charles & Luong, 2013; Mather & Knight, 2005). As such, when cognitive function declines, the ability to regulate emotions effectively may deteriorate, leading to worsened emotional states and maladaptive outcomes. Using data from older hospitalized patients after acute care, this study examined how cognitive function levels influenced self-rated mobility, depressive mood, and post-discharge fall incidents in response to mobility decline during hospitalization.

3.5.1 Characteristics of Each Group

H Group (High Cognitive Function)

Although the H Group had significantly higher cognitive function as well as being younger and having higher objective mobility compared to the other two groups, their self-rated mobility and depressive mood were not more favorable than the other groups (Table 3.2).

The primary factor driving depressive mood was the direct impact of mobility decline at T1 (β = -.23). There was also a minor indirect effect, whereby the mobility decline at T1 influenced depressive mood via self-rated mobility (β = -.09). This indicates that, in the H Group, self-rated mobility did not mitigate depressive mood.

While the H Group had more resources than the other groups, there was no indication that they engaged in emotion regulation by optimistically evaluating their mobility to reduce depressive mood. Rather, having more resources may have led them to focus on primary control strategies (e.g., rehabilitation and treatment) to restore mobility instead of employing emotion regulation as an adaptive strategy.

M Group (Moderate Cognitive Function)

Participants in the M Group were older and had fewer resources than the H Group, with significantly lower mobility (Table 3.2).

However, in the M Group, there was no significant association between T1 objective mobility and self-rated mobility (β = .14, p = .105), while T1 self-rated mobility was significantly associated with depressive mood (β = -.24, p = .001). This suggests that emotion regulation was functioning to some extent, as optimistic self-evaluation of mobility could potentially alleviate depressive mood despite decreased objective mobility.

However, the mean depressive mood score in the M Group was 6.72 ± 3.87, exceeding the GDS-15 cutoff for mild depression (4/5 points) (Almeida & Almeida, 1999). This indicates that while emotion regulation was present, it was not sufficient to fully mitigate depressive mood, suggesting diminished emotion regulation capacity due to reduced resources and increased vulnerability.

L Group (Low Cognitive Function)

The L Group not only had the lowest cognitive function, but also comprised the oldest participants with the lowest objective mobility. In other words, they had the most depleted resources and the most advanced vulnerability. However, their self-rated mobility and depressive mood were not significantly different from other groups, and not necessarily worse (Table 3.2).

Unlike the other groups, T1 self-rated mobility in the L Group was influenced by T0 objective mobility rather than current (T1) objective mobility. Furthermore, T1 objective mobility had no direct impact on depressive mood, while self-rated mobility at T1 influenced depressive mood.

These results suggest that participants in the L Group might lack awareness of their mobility decline (anosognosia). This was further supported by the binary logistic regression analysis results, which showed that in the L Group, larger discrepancies

between T0 and T1 objective mobility were associated with increased fall risk (Table 3.4).

While unrealistically optimistic self-assessments in the L Group may alleviate the depressive mood, these findings suggested that such misperceptions could also lead to maladaptive outcomes, such as increased fall incidents, thereby potentially hindering overall adaptation.

3.5.2 Impact of Cognitive and Physical Vulnerabilities on Emotion Regulation

In both the H and M groups, declining objective mobility had a strong direct impact on depressive mood. This finding aligns with the SAVI model (Charles, 2010; Charles & Luong, 2013), suggesting that heightened vulnerability among hospitalized older adults may impair their emotion regulation.

However, in the M Group, the findings suggested that emotion regulation was functioning to some extent, as positive self-evaluation of mobility could potentially alleviate depressive mood despite decreased objective mobility. That is, although cognitive vulnerability was more advanced in the M group than in the H Group, emotion regulation appeared to function better than in the H Group.

3.5.3 Does an Optimistic Evaluation Indicate Psychological Adaptation?

In both the M and L groups, the self-rated mobility at T1 influenced depressive mood independently of T1 objective mobility. Compared to the H Group, self-assessments were more optimistic in these groups.

However, binary logistic regression analysis revealed a critical difference between the groups: while the gap between T0 and T1 mobility did not significantly affect fall risk in the M Group, it had a significant impact in the L Group. This suggests that the M Group maintained some awareness of their current (T1) mobility decline while making optimistic self-assessments, whereas the L Group lacked awareness of their decline, contributing to increased fall risk. Thus, the optimistic assessments in the L Group

appeared to stem from anosognosia rather than emotion regulation (Steward et al., 2019), leading to overconfidence in their mobility. This aligns with previous research suggesting that patients with anosognosia tend to exhibit overly positive self-assessments of physical ability, leading to maladaptive outcomes such as decreased treatment adherence and increased risks of accidents (Bertrand et al., 2016; Morese et al., 2018; Sunderaraman & Cosentino, 2017).

It is crucial to differentiate between "choosing not to recognize health decline" and "being unable to recognize health decline." While both can result in optimistic self-assessments, the former can contribute to adaptive emotional improvement, whereas the latter is more likely to result in maladaptive outcomes, as observed in the L Group.

In studies on normal aging, positive health self-assessments are considered indicators of well-maintained psychological adaptability (Mather & Carstensen, 2005), thus reflecting the capacity to reinterpret physical and cognitive challenges as well as adversities in a positive light through emotion regulation (Araujo et al., 2018; Mather et al., 2004; Mather & Carstensen, 2005). However, in pathological aging accompanied by cognitive vulnerabilities, it is essential to recognize the potential for maladaptive optimistic self-assessments.

3.6 Limitations

This study was a single-center observational study with a relatively small sample size, which limits generalizability of the findings. Moreover, depressive mood was assessed only at a single time point, thus preventing the analysis of temporal changes.

The cross-sectional design of the study precludes establishing causal relationships between variables. While depressive mood likely influenced the recovery from mobility decline and cognitive function, the study did not directly examine these bidirectional relationships.

Further longitudinal studies are thus needed to clarify the dynamic interplay between physical function, cognitive function, and emotional adaptation over time.

3.7 Conclusions

This study clarified how cognitive vulnerability influences the psychological adaptation to their health decline in older hospitalized patients after acute care. Specifically, it examined how the cognitive function levels affect the self-rated mobility, depressive mood, and fall incidents.

While previous research has indicated that increased cognitive vulnerability makes it difficult to effectively employ emotion regulation, resulting in worsened emotional states (Mather & Knight, 2005), in this study, although the H Group had more resources than other groups, there was no indication that they engaged in emotion regulation by positively evaluating their mobility to reduce depressive mood. Rather, having more resources might have led them to focus on primary control strategies (e.g., rehabilitation and treatment).

However, the M Group showed better functioning emotion regulation than the H Group despite their more advanced cognitive vulnerability. This suggests that moderate cognitive decline does not necessarily impair emotion regulation or adaptation. However, even in the M Group, depressive mood remained elevated. Although emotion regulation appeared to contribute somewhat to reducing post-acute care depressive mood, it was insufficient to fully mitigate depressive mood, suggesting that increased vulnerability may have diminished emotion regulation capacity.

Furthermore, participants in the group with severely impaired cognitive function showed signs of possible anosognosia, lacking awareness of their mobility decline. Their unrealistic optimistic perceptions due to anosognosia may have contributed to reduced depressive mood, but findings suggested that this simultaneously increased the risk of maladaptive outcomes, such as post-discharge falls, potentially hindering their overall adaptation.

In older adults with significant cognitive decline or heightened vulnerability, adaptive capacities may reach a limit, highlighting the need for psychological support to maintain both well-being and safety while preserving self-esteem.

3.8 List of Tables

Table 3.1

Characteristics of Participants Grouped by Cognitive Function Level

Participant Characteristics, *Mean* ± *SD* or *n* (%)	Total (*N* = 461)	H Group (*n* = 149)	M Group (*n* = 166)	L Group (*n* = 146)	*p*	Effect Size (η^2 / Cramér's V)
Sex, Female	324 (70.28)	106 (71.14)	113 (68.07)	105 (71.92)	.731	.04
Primary disease at admission					.047	.20
Vertebral fracture	159 (34.49)	54 (36.24)	60 (36.14)	45 (30.82)		
Femoral fracture	36 (7.81)	6 (4.03)	13 (7.83)	17 (11.64)		
Heart failure	33 (7.16)	7 (4.70)	14 (8.43)	12 (8.22)		
Pneumonia	21 (4.56)	2 (1.34)	11 (6.63)	8 (5.48)		
Parkinson's disease	20 (4.34)	7 (4.70)	8 (4.82)	5 (3.42)		
Upper limb fracture	16 (3.47)	7 (4.70)	6 (3.61)	3 (2.05)		
Stroke	15 (3.25)	4 (2.68)	4 (2.41)	7 (4.79)		
Other lower limb fractures	13 (2.82)	6 (4.03)	5 (3.01)	2 (1.37)		
Cancer	13 (2.82)	1 (0.67)	5 (3.01)	7 (4.79)		
Osteoarthritis of the knee	11 (2.39)	7 (4.70)	3 (1.81)	1 (0.68)		
Diabetes	8 (1.74)	4 (2.68)	2 (1.20)	2 (1.37)		
Lower limb amputation / Necrosis	5 (1.08)	4 (2.68)	1 (0.60)	0 (0.00)		
Other	111 (24.08)	40 (26.85)	34 (20.48)	37 (25.34)		
Care level certification at T0					< .001	.30
Not eligible	161 (34.92)	74 (49.66)	58 (34.94)	29 (19.86)		

Support required levels 1-2	100 (21.69)	44 (29.53)	43 (25.90)	13 (8.90)		
Care required levels 1-2	120 (26.03)	23 (15.44)	40 (24.10)	57 (39.04)		
Care required levels 3-4-5	80 (17.35)	8 (5.37)	25 (15.06)	47 (32.19)		
Care level certification at discharge from the community comprehensive care ward					< .001	.30
Not eligible	111 (24.08)	59 (39.60)	40 (24.10)	12 (8.22)		
Support required levels 1-2	82 (17.79)	35 (23.49)	39 (23.49)	8 (5.48)		
Care required levels 1-2	143 (31.02)	35 (23.49)	44 (26.51)	64 (43.84)		
Care required levels 3-4-5	124 (26.90)	20 (13.42)	43 (25.90)	61 (41.78)		
Unknown	1 (0.22)	0 (0.00)	0 (0.00)	1 (0.68)		
Length of stay in acute care, days	27.53 ± 20.75	24.93 ± 15.76	29.35 ± 25.37	28.1 ± 19.20	.156	.01
Length of stay in community comprehensive care ward, days	40.03 ± 13.78	39.11 ± 14.47	38.7 ± 13.54	42.48 ± 13.08	.033	.02

Note. One-way ANOVA was used for continuous variables to examine differences across the four age groups, with η^2.

The chi-square test was used for categorical variables, with Cramér's V reported.

Table 3.2

Differences in Key Variables among Cognitive Function Levels

Variables, *Mean* ± *SD* or *n* (%)	H Group (*n* = 149)	M Group (*n* = 166)	L Group (*n* = 146)	*p*	Effect Size (η^2 / Cramér's V)	Multiple comparisons
Age	79.62 ± 6.52	82.68 ± 6.63	85.16 ± 7.20	< .001	.10	L > M > H
Objective mobility at T0	18.76 ± 3.06	17.83 ± 3.77	15.29 ± 5.06	< .001	.11	H > M > L
Objective mobility at T1	15.49 ± 3.99	13.18 ± 4.38	9.77 ± 4.12	< .001	.23	H > M > L
Objective mobility difference (T0 - T1)	3.27 ± 3.67	4.64 ± 4.35	5.52 ± 4.64	< .001	.04	L > H, M > H
Self-rated mobility at T1	2.64 ± 1.10	2.81 ± 1.25	2.79 ± 1.34	.441	.00	–
Depressive mood at T1	6.10 ± 3.74	6.72 ± 3.87	7.06 ± 3.70	.086	.01	–
Occurrence of falls within 3 months after discharge (yes, %)	40 (26.85)	34 (20.48)	57 (39.04)	.001	.17	–

Note. One-way ANOVA was used for continuous variables, with η^2 reported as the effect size. Chi-square tests with Cramér's V as the effect size were used for categorical variables. Multiple comparisons for continuous variables were conducted using Tukey's or Tamhane's T2 tests based on Levene's test for equality of variances, while pairwise chi-square tests with Bonferroni correction were used for categorical variables.

Table 3.3

Relationship among Key Variables by Cognitive Function Level

Variables	a		b		c		d	
H Group (*n* = 149)								
a. Objective mobility at T0	–							
b. Objective mobility at T1	.48	***	–					
c. Objective mobility difference (T0 - T1)	.31	***	-.68	***	–			
d. Self-rated mobility at T1	.21	*	.46	***	-.32	***	–	
e. Depressive mood at T1	-.17	*	-.31	***	.20	*	-.29	***
M Group (*n* = 166)								
a. Objective mobility at T0	–							
b. Objective mobility at T1	.44	***	–					
c. Objective mobility difference (T0 - T1)	.42	***	-.63	***	–			
d. Self-rated mobility at T1	.19	*	.19	*	-.03		–	
e. Depressive mood at T1	-.19	*	-.34	***	.17	*	-.29	***
L Group (*n* = 146)								
a. Objective mobility at T0	–							
b. Objective mobility at T1	.51	***	–					
c. Objective mobility difference (T0 - T1)	.64	***	-.34	***	–			
d. Self-rated mobility at T1	.28	***	.25	**	.08		–	
e. Depressive mood at T1	-.10		-.09		-.03		-.33	***

Note. Pearson correlation coefficients were used to examine the relationships among the variables.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 3.4

Logistic Regression Analysis of Factors Related to Falls within 3 Months Post-Discharge by Cognitive Function Level

Cognitive Function	Explanatory Variables	Odds Ratio (OR)	95% Confidence Interval	*p*	Hosmer-Lemeshow Test	VIF
H Group (*n* = 149)	Objective mobility at T1	1.05	.90–1.25	.566	.530	3.06
	Objective mobility difference (T0 - T1)	1.13	.97–1.37	.161		2.84
	Self-rated mobility at T1	1.21	.83–1.77	.328		1.30
M Group (*n* = 166)	Objective mobility at T1	0.98	.87–1.11	.733	.727	1.89
	Objective mobility difference (T0 - T1)	1.07	.96–1.21	.273		1.82
	Self-rated mobility at T1	0.92	.66–1.26	.591		1.07
L Group (*n* = 146)	Objective mobility at T1	1.07	.98–1.19	.158	.532	1.37
	Objective mobility difference (T0 - T1)	1.15	1.05–1.26	.003		1.30
	Self-rated mobility at T1	0.82	.62–1.08	.162		1.11

Note. Results of a binary logistic regression analysis (forced entry method).

3.9 List of Figures

Figure 3.1

Flowchart of the Selection Process of Analysis Participants

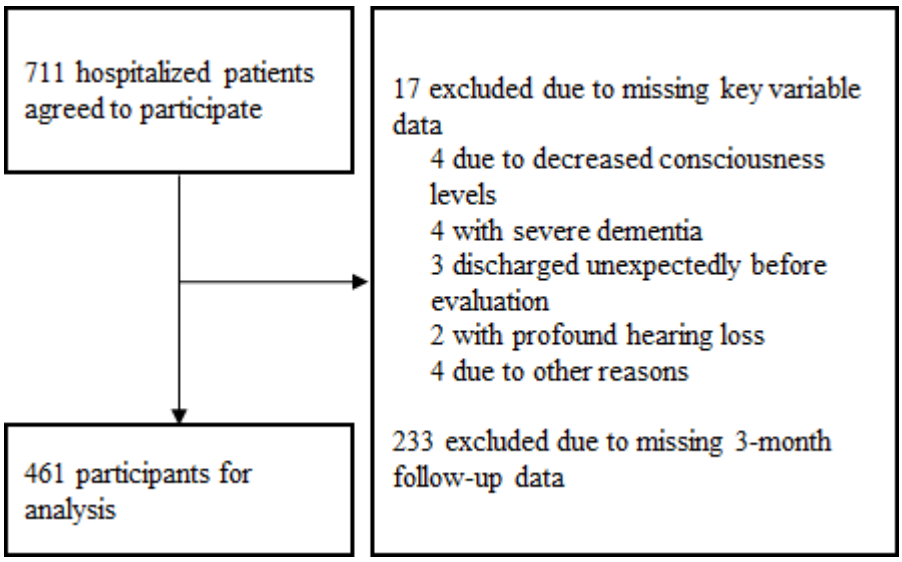
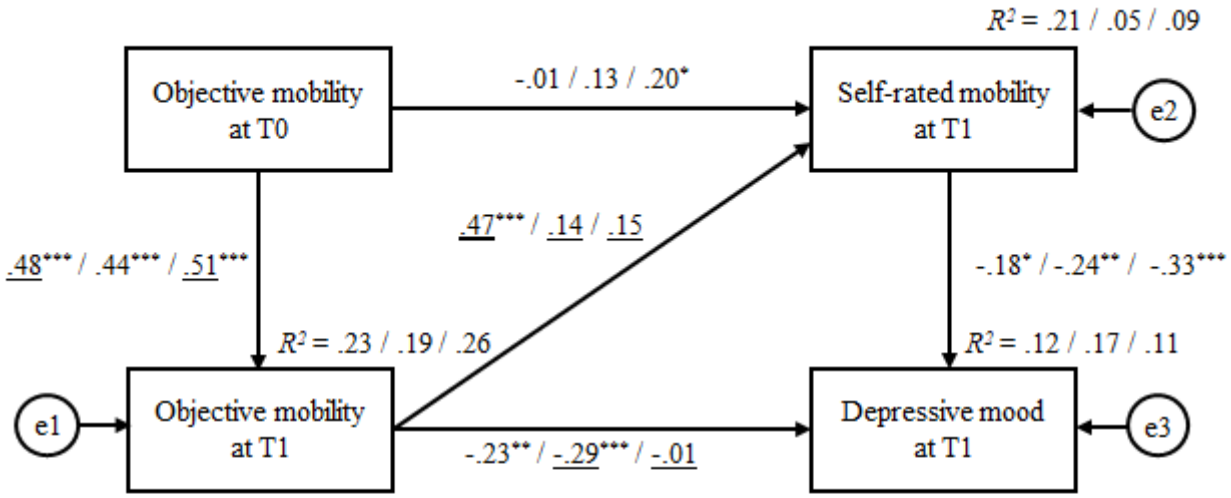


Figure 3.2

Comparison of Self-rated Mobility and Emotional Distress Across Cognitive Function Levels



CFI = 1.000, RMSEA = .000, $\chi^2(3) = 0.168$ ($p = .983$)

Note. The values on the left represent the H Group ($n = 149$), the center values represent the M Group ($n = 166$), and the right values represent the L Group ($n = 146$). Results are based on a multiple group analysis model without equality constraints. Each path coefficient is a standardized coefficient, and underlined path coefficients indicate significant differences between groups at the 5% level.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Chapter 4

A Machine Learning Approach to Predicting Conversion to Dementia Using the Cube Copying Test: Exploring the impact of controllability on illness self-awareness

4.1 Introduction

In individuals aged 60 and older, dementia worry tends to intensify due to age-related cognitive changes and an increase in the number of dementia patients in their surroundings (Kessler et al., 2012). Dementia worry is widely observed among middle-aged and older adults and is reported to be particularly pronounced when a parent has developed dementia (Kessler et al., 2012). In recent years, significant progress has been made in developing therapeutic drugs and studying exercise therapy for patients in the early stages of disease onset. However, effective treatments for advanced stages have yet to be established. As a result, many patients seek medical consultation during the early stages, hoping for early detection and primary management through pharmacological or exercise therapy.

Early detection of dementia is crucial for delaying its onset and progression. Recent advancements in the development of dementia treatments targeting patients in the early

stages of mild cognitive impairment (MCI) (Sevigny et al., 2016) have heightened the need for early detection before conversion to dementia. Dementia progresses along a continuum from normal cognitive function (NC) to subjective cognitive impairment (SCI), MCI, and dementia (Jack Jr. et al., 2018; Petersen, 2004; Petersen, 2011). Cognitive decline, accompanied by the accumulation of amyloid-β and other neuropathological changes, begins approximately 10–20 years before an MCI diagnosis (Caselli et al., 2020; Sperling et al., 2011; Weintraub et al., 2012), with accelerated cognitive decline starting 3–7 years prior (Karr et al., 2018).

With growing evidence of this extended preclinical phase, recent attention has focused on the possibility that patients at high risk of progressing to dementia may already exhibit subtle abnormalities even before reaching the MCI stage. In practice, some patients who suspect dementia seek medical consultation despite not showing detectable cognitive decline on objective assessments, a condition referred to as SCI. These patients often perceive subtle abnormalities and are motivated to seek medical attention to take proactive measures against potential progression as early as possible.

Traditionally, SCI has been regarded as a manifestation of excessive anxiety about dementia, depression, or personality issues due to the absence of detectable abnormalities in cognitive function tests (Reid & Maclullich, 2006). However, recent findings indicate that patients with SCI have more than twice the risk of progressing to MCI (Mitchell et al., 2014). This suggests that some of the subjective cognitive symptoms reported in SCI may reflect subtle undetectable changes by objective assessments.

Early signs of cognitive decline manifest in various domains, including episodic memory, working memory, language, visuospatial abilities, and executive functions (Caselli et al., 2020; Jessen, 2014; Weintraub et al., 2012). Among these, visuospatial function tends to decline earlier than other cognitive functions, such as memory, in major dementia subtypes like AD and dementia with Lewy bodies (DLB) (Caselli et al., 2020; Johnson et al., 2009; Weintraub et al., 2012). Consequently, recent research has focused on visuospatial cognitive function as a key indicator for early dementia detection (Bäckman et al., 2005; Johnson et al., 2009).

Early decline in visuospatial function is often assessed using tasks such as the Cube Copying Test (CCT), Clock Drawing Test (CDT), and Double Pentagon Test. The CCT is widely used in clinical settings due to its high sensitivity to subtle changes, making it effective for detecting cognitive impairment (Ericsson et al., 1991; Ericsson et al., 1996; Salimi et al., 2019). However, the performance on tasks like the CCT can be influenced by age-related changes, even in the absence of dementia. For instance, Ericsson et al. reported that the accuracy of CCT decreases with age, with rates of 42% for those aged 75–79 years and 24% for those aged 90 years and older (Ericsson et al., 1996). Additionally, demographic factors such as sex and years of education also play a role; women tend to score lower than men and higher levels of education are associated with better performance in drawing performance (Gaestel et al., 2005; Paganini-Hill & Clark, 2006).

In other words, using drawing tests related to visuospatial function for early dementia detection requires a clear distinction between distortions in drawings due to normal aging and subtle pathological distortions that occur before the conversion to dementia. However, drawing tests like the CCT have traditionally relied on qualitative evaluation, where scoring is based on visual judgment of whether the criteria are met. This subjective method makes it difficult for minor abnormalities to be reflected accurately in scores and is susceptible to the influence of the scorer's experience and biases. As a result, even when minor abnormalities were present, traditional scoring methods failed to detect them with high precision and consistency.

Conversely, artificial intelligence (AI) can extract and evaluate features from images in an exact, quantitative, and objective manner, potentially addressing the limitations of traditional manual scoring of drawing tests. Furthermore, machine learning approaches utilizing image data have demonstrated superior performance compared to those using other modalities, as image data more effectively leverages the strengths of AI (Javeed et al., 2023).

In this study, a predictive model was developed to detect patients at high risk of progressing to dementia within 3–5 years by analyzing the geometric elements and overall shapes of CCT drawings made by patients with normal cognition to MCI.

Using AI technology, this study aimed to detect subtle cognitive abnormalities that conventional methods could not identify, exploring the possibility that cognitive changes reported by SCI patients and their families might already exist in the early stages of onset. The study also examined both clinical psychologists' scoring results and patients' self-awareness of cognitive decline.

4.2 Materials and Methods

4.2.1 Participants for the Analysis

This retrospective study employed an opt-out procedure, as many patients had already passed away, moved, or were transferred to other institutions, making the acquisition of individual consent impractical. The study was conducted by the Declaration of Helsinki and was approved by the Research Ethics Committee of the National Center for Geriatrics and Gerontology (approval number 1449).

From January 2011 to December 2020, patients aged 60 and above who visited the Center for Comprehensive Care and Research on Memory Disorders at the National Center for Geriatrics and Gerontology were included in the study. Inclusion criteria were a baseline Mini-Mental State Examination (MMSE) score of 24 or higher, the availability of CCT image data, no dementia diagnosis, and no pharmacological treatment for dementia. Patients ranged from NC function to MCI. Those diagnosed with Alzheimer's disease (AD), DLB, or frontotemporal dementia (FTD) within 3–5 years from the baseline were classified as "converters." Those who did not meet the criteria for MCI or dementia at the 3–5 year follow-up and whose cognitive function remained within the normal range, as determined by comprehensive physician assessment, brain imaging, and neuropsychological tests, were classified as "non-converters." Diagnoses were based on established clinical criteria for AD (McKhann et al., 1984), DLB (McKeith et al., 2005), and FTD (McKhann et al., 2001), as well as the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria for major neurocognitive disorders. MCI was diagnosed based on Petersen (Petersen et al., 2001) and DSM-5 criteria for minor neurocognitive disorders. The observation period was set at 3–5 years to accommodate variations in follow-up visits, as not all patients had exact 3-year follow-up visits.

Participants with unclear pathology or undetermined diagnoses at the 3–5 year follow-up were excluded. MCI represents a gray zone (Petersen, 2004; Petersen, 2011) with some patients progressing to dementia, while 4–15% may revert even in clinical populations (Gainotti et al., 2014; Koepsell & Monsell, 2012; Petersen, 2011).

Therefore, those diagnosed with MCI 3–5 years after the baseline were excluded. Additionally, individuals with visual impairments (such as cataracts or glaucoma), essential tremors, schizophrenia or delusional disorders, mood disorders, delirium, alcohol or substance dependence, intellectual disabilities, higher brain dysfunction, developmental disorders, epilepsy, subarachnoid hemorrhage, stroke, subdural hematoma, epidural hematoma, multiple cerebral infarctions, brain tumors, normal pressure hydrocephalus, Parkinson's disease, or other conditions that could affect drawing or cognitive function were excluded at baseline. Moreover, those who developed new neurovascular diseases during the 3–5 year observation period, such as subarachnoid hemorrhage, stroke, subdural or epidural hematoma, brain tumors, meningiomas, or head injuries, were excluded because it was difficult to determine whether the cognitive decline was due to these new events (Figure 4.1).

4.2.2 Data for Analysis

Image Features

The image data from CCT drawings made at baseline were used for analysis. Patients were shown a model cube picture (4 cm on the long side, 1.9 cm on the diagonal, 5.5 cm from the top of the A4 paper in portrait orientation) and instructed to copy it in pencil below the model (Figure 4.2). The test was conducted individually by a clinical psychologist in a quiet room with no time limit. If the patient redrew the image, the clinical psychologist asked the patient to choose one. The chosen images were then used for analysis. After the tests, the test papers were saved as PDF files. For analysis, PDF data were extracted, and after deleting the clinical psychologists' notes, only the patients' drawings were cropped and used.

Related Features

Since CCT performance is influenced by age, sex, and years of education (Paganini-Hill & Clark, 2006; Staios et al., 2022), the model included age at baseline, sex (male = 0, female = 1), and years of education since elementary school as related features.

4.2.3 Design of the Machine Learning Model

Dataset division: Thirty-three percent of the entire non-converter dataset was randomly selected as the core image data set for generating features using the anomaly detection models (PatchCore and convolutional autoencoders [CAE]). Subsequently, 80% of the remaining non-converter images (67% of the total) and all images of converters (100%) were randomly set as training data, and the remaining 20% were set as testing data (Figure 4.3).

Image data pre-processing: After removing any stains on the paper or notes made by the clinical psychologist from all image data, the images were cropped and enclosed in a bounding box based on the outermost points of the objects. The cropped images were then resized so that the long side measured 200 pixels and were centered on a 220 × 220 pixel white background. Finally, the image size was resized to 224 × 224 pixels and converted to grayscale. The exact process was applied to the model cube picture for matching score calculation.

Data augmentation: Data augmentation was applied to all images except for the test dataset. For images drawn by non-converters, seven augmented images were generated per image, while for images drawn by converters, three augmented images were generated per image. First, one of three types of rotation processing (180-degree rotation, 90-degree rotation followed by horizontal flip, and -90-degree rotation followed by horizontal flip) was randomly selected and applied. Gaussian noise was then randomly added to the images. Additionally, while maintaining the long side of the images, the short side was randomly scaled by -5% to 5%. Subsequently, the images were randomly rotated within the range of -3 degrees to 3 degrees and then binarized. The images were then randomly shifted from -7 pixels to 7 pixels in both the X and Y directions. Based on these modifications, random affine transformations were generated, and after calculating the display range so that the transformed images were centered, the affine transformations were applied. Finally, the images were saved in PNG format with a size of 224 × 224 pixels.

Local Features:

In the instruction manual for the Japanese version of the Montreal Cognitive Assessment (MoCA-J) (Suzuki & Fujiwara, 2010), the scoring criteria for the CCT include the presence of all necessary lines, the absence of unnecessary lines, the preservation of parallel relationships between lines, and the similarity in their lengths. Considering these criteria, features were extracted using the following procedure:

After converting the images to grayscale, the Hough transform was applied to identify line segments within the images. Based on the angles of the lines relative to the horizontal direction, the lines were classified as horizontal (angles within the range of -10 to 10 degrees, or 170 to 190 degrees), vertical (angles within the range of 80 to 100 degrees, or -100 to -80 degrees), or diagonal (all other angles). After extracting the endpoints of the lines, the number of lines, the average and variance of line lengths, and the average and variance of the angles between lines of the same type (as a measure of line parallelism) were calculated for three directions: horizontal, vertical, and diagonal. Additionally, the number of vertices was calculated. For the number of lines in each direction (horizontal, vertical, and diagonal) and the number of vertices, the differences from the reference values (four lines in each direction and eight vertices) were calculated, and the absolute values of these differences were used as feature values.

Global Features:

The instruction manual of the MoCA-J (Suzuki & Fujiwara, 2010) specifies that CCT must be drawn in three dimensions. Additionally, normal aging may result in distorted CCT images (Ericsson et al., 1996; Gaestel et al., 2005; Paganini-Hill & Clark, 2006), suggesting that even non-converters may produce drawings that deviate from the model cube picture. Therefore, features were generated considering the degree of deviation from the model and deviation from non-converters.

Matching Score: The Speeded-Up Robust Features (SURF) algorithm was used to evaluate the similarity with the model cube image. This algorithm detects feature points in both images, extracts their descriptors, and matches them. The matching score is generated based on the number of matched feature points.

PatchCore Score: Distance features representing the degree of difference from non-converter images were generated using 33% of the non-converter images as a core set. This feature generation process for the remaining images (67% of non-converters and 100% of converters) followed these steps: After extracting features from the images using a pre-trained ResNet50 model, the PatchCore score (Roth et al., 2022), which is the distance to the nearest point within the core set, was calculated and saved as a feature. Additionally, the detected anomalies were visualized to confirm the appropriateness of the model. A more significant PatchCore score indicates a greater deviation from the images of non-converters that comprise the core set.

Reconstruction Error: Similar to the PatchCore score, 33% of the non-converter images were used as a core set, and features representing the structural differences from non-converter images for the remaining images (67% of non-converters and 100% of converters) were generated using the following process: After extracting features from the images using a pre-trained ResNet18 model, a convolutional autoencoder (CAE) was trained based on the features of the core set images. The hyperparameters, including the hidden layer's size, the number of epochs, L2 weight regularization, and sparsity proportion, were optimized using Bayesian optimization. The reconstruction error was calculated and saved as a feature. A more significant reconstruction error indicates a greater structural deviation from the images of the non-converters that comprise the core set.

Handwriting Pressure Features:

Since dementia is associated with weak handwriting pressure (Yamada et al., 2022), the average and variance of line thickness and the ratios of foreground pixels were calculated to quantify handwriting pressure as a feature.

Additional Variables Other Than Image Features:

Psychologist Scoring: Following the completion of the CCT, psychologists scored the drawings as either "correct" or "incorrect" based on the MoCA-J (Suzuki & Fujiwara, 2010) manual.

Patients' Self-Awareness of Cognitive Decline: On the same day as the CCT, psychologists conducted interviews to assess patients' self-awareness of cognitive decline. Based on the patients' self-reported symptoms, responses were classified as either "Aware" or "Unaware."

4.2.4 Image Feature Selection, Model Training and Evaluation

Missing values were estimated and imputed using the k-nearest neighbor (KNN) method. Related features (age, sex, and years of education) were examined using a two-sided *t*-test to assess differences between the converter and non-converter groups. Subsequently, the model included these variables as covariates to adjust for their effects. The differences in image features between the non-converters and converters were examined using two-sided ANCOVA. Correlation coefficients between the selected image features were calculated to prevent multicollinearity, and pairs of features with an absolute value of .80 or higher were identified, with one of each pair being excluded. The mean and standard deviation were calculated for each feature using the labels. If more than half of the features for each image data point were ± 3 *SD* or more, that image data point was considered an outlier and excluded.

Using the selected image and related features, Bayesian optimization was employed on the training dataset to search for optimal hyperparameters, including the number of learning cycles, the maximum number of splits, the minimum leaf size, and the number

of variables to sample. The optimal hyperparameters were applied to train a random forest ensemble model using the training data. Shapley Additive exPlanations (SHAP) values were calculated to identify features with minimal contributions to reduce overfitting. Image features with SHAP values below a set threshold were excluded, and the model was retrained using the remaining features. To ensure consistency and prevent data leakage, the test data were processed using the same methods used for the training data. The final model was trained, and predictions were made independently of the test data using the same parameters as the training dataset.

A 10-times 5-fold cross-validation was performed to evaluate the accuracy and area under the curve (AUC) of the final model. Accuracy, sensitivity, specificity, F1 score, and AUC were calculated for both the simple model using only related features (age, sex, and years of education) and the final model that included image features in addition to the related features. Additionally, 95% confidence intervals (CI) for the model metrics were computed using bootstrap resampling. The AUCs of the two models were compared using a two-sided DeLong test.

SHAP values, which indicate the contribution of each feature to the final model, were calculated. The absolute SHAP values were computed to assess the average impact of each feature on the predictions, and the mean and standard deviation for each feature were calculated. Furthermore, a beeswarm plot was created for each label using SHAP values.

Two-sided t-tests were used to examine the differences in image features between the misclassified and correctly classified images in the test dataset.

Finally, the accuracy of psychologist scoring and patients' self-awareness of cognitive decline was also evaluated.

All analyses were conducted at a significance level of $p < .05$, and effect sizes were calculated using Cohen's d for mean differences or φ for categorical data.

4.2.5 Software

The analysis was performed using MATLAB R2024a® from The MathWorks®. Additionally, the Deep Learning Toolbox (version 24.1), Image Processing Toolbox (version 24.1), Statistics and Machine Learning Toolbox (version 24.1), Parallel Computing Toolbox (version 24.1), and Computer Vision Toolbox add-ons for MATLAB® were used. The SHAP values were calculated using the Python SHAP library (version 0.46.0).

4.3 Results

A total of 767 participants met the criteria, including 457 converters (318 with AD, 116 with DLB, 23 with FTD) and 310 non-converters. Some patients with DLB and FTD had comorbid AD. Generally, the proportion of dementia is 60–77% for AD, 15–20% for DLB, and 5–15% for FTD (Barker et al., 2002; Campbell et al., 2001; DeTure & Dickson, 2019; Hansen et al., 1990; Knopman et al., 1990). The proportion of converter subtypes in this study did not differ significantly from these proportions (Table 4.1).

ANCOVA revealed significant differences between converters and non-converters for all but one image feature. For local features, converters showed greater absolute differences from the reference values (four lines in each direction) in the number of lines detected in all directions (horizontal, vertical, and diagonal) than non-converters. Additionally, the number of vertices showed larger absolute differences from the reference values (eight vertices) for converters than for non-converters. Converters exhibited shorter horizontal and vertical lines and longer diagonal lines than non-converters. Moreover, for all types of lines, converters had greater variance in the lengths, larger average angle differences between lines of the same type, and greater variance in angle differences for horizontal and diagonal lines than non-converters.

Regarding global features, converters had lower matching scores, higher PatchCore scores, and greater reconstruction errors. For handwriting pressure features, converters had lower mean thicknesses, greater variance, and lower foreground ratios than non-converters (Table 4.2).

To prevent multicollinearity, correlation coefficients for all image feature values were examined, and no feature pairs with absolute values of .80 or higher were found. Outliers were checked for; however, none were found. Therefore, 22 image features were selected for inclusion in the initial model.

Using the selected 22 image features and 3 related features, hyperparameters were optimized using Bayesian optimization, and the initial random forest ensemble model

was trained. SHAP values were calculated to improve the model, and one image feature (number of vertical lines) with SHAP values below the threshold of 0.0005 was excluded. The remaining 21 image features and 3 related features were selected as the input features for the final model, which was then retrained.

After performing 10 iterations of 5-fold cross-validation, the AUC for the test data was .85 [95% CI: .78–.91] (Table 4.3). The ROC curves are shown in Figure 4.4. The difference in the AUC between the developed final model and a simple model using only the related variables was evaluated using the DeLong test, and the developed model had a significantly higher AUC (p = .000, Cohen's d = .33).

SHAP values indicated that, among the image features, the PatchCore score, reconstruction error, and variance of the horizontal and vertical line lengths significantly contributed to the final model's predictions (Table 4.4, Figure 4.5).

Finally, for the test dataset, the differences in image features between the misclassified and correctly classified images were examined by labels (Table 4.5). The results showed that for converters, misclassified images had smaller absolute differences from the reference values in the number of lines detected in horizontal and diagonal directions, as well as in the number of vertices. Additionally, misclassified images had longer horizontal and vertical lines, shorter diagonal lines, and smaller variances in the lengths of the horizontal and diagonal lines compared to correctly classified images. The misclassified images also had smaller average angle differences between vertical lines and diagonal lines, with smaller variance in the angle differences between diagonal lines. Misclassified images had higher matching scores, lower PatchCore scores, and fewer reconstruction errors. They also had higher mean thickness, lower variance, and higher foreground ratios in the handwriting pressure feature.

For non-converters, misclassified images had shorter horizontal and vertical lines compared to correctly classified images. Additionally, they had lower matching scores, higher PatchCore scores, and greater reconstruction errors. The handwriting pressure features of misclassified images exhibited lower mean thickness, greater variance in thickness, and lower foreground ratios compared to correctly classified images.

These results suggest that, for converters, subtle abnormalities may already be present in the early stages of onset. Table 4.6 presents two cross-tabulations: the first compares psychologists' traditional manual scoring of the CCT with the labels (converted or not), and the second compares patients' self-awareness of cognitive decline ("aware" or "unaware") with the labels (converted or not). The accuracy of psychologists' visual scoring yielded an AUC of .64, 95% CI [.61–.67], sensitivity of .39, 95% CI [.34–.43], and specificity of .89, 95% CI [.86–.93], indicating low sensitivity in detecting converters. On the other hand, the accuracy of patients' self-awareness of cognitive decline showed an AUC of .46, 95% CI [.43–.48], sensitivity of .78, 95% CI [.75–.82], and specificity of .13, 95% CI [.09–.17], suggesting higher sensitivity in detecting converters.

4.4 Discussion

In this study, using AI technology, this study aimed to detect subtle cognitive abnormalities that conventional methods could not identify, exploring the possibility that cognitive changes reported by SCI patients and their families might already exist in the early stages of onset. The model achieved an AUC of .85, a sensitivity of .80, and a specificity of .71 using the CCT image features and related features (age, sex, and years of education).

Previous research using CCT drawing data reported distinguishing whether a participant had dementia at the time of drawing, with a sensitivity of 81.9% and specificity of 53.9%, by manually scoring the number of vertices, edge length, three-dimensionality, and other features (Mathew et al., 2018). Another study achieved an AUC of .77 to .78 in classifying normal cognition and MCI using deep learning with CCT (Ruengchaijatuporn et al., 2022). In contrast to these studies, the present research focused not on classifying participants' conditions at the time of drawing but on predicting the risk of developing dementia within 3–5 years post-drawing. Despite the expectation that the differences in the drawings between converters and non-converters would be more subtle than those identifiable at the time of CCT drawing, comparable results were obtained.

Visuospatial dysfunction in patients with dementia encompasses difficulties with object recognition, spatial orientation, figure-ground discrimination, visual integration, and visual attention (Mendez et al., 1990; Parsey & Schmitter-Edgecombe, 2011; Quental et al., 2009; Trojano & Gainotti, 2016). These impairments are often reflected in CCT drawings as inappropriate sizes, inaccurate line lengths and shapes, failures in connecting lines or positioning, lack of parallelism, missing elements, unnecessary lines, and simplifications or distortions of three-dimensional structures (Mendez et al., 1990; Palmqvist et al., 2008, 2009; Parsey & Schmitter-Edgecombe, 2011; Trojano & Gainotti, 2016).

Analysis of the present study revealed that the drawings of converters exhibited greater discrepancies from the reference values for the number of lines in all directions

(horizontal, vertical, and diagonal) and the number of vertices compared to those of non-converters. These deviations may reflect characteristics such as drawing with multiple discontinuous lines rather than a single straight line, producing wavy lines, endpoints not overlapping at a single point, and lines inappropriately segmented or connected at incorrect points.

Converters also had shorter horizontal and vertical lines and longer diagonal lines than non-converters, along with greater variance in the lengths of all line types. This suggests a distorted drawing style with compromised perspective and accuracy. Additionally, the average angle differences between lines of the same type, as well as the variance of angle differences between horizontal lines and between diagonal lines, were larger. This indicates that the converters' drawings exhibited a loss of parallelism, suggesting a lack of consistency in their drawing styles (Figure 4.6).

The lower matching scores observed in converters further supported the distinct drawing characteristics associated with the progression to dementia. Conversely, non-converters had higher matching scores, indicating that although aging may cause some drawing distortions, as noted in previous studies, their drawings remain closer to the model cube image than those of converters. The higher PatchCore scores and reconstruction errors of the convolutional autoencoder (CAE) using the core set suggest that converters exhibit a structurally different drawing style, not only compared to the model cube image but also to non-converters. While normal aging can lead to distortions in drawing and a decrease in the accuracy of the CCT (Ericsson et al., 1996), this study found that the distortions observed in drawings by older adults due to normal aging have structurally different characteristics from those seen in patients at high risk of progressing to dementia within 3 to 5 years.

Consistent with previous studies (Yamada et al., 2022), converters exhibited weaker handwriting pressure, drew thinner lines, and showed more variability in line darkness compared to non-converters. The association between lower grip strength and increased dementia risk has been previously highlighted (Buchman et al., 2008; Buchman et al., 2007; Wang et al., 2006), and the results of this study align with those findings.

In comparison to DLB, AD typically exhibits milder degrees of visuospatial impairment or constructional disability, while frontotemporal dementia (FTD) shows even milder visuospatial impairment than AD and DLB, as reported in previous studies (Bondi et al., 2017; Cronin-Golomb, 2011; Karantzoulis & Galvin, 2011; Salimi et al., 2019; Salmon et al., 1996). Despite the majority of converters in this study being patients with AD, the model achieved an AUC of .85 based on a single test result related to visuospatial impairment. This result supports previous research indicating that drawing tests focused on visuospatial function can effectively identify patients at high risk of progressing to dementia.

However, an examination of the misclassified cases revealed that images of converters misclassified as non-converters had features more similar to those of non-converters, while images of non-converters misclassified as converters exhibited features more akin to those of converters. In other words, a certain number of converters exhibit drawing styles similar to those of non-converters, and vice versa. This suggests that even when using advanced AI technology, these images may be misclassified. For older adults at high risk of progressing to dementia but without visuospatial impairments, or for those who draw significantly distorted pictures due to factors such as educational background despite normal aging, predicting the risk of dementia progression using AI-based image analysis focused solely on visuospatial function tests can be challenging. Therefore, it is essential to combine visuospatial function tests with other assessments related to areas such as memory to accurately predict the risk of progression to dementia.

The SHAP values indicated that among the image features, those generated using the PatchCore algorithm contributed the most to the model's predictions. Additionally, when the anomaly detection points identified by the PatchCore algorithm were visualized to confirm the model's appropriateness, these points corresponded closely to the areas that clinical psychologists typically focus on during assessments (Figure 4.7). Although PatchCore is commonly used to detect anomalies in industrial products, it also shows promise for effectively detecting anomalies in drawing tests related to visuospatial cognition. Furthermore, the reconstruction error of the CAE and the variances in horizontal and vertical line lengths contributed significantly, indicating that

both overall structural features and local features, particularly those related to parallelism, distortion, and consistency, are critical for accurate prediction.

The findings of this study demonstrated that using AI technology to extract subtle abnormalities in CCT drawings enables the early detection of patients at high risk of progressing to dementia. This suggests that the subjective abnormalities perceived by SCI patients may already exist in the early stages of onset. Furthermore, the sensitivity of traditional manual scoring by psychologists was low (sensitivity = .39), indicating difficulties in accurately detecting abnormalities in converters. In contrast, patients' self-awareness exhibited a higher sensitivity (sensitivity = .78), suggesting that patients may be highly attuned to subtle changes in their bodily or cognitive functions.

4.5 Limitations

The sensitivity and specificity of the model with added image features were evaluated. While the model demonstrated a good sensitivity of .80, its specificity was relatively low at .71. The data were collected retrospectively from a memory clinic, which may have introduced certain biases. Notably, patients with subjective memory complaints have a 2.07 times higher relative risk of progressing to dementia than those without such impairment (Mitchell et al., 2014). Depression is also a known risk factor for dementia (Gauthier et al., 2006). The study participants were patients who visited the clinic multiple times due to perceived cognitive abnormalities reported by themselves or their families. As a result, the sample may have included a higher proportion of individuals with SCI or depressive tendencies compared to the general population, indicating a potentially high-risk sample.

The observation period in this study was limited to 3–5 years from the baseline; however, progression to dementia can take longer than this period (Caselli et al., 2020; Sperling et al., 2011; Weintraub et al., 2012). Some patients classified as non-converters during this period may have developed the condition later. This means that some non-converters may have been misclassified due to the study's time constraints, potentially affecting the classification accuracy. Additionally, patients with MCI or an undetermined diagnosis after 3–5 years, as well as those who were challenging to follow up with, were excluded. Among those difficult to follow up, some may have been institutionalized or deceased, while others may have shown improved or stable cognitive function and thus did not return to the clinic. This selection bias may have influenced the study's results.

The data used in this study were collected from a single facility in Japan. The CCT is influenced by the educational content and standards of a country or region (Gaestel et al., 2005; Paganini-Hill & Clark, 2006). Therefore, the findings may reflect Japan-specific factors, such as mathematics education. Consequently, the results may differ in countries or regions where drawing cubes is less common in the school curriculum.

4.6 Conclusion

This study developed a predictive model using AI technology to identify patients at high risk of progressing to dementia within 3-5 years by analyzing the geometric elements and overall shapes of CCT drawings. The aim was to detect subtle cognitive abnormalities that conventional methods could not identify, exploring the possibility that cognitive changes reported by SCI patients and their families might already be present in the early stages of onset. The model achieved an AUC of .85, a sensitivity of .80, and a specificity of .71 by utilizing CCT image features along with related features such as age, sex, and years of education.

The analysis revealed subtle differences in drawing styles between individuals who converted to dementia within 3–5 years and those who did not. Patients' self-awareness exhibited a higher sensitivity (sensitivity = .78), suggesting that patients may be highly attuned to subtle changes in their bodily or cognitive functions. This suggests that the subjective abnormalities perceived by SCI patients may already exist in the early stages of onset.

4.7 List of Tables

Table 4.1

Characteristics of the Participants (N =767)

Participant Characteristics, *Mean* ± *SD* or *n* (%)	Label: Converters (*n* = 457)	Label: Non-Converters (*n* = 310)	*t*-statistic or chi-square	*p*	Effect Size (Cohen's *d* or *φ)*
Age, years	77.55 ± 5.88	73.92 ± 5.77	8.46	.00	.62
Sex, Female	299 (65.43)	162 (52.26)	13.36	.00	-.13
Years of education, years	11.28 ± 2.61	12.53 ± 2.52	-6.60	.00	-.49
MMSE	26.05 ± 1.68	28.25 ± 1.79	-17.27	.00	-1.27
Diagnosis					
Alzheimer's disease dementia (AD)	318 (69.58)				
Lewy body dementia (DLB)	116 (25.38)				
Frontotemporal dementia (FTD)	23 (5.03)				
No cognitive impairment (NC)		310 (100.00)			

Note. Sex was analyzed using χ^2 test and φ. Age, years of education, and MMSE scores were analyzed using *t*-test and Cohen's *d*.

Table 4.2

Differences between Converters and Non-Converters after Adjusting for Related Features (ANCOVA)

Feature	Converters (n = 1464) *Mean* (*SD*)	Non-Converters (n = 1328) *Mean* (*SD*)	*p*	Cohen's *d*
Local features				
Number of lines (Abs)				
horizontal	0.477 (0.772)	0.175 (0.439)	.00	.48
vertical	0.449 (0.744)	0.193 (0.487)	.00	.40
diagonal	1.480 (1.274)	1.222 (1.124)	.00	.21
Number of vertices (Abs)	2.059 (2.730)	1.102 (2.090)	.00	.39
Average line length				
horizontal	111.104 (26.588)	117.687 (20.527)	.00	-.28
vertical	113.533 (25.982)	122.158 (20.146)	.00	-.37
diagonal	88.141 (88.071)	72.265 (62.758)	.00	.21
Variance of line length				
horizontal	1063.765 (1487.302)	502.276 (900.328)	.00	.45
vertical	1014.968 (1488.599)	547.037 (963.425)	.00	.37
diagonal	5550.603 (17183.455)	2618.515 (12008.967)	.00	.20
Average angle difference of lines				
horizontal	3.236 (2.388)	2.582 (1.723)	.00	.31
vertical	2.612 (1.696)	2.228 (1.620)	.00	.23
diagonal	25.322 (12.373)	21.646 (12.052)	.00	.30
Variance of angle difference of lines				
horizontal	10.031 (16.989)	6.572 (7.966)	.00	.26
vertical	7.841 (35.705)	6.826 (48.928)	.60	.02
diagonal	587.061 (458.210)	449.658 (381.093)	.00	.32
Global features				
Matching score	3.903 (2.203)	5.149 (2.438)	.00	-.54
PatchCore score	17.290 (1.927)	15.978 (1.470)	.00	.76
Reconstruction error	0.040 (0.008)	0.036 (0.006)	.00	.63
Handwriting pressure features				
Mean thickness	3.478 (0.079)	3.497 (0.059)	.00	-.27

Variance of thickness	0.459 (0.036)	0.452 (0.035)	.00	.19
Foreground ratio	0.071 (0.006)	0.072 (0.004)	.00	-.19

Note. ANCOVA was conducted after standardization, but the means and standard deviations in the table are the scores before standardization.

Table 4.3

Performance Evaluation of Test Data

	Developed Model	Simple Model
Accuracy	.77 [.70–.83]	.43 [.35–.51]
Sensitivity	.80 [.72–.88]	.48 [.38–.58]
Specificity	.71 [.56–.84]	.31 [.18–.46]
F1 score	.83 [.76–.88]	.54 [.44–.62]
AUC	.85 [.78–.91]	.31 [.22–.41]

Note. Values in brackets are 95% CIs.

Table 4.4

Mean and Standard Deviation of Absolute SHAP Values for Features Selected in the Final Model

Features		*Mean* Abs (*SD* Abs)
Local features		
Number of lines (Abs)		
	horizontal	0.00169 (0.00140)
	diagonal	0.00173 (0.00182)
Number of vertices (Abs)		0.00573 (0.00431)
Average line length		
	horizontal	0.00877 (0.00945)
	vertical	0.00992 (0.00723)
	diagonal	0.00399 (0.00206)
Variance of line length		
	horizontal	0.04426 (0.02022)
	vertical	0.03207 (0.01494)
	diagonal	0.00403 (0.00265)
Average angle difference of lines		
	horizontal	0.00388 (0.00279)
	vertical	0.00105 (0.00084)
	diagonal	0.00534 (0.00227)
Variance of angle difference of lines		
	horizontal	0.00764 (0.00450)
	vertical	0.00374 (0.00227)
	diagonal	0.00568 (0.00368)
Global features		
Matching score		0.02352 (0.01237)
PatchCore score		0.12919 (0.04482)
Reconstruction error		0.08193 (0.04205)
Handwriting pressure features		
Mean thickness		0.00753 (0.00530)
Variance of thickness		0.00220 (0.00159)
Foreground ratio		0.01228 (0.01216)
Related features		
Age		0.00736 (0.00625)
Sex		0.00245 (0.00152)
Years of education		0.00622 (0.00646)

Table 4.5

Differences in Image Features between Misclassified and Correctly Classified Images by Label

Image Features	Converters (*n* = 91)					Non-Converters (*n* = 42)				
	Misclassified (*n* = 18) *Mean* (*SD*)	Correctly classified (*n* = 73) *Mean* (*SD*)	*t*	*p*	*d*	Misclassified (*n* = 12) *Mean* (*SD*)	Correctly classified (*n* = 30) *Mean* (*SD*)	*t*	*p*	*d*
Local features										
Number of lines (Abs)										
horizontal	0.167 (0.514)	0.630 (0.874)	-2.92	.01	-.57	0.250 (0.452)	0.067 (0.254)	1.32	.21	.57
diagonal	0.500 (0.618)	1.644 (1.295)	-5.44	.00	-.96	1.583 (0.996)	1.033 (0.999)	1.61	.11	.55
Number of vertices (Abs)	0.556 (0.616)	2.356 (2.359)	-5.77	.00	-.84	0.833 (1.030)	0.500 (0.777)	1.14	.26	.39
Average line length										
horizontal	134.837 (17.243)	110.026 (25.509)	4.92	.00	1.03	120.761 (16.077)	136.307 (10.920)	-3.63	.00	-1.24
vertical	121.719 (14.970)	101.970 (22.329)	3.55	.00	.94	98.692 (17.879)	126.170 (15.753)	-4.92	.00	-1.68
diagonal	58.305 (8.550)	89.822 (52.795)	-4.85	.00	-.66	92.714 (62.321)	58.699 (16.524)	1.86	.09	.96
Variance of line length										
horizontal	325.591 (691.455)	1715.410 (1872.001)	-5.09	.00	-.81	876.972 (1287.105)	383.281 (809.974)	1.23	.24	.51
vertical	545.858 (1125.767)	1281.306 (1556.254)	-1.88	.06	-.50	241.156 (294.579)	174.104 (486.608)	0.44	.66	.15

diagonal	339.927 (406.161)	7454.334 (16260.060)	-3.73	.00	-.49	2245.602 (3160.454)	962.961 (3046.138)	1.22	.23	.42
Average angle difference of lines										
horizontal	2.868 (2.032)	4.209 (4.267)	-1.29	.20	-.34	2.585 (1.681)	2.358 (1.305)	0.47	.64	.16
vertical	1.641 (0.948)	3.098 (2.333)	-2.59	.01	-.68	2.706 (1.635)	2.007 (1.073)	1.63	.11	.56
diagonal	13.263 (9.284)	26.563 (9.868)	-5.18	.00	-1.36	19.923 (9.886)	16.846 (8.435)	1.02	.32	.35
Variance of angle difference of lines										
horizontal	6.409 (6.678)	17.964 (53.857)	-0.90	.37	-.24	7.160 (5.730)	4.641 (5.258)	1.37	.18	.47
vertical	2.297 (2.015)	25.276 (144.780)	-0.67	.50	-.18	6.651 (5.695)	4.544 (5.063)	1.18	.25	.40
diagonal	271.869 (342.326)	641.750 (419.728)	-3.46	.00	-.91	322.801 (194.253)	357.422 (235.139)	-0.45	.65	-.15
Global features										
Matching score	6.222 (1.865)	3.890 (2.183)	4.17	.00	1.10	4.000 (1.537)	5.667 (2.721)	-2.50	.02	-.68
PatchCore score	15.789 (0.795)	18.257 (1.719)	-8.98	.00	-1.56	17.089 (0.916)	15.713 (1.211)	3.54	.00	1.21
Reconstruction error	0.034 (0.004)	0.042 (0.008)	-5.53	.00	-1.01	0.040 (0.006)	0.031 (0.004)	5.67	.00	1.94
Handwriting pressure features										
Mean thickness	3.566 (0.049)	3.479 (0.074)	4.70	.00	1.24	3.467 (0.085)	3.552 (0.056)	-3.79	.00	-1.30
Variance of thickness	0.414 (0.026)	0.455 (0.035)	-4.58	.00	-1.20	0.463 (0.040)	0.420 (0.032)	3.70	.00	1.26
Foreground ratio	0.076 (0.004)	0.072 (0.005)	2.73	.01	.72	0.069 (0.004)	0.076 (0.003)	-6.00	.00	-2.05

Note. "*d*" represents the effect size, specifically Cohen's *d*.

Table 4.6

Psychologists' CCT Scoring and Patients' Self-Awareness of Cognitive Decline by Label

Assessment Source, *n* (%)	Label		
	Converters (*n* = 457)	Non-Converters (*n* = 310)	Total (*N* = 767)
Psychologists' CCT Scoring			
Incorrect (Abnormal)	176 (38.51)	33 (10.65)	209 (27.25)
Correct (Normal)	281 (61.49)	277 (89.35)	558 (72.75)
Patients' Self-Awareness of Cognitive Decline			
Aware (Abnormal)	358 (78.34)	270 (87.10)	628 (81.88)
Unaware (Normal)	99 (21.66)	40 (12.90)	139 (18.12)

4.8 List of Figures

Figure 4.1

The Process of Screening Participants for Analysis

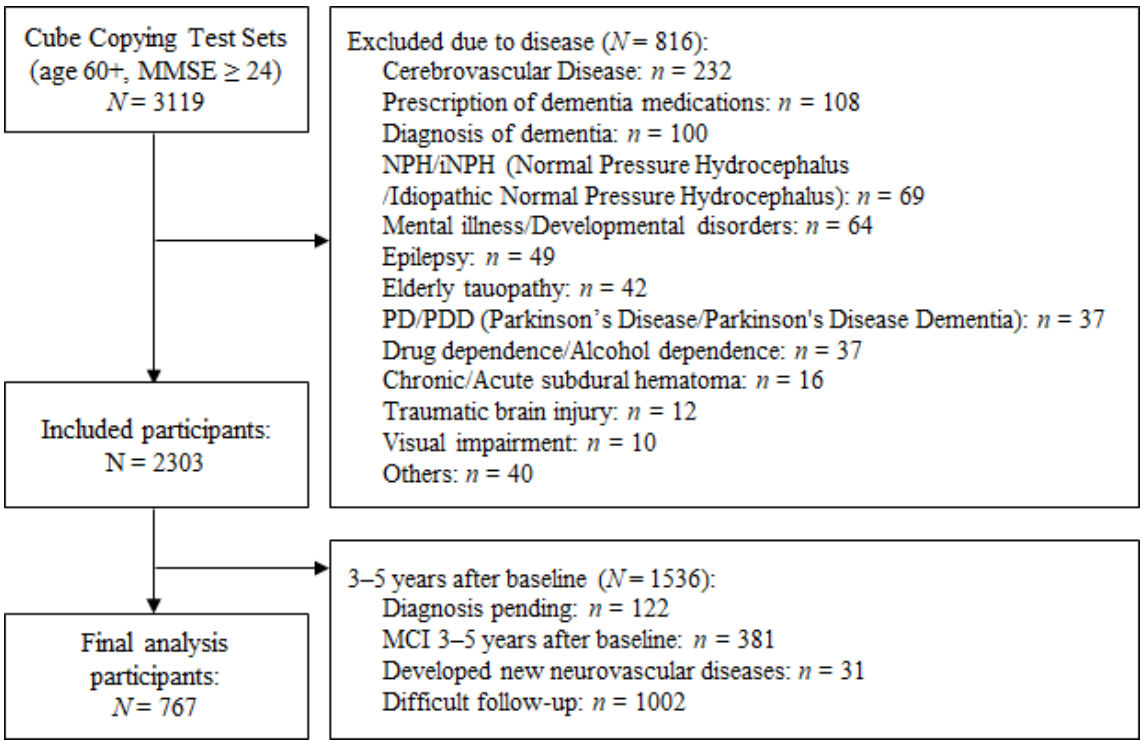


Figure 4.2

CCT Paper Used for Testing

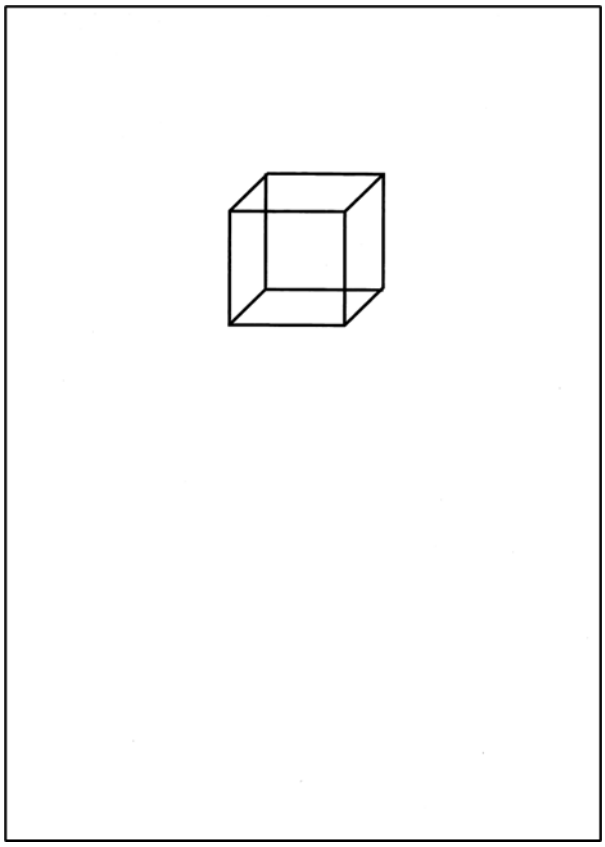


Figure 4.3

Data Division and Analysis Flow

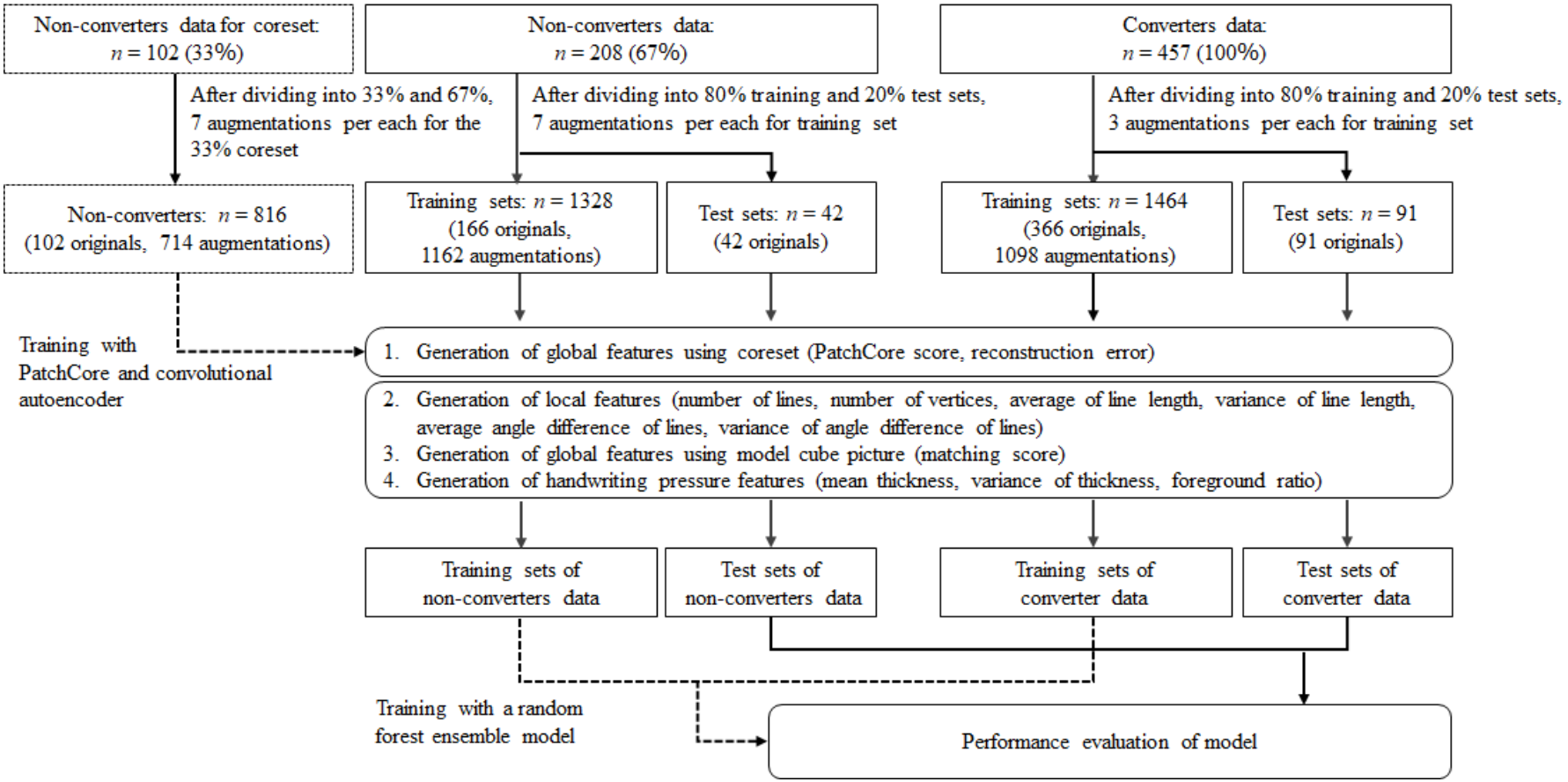


Figure 4.4

ROC Curve for the Final Model

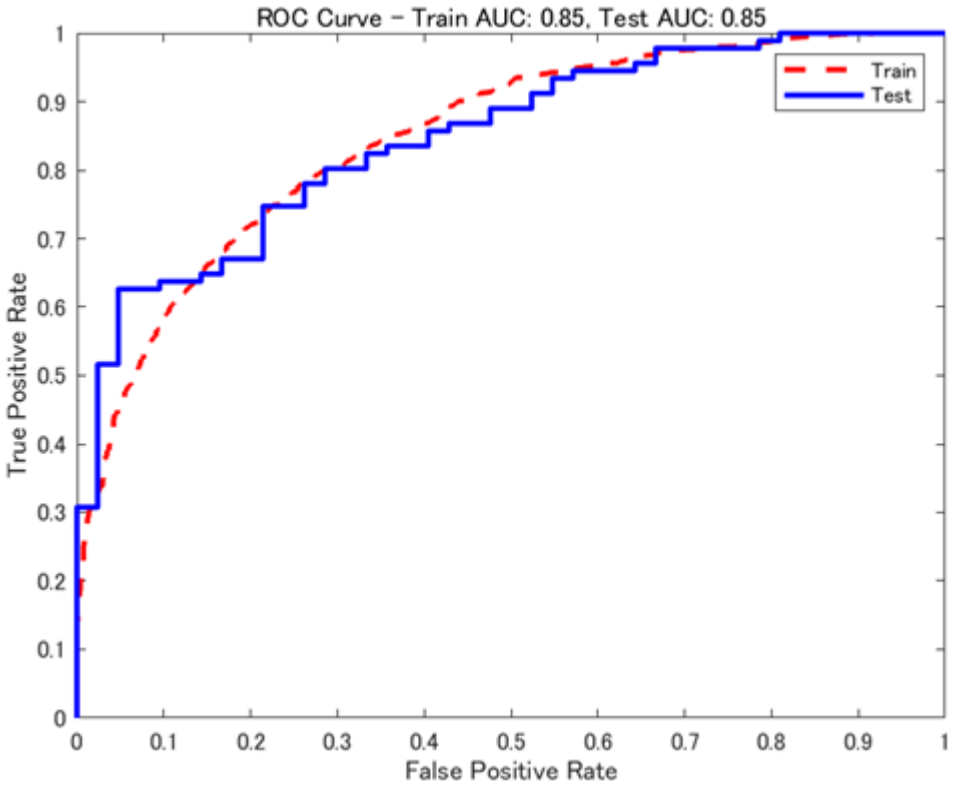


Figure 4.5

SHAP Beeswarm Plot by Label for Features Selected in the Final Model

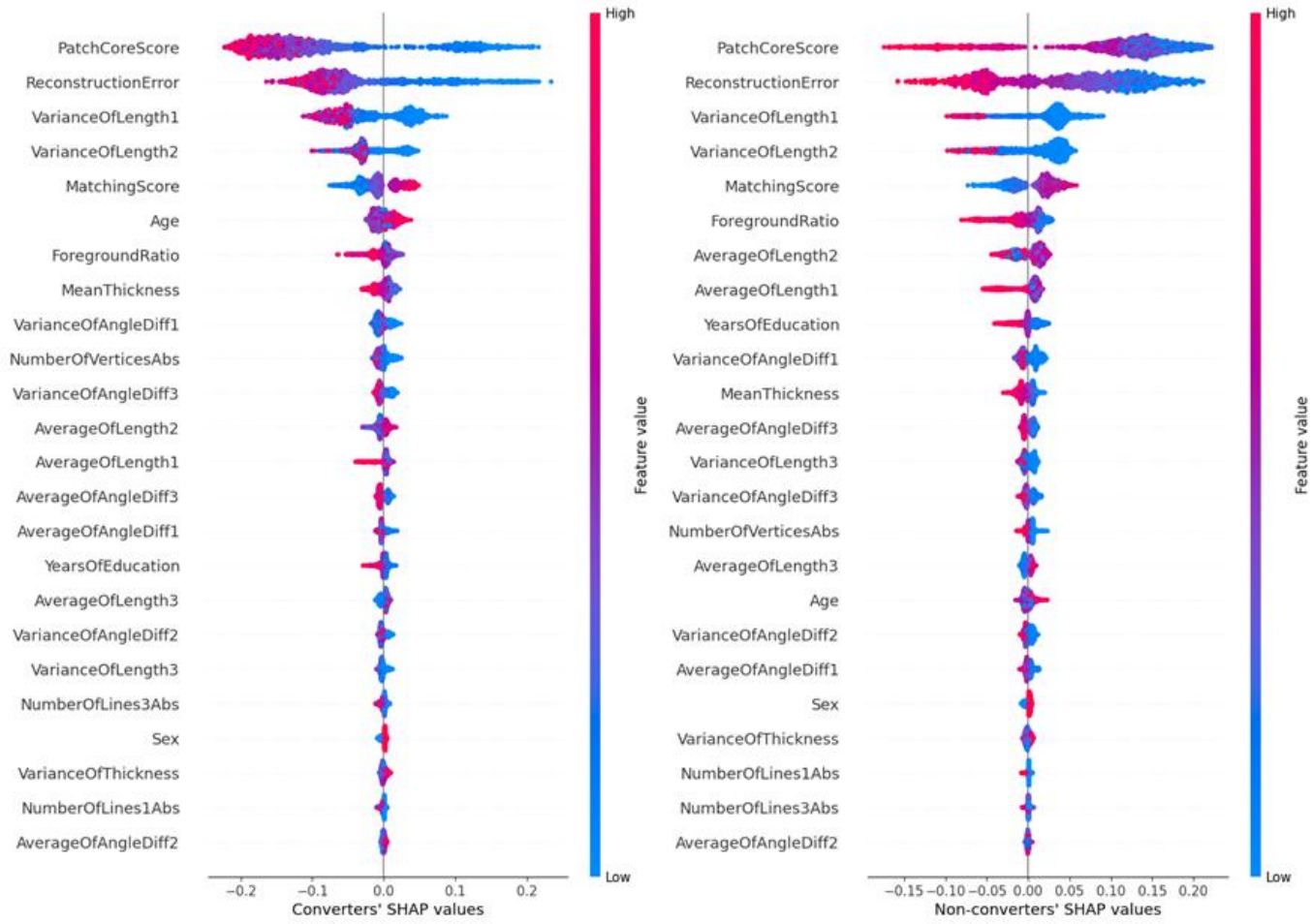
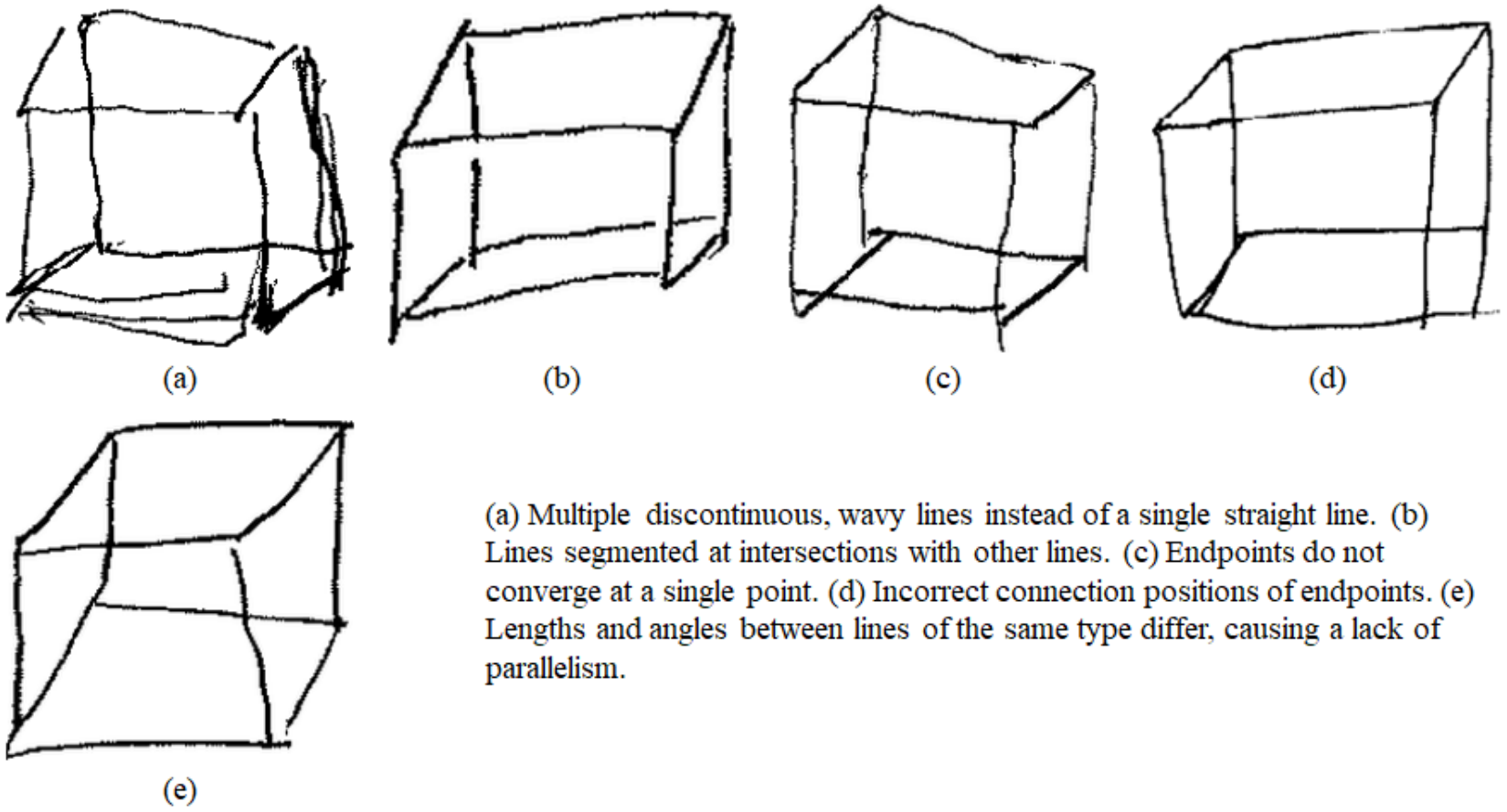


Figure 4.6

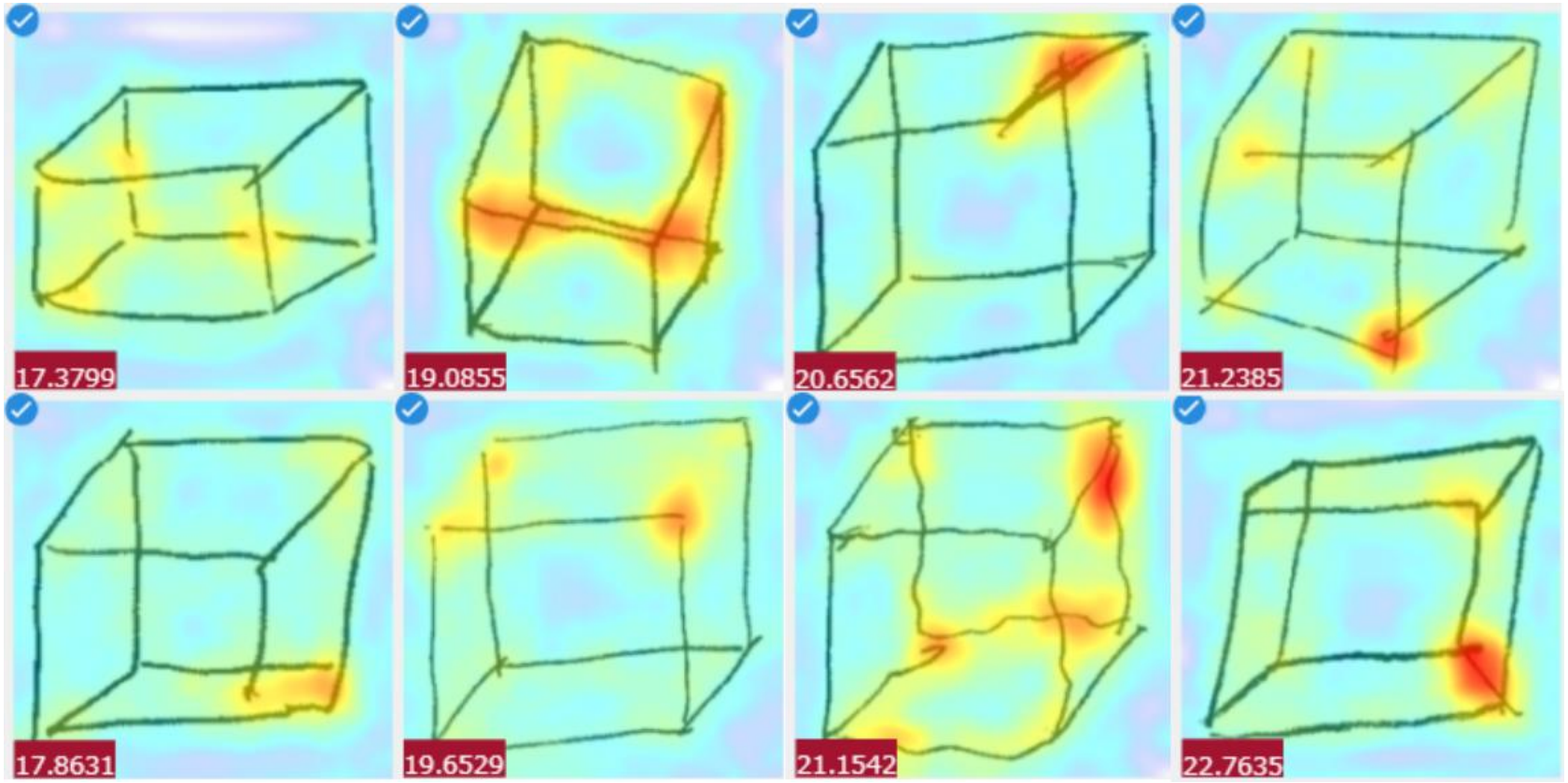
Characteristics of converters' drawings



(a) Multiple discontinuous, wavy lines instead of a single straight line. (b) Lines segmented at intersections with other lines. (c) Endpoints do not converge at a single point. (d) Incorrect connection positions of endpoints. (e) Lengths and angles between lines of the same type differ, causing a lack of parallelism.

Figure 4.7

Visualization of anomaly detection locations using PatchCore



Chapter 5
Discussion and Conclusions

Traditional models based on normal aging have primarily focused on the resource depletion associated with aging as a key factor in adaptive strategy selection. However, pathological aging is characterized by the dramatic manifestation and rapid progression of symptoms, which distinguishes it from the gradual decline observed in normal aging. These differences in progression patterns may influence how individuals psychologically adapt to health decline in the context of pathological aging.

This study aimed to elucidate the psychological adaptation mechanisms specific to health decline in pathological aging and provide insights into psychological support for older adults facing adaptation challenges. To this end, three investigations were conducted using data collected from older adults hospitalized or receiving outpatient care. Through these studies, the contribution of self-rated health and emotion regulation to adaptive strategies was examined, with a particular focus on how factors such as aging, vulnerability, and controllability influence the selection and effectiveness of these strategies.

5.1 Three Studies on Pathological Aging

5.1.1 Study 1: Examining the Effects of Physical Vulnerability and Aging on Emotion Regulation and Self-Rated Health

According to SST, older adults tend to prioritize positive emotional experiences and enhance emotion regulation to avoid negative information as they age. By contrast, models such as the SAVI and terminal decline models suggest that advancing vulnerability may impair emotion regulation.

Study 1 examined older inpatients following acute care treatment to investigate whether age-related mitigating effects on the relationships among objective physical function, self-rated physical health, and depressive mood could be observed even in the presence of progressive physical vulnerability.

Specifically, this study investigated whether age-related improvements in emotion regulation function could be observed among patients with increased physical vulnerability during pathological aging. The results revealed that even in such circumstances, older patients could reduce their depressive mood by maintaining positive self-rated health despite deteriorating physical health, with this ability becoming more pronounced with advancing age. These findings suggested that despite their increased physical vulnerability, older adults in more advanced age groups may retain superior emotion regulation capabilities. That is, the age-related positivity effect was confirmed in the relationship between objective physical function and self-rated physical health, suggesting the potential for this effect to moderate depressive mood associated with physical decline.

However, while these emotion regulation abilities in older patients appeared to function to some extent, the findings suggested that they were not sufficiently effective under conditions of increased vulnerability such as following acute care treatment. Furthermore, for older adults approaching the end of life, the findings suggested that emotional functioning may deteriorate due to terminal decline regardless of age, with

the effects of time-to-death potentially overriding age-related strengths in emotion regulation, leading to increased depressive mood.

5.1.2 Study 2: Examining the Impact of Cognitive Vulnerability on Self-Rated Mobility, Depressive Mood, and Maladaptive Outcomes

Emotion regulation requires sufficient cognitive resources and cognitive vulnerability may make emotion regulation more challenging (Charles & Luong, 2013; Mather & Knight, 2005). Additionally, in patients with anosognosia who cannot recognize their own health status (Steward et al., 2019), this condition may influence not only their self-rated health but also lead to maladaptive outcomes such as an increased risk of falls.

Study 2 examined the effects of cognitive vulnerability on self-rated mobility, depressive mood, and falls in older inpatients following acute care treatment. Specifically, this study investigated whether age-related improvements in emotion regulation function could be observed among patients with increased cognitive vulnerability during pathological aging and how their greater cognitive vulnerability could influence maladaptive outcomes.

The results showed that although the group with high cognitive function had more resources than other groups, there was no indication that they used emotion regulation by positively evaluating their mobility to reduce depressive mood. Rather, having more resources may have led them to focus on primary control strategies (e.g., rehabilitation and treatment).

By contrast, the group with moderate cognitive function demonstrated better emotion regulation than the high cognitive function group despite their more advanced cognitive vulnerability. This finding suggested that moderate cognitive decline did not necessarily impair emotion regulation or adaptation. However, depressive mood remained elevated even in this group, suggesting that increased vulnerability may have diminished emotion regulation capacity.

Furthermore, participants in the group with severely impaired cognitive function showed signs of possible anosognosia, lacking awareness of their mobility decline. While their unrealistic optimistic perceptions due to anosognosia may have contributed to reduced depressive mood, the findings suggested that this simultaneously increased the risk of maladaptive outcomes such as post-discharge falls, potentially hindering their overall adaptation.

5.1.3 Study 3: Exploring the impact of controllability on illness self-awareness

In the early stages of onset when treatment controllability remains achievable, patients may prioritize primary control—accurately recognizing abnormalities and seeking appropriate medical care—over secondary control such as emotion regulation.

Study 3 developed a predictive model using AI technology to identify patients at high risk of progressing to dementia within three to five years by analyzing the geometric elements and overall shapes of CCT drawings. The aim was to detect subtle cognitive abnormalities that conventional methods could not identify, exploring the possibility that cognitive changes reported by SCI patients and their families may already be present in the early stages of onset. The model achieved an AUC of .85, a sensitivity of .80, and a specificity of .71 by using CCT image features along with related features such as age, sex, and years of education.

The analysis revealed subtle differences in drawing styles between individuals who converted to dementia within three to five years and those who did not. Patients' self-awareness exhibited a higher sensitivity (sensitivity = .78), indicating that patients may be highly attuned to subtle changes in their bodily or cognitive function. This suggests that the subjective abnormalities perceived by SCI patients may already exist in the early stages of onset.

During the early stage in which treatment interventions can effectively provide control, it seems likely that patients may prioritize primary control strategies such as early detection and the proactive recognition of abnormalities rather than focusing on

maintaining emotional well-being. Such behavioral patterns may ultimately contribute to maximizing survival potential.

5.1.4 Insights from the Three Studies

The findings from Studies 1, 2, and 3 revealed that controllability through treatment plays a crucial role in the selection of adaptive strategies for pathological aging. When treatment-induced improvements are expected during the early stages, primary control strategies that focus on recognizing and treating abnormalities are prioritized. Conversely, when treatment becomes less feasible, secondary control strategies centered on emotion regulation become the primary means of adaptation.

Choosing primary control strategies during the stages in which treatment is viable contributes to increased survival rates. However, as health decline progresses and primary control becomes less viable, transitioning to secondary control strategies that focus on emotion regulation can be seen as a natural adaptation to the prevailing circumstances in order to maintain well-being. Maintaining positive emotions and preventing depressive mood through emotion regulation have been shown to support functional recovery after acute illness (Ostir et al., 2008), preserve physical health and functionality (Bailis et al., 2005; Ostir et al., 2000, 2004; Ruthig & Chipperfield, 2007; Steptoe et al., 2015), and even reduce mortality risk (Carstensen et al., 2011; Chipperfield, 1993; Ostir et al., 2000).

These findings suggested that the flexible selection of adaptation strategies by older adults based on the situation represents rational behavior aimed at maximizing survival and maintaining psychological well-being.

5.2 Can the Adaptive Mechanisms of Pathological Aging Be Explained by Models of Normal Aging?

The apparent contradiction between increasing health decline in later life and the maintenance of positive psychological states has been termed the “aging paradox” (Charles & Carstensen, 2010; Kunzmann et al., 2000; Mather, 2012; Mroczek & Kolarz, 1998). Theoretical perspectives in gerontological psychology that attempt to explain this paradox have emerged from studies primarily focused on normal aging, in which individuals experience a gradual decline in health over time. However, these theories may not fully explain the experiences of individuals undergoing pathological aging, which is characterized by rapid and severe health deterioration beyond normal age-related changes. This subsection examines the extent to which conventional models of normal aging can explain the adaptive mechanisms of pathological aging based on the findings from this study.

5.2.1 Applicability of SST to Pathological Aging

SST posits that as older adults become aware of their limited remaining time, their motivations shift, leading them to prioritize positive emotional experiences. This study also suggested that older adults experiencing pathological aging tend to seek psychological stability through positive evaluation and emotion regulation when primary control becomes a challenge.

However, even among individuals in their early 80s, who are generally considered at an advanced age, optimistic self-rated health is not observed when treatment-related improvements are anticipated. Instead, the findings suggested a stronger tendency to accurately recognize negative information about health decline. In the face of life-threatening issues such as illness and disability, the motivation for primary control through accurate information recognition seems to take precedence over the motivation to improve emotional state, indicating situations in which the SST model may not fully apply.

5.2.2 Applicability of the SAVI Model to Pathological Aging

The SAVI model suggests that emotion regulation improves with age; however, heightened vulnerability can impair this capacity. Similar trends were observed in this study. Furthermore, this study revealed that pathological aging introduces additional challenges beyond the natural vulnerabilities associated with aging. For example, pathological traits such as anosognosia (the inability to recognize one's own illness or disability) could create adaptive challenges that go beyond the scope of the SAVI model.

5.2.3 Applicability of the Terminal Decline Model to Pathological Aging

As death approaches, the terminal decline model predicts a rapid decline in physical and psychological functions, including emotion regulation. This study observed that at advanced stages of pathological aging, emotion regulation among older adults is impaired and depressive tendencies increase. These findings were consistent with the predictions of the terminal decline model, suggesting that the final stages of pathological aging converge with this model.

5.2.4 Summary

This study revealed that while models of normal aging provide some insights into the adaptive mechanisms of pathological aging, they are insufficient to explain its distinct characteristics fully. The findings highlight several aspects that are not adequately addressed in normal aging models.

Although the capacity for emotion regulation in managing losses improves with age, the decision to employ emotion regulation depends on the controllability of the disease. In the early stages of pathological decline, older adults prioritize primary control when it is possible, even at the cost of emotional well-being. This aspect is not fully accounted for in models of normal aging.

Moreover, in pathological aging, heightened vulnerability and depleted resources may limit the effectiveness of emotion regulation as a secondary control strategy, potentially making it insufficient to adequately reduce depressive mood. Furthermore, disease progression in pathological aging introduces new sources of vulnerability. For example, pathological conditions such as anosognosia can lead to maladaptive optimism and adverse outcomes, including an increased risk of falls. Older adults in terminal stages face significant challenges in adaptation and experience deterioration of psychological health. The adaptive challenges caused by these vulnerabilities associated with disease progression are not adequately explained by existing models of normal aging.

These findings indicate the need for new theoretical frameworks to better explain the psychological adaptation processes in pathological aging. Figures 5.1 and 5.2 present the model diagrams of normal aging and pathological aging, respectively.

5.3 Can Normal Aging, Pathological Aging, and Terminal Aging Be Clearly Differentiated?

Aging has been discussed in three categories: normal, pathological, and terminal aging. However, whether these categories can be clearly differentiated remains a matter of discussion.

Even in geriatric clinical practice, it is often difficult to distinguish between normal and pathological aging. Many older adults live with lifestyle-related diseases or chronic conditions, blurring the boundary between normal aging, which is considered physiological aging, and pathological aging. Furthermore, normal and pathological aging often progress continuously during terminal aging. Therefore, rather than strictly categorizing these types, some may consider it more appropriate to view them as a continuum of quantitative changes in which conditions are regarded as pathological aging once they surpass certain thresholds.

While such a continuous perspective may be valid, pathological aging can involve qualitatively distinct changes. Particularly during the early stages of onset, acute exacerbation, or terminal stage with rapid functional decline, discontinuous processes that go beyond mere gradual age-related decline may occur, such as in cases in which a stroke results in a sudden inability to live independently or the acute exacerbation of respiratory failure necessitates home oxygen therapy. These examples illustrate that pathological aging can involve abrupt and significant changes, underscoring the importance of distinguishing among the three categories of aging in certain contexts.

5.4 Clinical Implications for Managing Severe Health Decline in Later Life

The results of this study indicated that even in pathological aging, a certain level of emotion regulation is maintained, contributing to psychological adaptation to severe health decline. However, its effectiveness was limited due to increased vulnerability, with depressive mood remaining substantially higher than in normal aging. Particularly, older adults with severe cognitive impairment or those in the terminal stages of aging may reach the limits of their adaptive capacities, preventing them from fully utilizing their inherent emotion regulation and psychological adaptation abilities. The following support strategies could be effective for older adults under such circumstances.

5.4.1 Focusing on Remaining Abilities

Older adults tend to show a cognitive bias known as the age-related positivity effect (Carstensen et al., 2003; Charles et al., 2003; Isaacowitz, 2022; Mather & Carstensen, 2003, 2005; Reed et al., 2014), which helps them maintain a positive self-perception and contributes to psychological adaptation. However, for older adults with heightened vulnerability, this adaptive bias may not function as effectively. In such cases, focusing on what they can still do and emphasizing their healthy aspects can be beneficial. This approach may encourage adaptive and positive self-evaluation, support self-esteem and the desire to live, and help maintain psychological stability.

5.4.2 Supporting Emotion Regulation

Older adults tend to interpret age-related health changes as a natural process, which helps them accept illness and disability and reduces psychological distress (Hoeymans et al., 1997; Idler et al., 1999; Kunzmann et al., 2000; Turner & McLean, 1989). They often engage in downward social comparison with same-aged peers to maintain positive self-perceptions (Gibbons, 1999; Sprangers & Schwartz, 1999) and achieve

psychological adaptation by disengaging from unattainable goals or adjusting them to realistic levels (Heckhausen & Schulz, 1993). These strategies effectively support emotional well-being in normal aging.

However, in older adults experiencing pathological aging with intensified physical, psychological, or cognitive vulnerabilities, these self-regulatory mechanisms often become less effective, leading to adaptation difficulties. External psychological support may help compensate for their diminished adaptive capacity in such cases. For example, facilitating interactions with peers who have similar conditions can reduce isolation and promote adaptive social comparison, potentially helping them adjust their values and standards while supporting goal modification and self-enhancement.

5.4.3 Validating and Addressing Patients' Subjective Sensations

It is also important not to dismiss patients' subjective sensations—particularly those that convey a vague sense that "something is wrong," yet cannot be detected through standard objective tests—as vague complaints. Although subjective sensations may stem from health anxiety alone, they may also reflect subtle changes during the early stages of disease development. The suitable assessment of these sensations can provide valuable cues for the early detection of abnormalities.

The findings of this study provided concrete strategies to support the psychological stability of older adults facing pathological aging and enhance their quality of life. In particular, compensatory support for those struggling with emotion regulation and approaches that appropriately assess and address subjective discomfort in the early stages of disease development offer critical insights for improving the quality of interventions in clinical practice.

5.5 Challenges and Future Research Directions

5.5.1 Challenges of this Study

Limited Assessment Duration

In Studies 1 and 2, depressive mood was evaluated using the GDS-15 only once during hospitalization, without follow-up assessments to track temporal changes. This single-point assessment raises concerns about whether the emotion regulation effects were temporary, associated only with the acute hospitalization period rather than representing sustained adaptive processes that continued after discharge.

In Study 3, observations were limited to three to five years after initial evaluation. This duration may be insufficient to fully capture the progression to dementia, which can extend beyond this timeframe (Caselli et al., 2020; Sperling et al., 2011; Weintraub et al., 2012). Consequently, patients classified as non-converters during the study period may have subsequently developed dementia, potentially affecting the accuracy of the classification results.

Bidirectional Causality Issues

A critical methodological limitation concerns the potential bidirectional relationships between the variables studied. With reference to Studies 1 and 2, the relationship between physical health and depression has been established as bidirectional in the literature (Bruce, 2001; Evans et al., 2005; Lenze et al., 2001). While deteriorating physical health may contribute to increased depressive mood, depression itself could adversely affect physical health outcomes, making it challenging to determine the primary direction of causality.

Similarly, Study 3 faces a comparable bidirectional challenge. The sample likely included patients with heightened anxiety about dementia and depressive tendencies. Given that depression is a recognized risk factor for dementia, these psychological

factors may have influenced the progression to dementia among participants. This creates a complex causal network in which psychological distress could be both a predictor and a consequence of cognitive decline.

Additionally, in Studies 1 and 2, the small sample size limited control over the confounding effects of age and cognitive function. In general, older age is associated with lower cognitive function, meaning that this relationship was inherently present in the data. Consequently, it remains difficult to ascertain whether age was the primary factor or if other psychological or health-related variables played a more significant role in the observed outcomes.

Unmeasured Psychological and Social Factors

This study was limited by several unmeasured variables that could significantly influence self-rated health, depressive mood, and emotion regulation. Social factors, including social isolation and economic hardship, may affect these psychological processes (Chipperfield, 1993; Fiske et al., 2009). Moreover, individual perceptions of aging can impact how older adults evaluate their health status and regulate their emotions (Levy, 2003; Tully-Wilson et al., 2021).

Personality traits represent another crucial unmeasured factor. Characteristics such as neuroticism and extraversion may influence how individuals evaluate their health, experience depressive mood, and regulate their emotions (Chapman et al., 2006; Charles et al., 2001; Duberstein et al., 2003). In Study 3, personality traits such as neuroticism may have affected participants' sensitivity to subtle cognitive changes. Previous research has also indicated that individuals with positive emotions tend to have higher survival rates (Fredrickson, 2001; Ostir et al., 2000), suggesting complex interactions among personality traits, emotion regulation, and health outcomes.

5.5.2 Future Directions

Need for Longitudinal Investigations

Given that Studies 1 and 2 evaluated the effects of emotion regulation only during hospitalization, longitudinal investigations with extended observation periods are necessary to examine the long-term effects of emotion regulation. Specifically, research is needed to examine how the maintenance of positive emotional states during hospitalization influences post-discharge functional recovery, sustained psychological well-being, and survival rates. Such extended observations would help elucidate the potential protective effects of adaptive emotion regulation on long-term health trajectories and quality of life.

Clarification of Disease-Specific Adaptation Processes

This study treated pathological aging as a single category; however, adaptation processes may differ depending on the disease. For example, chronic heart failure progresses slowly, whereas cancer often exhibits a sharp decline near death. Dementia and Parkinson's disease are associated with long-term disability and eventually total dependency (Cohen-Mansfield et al., 2017; Lunney et al., 2003). Elucidating the adaptation mechanisms specific to each disease and developing tailored interventions are essential.

Understanding Early Subjective Symptoms

Although Study 3 suggested that patients in the early stages may accurately recognize their cognitive decline, it was not possible to match their subjective experiences with objective findings. This was primarily because early subjective complaints are often vague and difficult to articulate, such as "something feels off" and "my mind feels fuzzy," making it challenging to verify these subtle experiences through objective cognitive tests. Future research should analyze the content of these subjective complaints through text analysis to identify common patterns among individuals who later progress to dementia. Clarifying the nature of these early subjective complaints could contribute to the development of more effective self-assessment tools for early detection.

5.6. Conclusion

This study aimed to elucidate how older adults with pathological aging, who face adaptation challenges due to rapid functional decline and dramatic suffering, regulate their emotions and achieve psychological adaptation when facing health losses as well as provide insights into psychological support for these older adults. Self-rated health and emotion regulation were positioned as key components of adaptation strategies in pathological aging and their roles in adaptation were examined, focusing on how aging, vulnerability, and controllability influence the selection and effectiveness of these strategies.

Using data collected from hospitalized and outpatient older adults, three studies were conducted with a focus on physical and cognitive vulnerability as well as controllability. The results revealed that disease controllability and the degree of vulnerability play crucial roles in determining the selection and effectiveness of adaptation strategies in pathological aging. In the early stages of illness when primary control through treatment is still feasible, older adults become highly sensitive to subtle pathological changes. However, as the disease progresses and treatment feasibility declines, emotion regulation strategies become more prominent, with older adults maintaining positive emotions by perceiving their health status more optimistically than the actual situation. This context-dependent selection of adaptation strategies appears to contribute to increased survival rates and the maintenance of psychological well-being.

Regarding vulnerability, the findings suggested that among older adults with pathological aging, those of more advanced age are better able to alleviate depressive mood through optimistic health perceptions, even in the presence of increased physical vulnerability. This indicates that the advanced emotion regulation capacity described in SST persists in pathological aging, supporting psychological adaptation to health losses. The findings also suggested that moderate cognitive vulnerability does not impair psychological adaptation capacity through emotion regulation.

However, despite the benefits of optimistic health perceptions, depressive mood remains substantially higher than that in normal aging. Furthermore, patients near the

end of life and those with severe cognitive impairment could face difficulties in psychological adaptation. These findings supported the assertion of the SAVI model that increased vulnerability reduces the effectiveness of emotion regulation.

Therefore, while older adults with pathological aging maintain some capacity for psychological adaptation through emotion regulation, its effectiveness is diminished, potentially leading to deterioration in psychological health. In particular, those with extreme vulnerability, those in terminal stages, or those with severe cognitive decline may experience compromised emotion regulation function, suggesting the need for support to bolster their emotion regulation and psychological adaptation capacities.

These findings highlighted the limitations of traditional normal aging models to adequately explain pathological aging and underscored the need for a new theoretical framework that incorporates adaptation mechanisms specific to pathological aging.

5.7 List of Figures

Figure 5.1

Model of Normal Aging

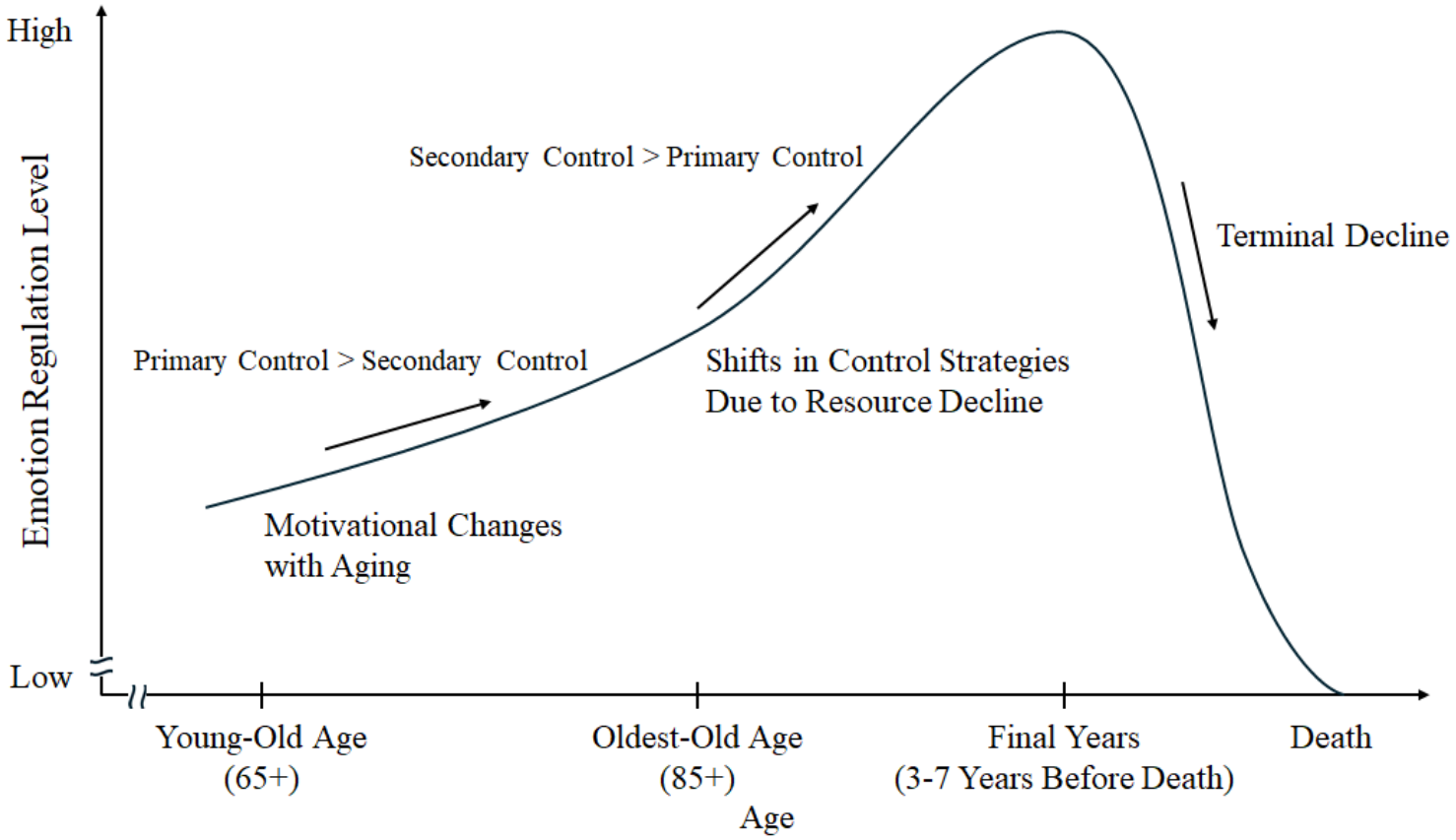
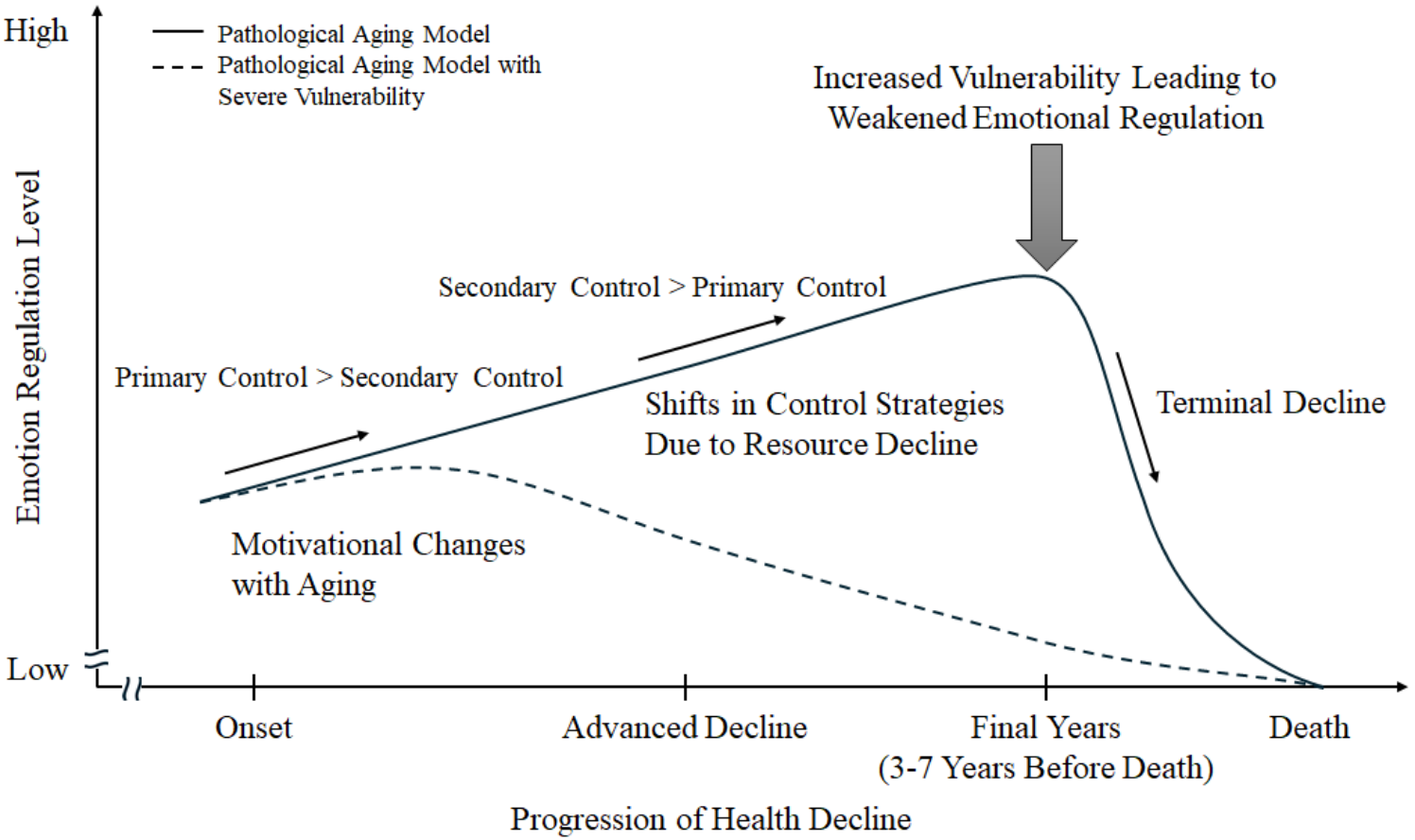


Figure 5.2

Model of Pathological Aging



Acknowledgments

Approximately 20 years ago, when I was a graduate student at Kyoto University, one of my classmates passed away from a cerebral hemorrhage while staying up all night helping me organize my data. My supervisor, Professor Toshihiko Endo, spared no effort in guiding me to become an independent researcher and taught me the importance of approaching academic endeavors with integrity. However, I found myself unable to continue writing papers as the mere act of engaging in research triggered flashbacks. After completing my three-years doctoral program, I decided to abandon becoming a researcher. Without submitting my dissertation, I withdrew from the doctoral program at Kyoto University and enrolled in a clinical psychology graduate program, ultimately becoming a clinical psychologist—the profession my late friend had aspired to pursue.

Later, I faced a life-threatening illness myself. At that time, I deeply regretted having abandoned the path of a researcher. Fortunately, I was given another chance at life. In 2015, while working as a clinical psychologist at the National Center for Geriatrics and Gerontology, I resolved to resume research and quietly prepared for that goal. In 2017, I was able to restart my research in earnest thanks to research funding provided by President Kenji Toba.

During those days without a dedicated research room or desk, I spent approximately five years on the wards from morning to night, collecting and organizing research data while observing the daily lives of older inpatients. This was invaluable. I learned everything about aging from these patients, and their resilience in the face of challenges strengthened me. I also gained extensive knowledge about clinical care for older adults from experienced nurses Ms. Shigemi Yamamoto and Ms. Masayo Kakiya. Additionally, I was inspired by dedicated faculty members at the National Center for Geriatrics and Gerontology who approached clinical care and research for older adults with a strong sense of mission.

In the spring of 2022, amid the COVID-19 pandemic, I was given the opportunity to pursue a doctoral dissertation once again at Osaka University thanks to Professor Yasuyuki Gondo. From Professor Gondo, I learned the importance of enjoying research.

I would like to extend my heartfelt gratitude to my mentors who have guided and supported me in both research and clinical practice from my undergraduate days to the present. Without their guidance, I would not be who I am today.

Professors Hideo Kojima and Takashi Murakami (Nagoya University, Faculty of Education)

Professor Toshihiko Endo (Kyoto University, Graduate School of Education (former); University of Tokyo, Graduate School of Education (current))

Professors Yuko Okamoto and Kenichi Kodama (Hiroshima University Graduate School of Education)

Professor Yasuyuki Gondo, Associate Professor Takeshi Nakagawa, and Associate Professor Michio Yamamoto (Osaka University, Graduate School of Human Sciences)

Dr. Yutaka Arahata, Dr. Takashi Sakurai, Dr. Shosuke Satake, Dr. Akinori Takeda, Dr. Izumi Kondo, Dr. Kenji Toba, and Dr. Hidenori Arai (National Center for Geriatrics and Gerontology)

Dr. Kenichi Kuriyama (National Center of Neurology and Psychiatry)

Dr. Hiroyuki Hishida (MathWorks Japan), Professor Takashi Suzuki (Osaka University, Center for Mathematical Modeling and Data Science), Associate Professor Takashi Nakazawa (Kanazawa University, Emerging Media Initiative), and Associate Professor Atsushi Koike (Tohoku University, Graduate School of Information Sciences)

Dr. Kazuhiro Nakagawa (Chugoku Rosai Hospital, Department of Psychiatry)

I am also deeply grateful to Ms. Shigemi Yamamoto, Ms. Masayo Kakiya, Ms. Yuko Sugiura, and Ms. Shihoko Matsuda (Department of Neurology, National Center for Geriatrics and Gerontology) for their encouragement and assistance in organizing the data.

I would also like to thank Mr. Naoya Takahashi (Kyoto University, Graduate School of Education) for supporting me during my most difficult time as a graduate student at Kyoto University.

Finally, I would like to express my heartfelt gratitude to the patients and their families who participated in this study and provided me with support and encouragement.

Funding

This work was supported by a JSPS KAKENHI Grant-in-Aid for JSPS Fellows (Grant Number 23KJ1482), a Grant-in-Aid for Scientific Research (C) (Grant Number 19K03334), and Research Funding for Longevity Sciences (26-34, 29-1, 29-35, and 20-43) from the National Center for Geriatrics and Gerontology, Japan.

Mio Shinozaki

December 2024

List of References

Affleck, G., & Tennen, H. (1991). Social comparison and coping with major medical problems. In *Social comparison: Contemporary theory and research.* (pp. 369-393). Lawrence Erlbaum Associates, Inc.

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Sage Publications, Inc. https://psycnet.apa.org/record/1991-97932-000

Almeida, O. P., & Almeida, S. A. (1999). Short versions of the geriatric depression scale: a study of their validity for the diagnosis of a major depressive episode according to ICD-10 and DSM-IV. *International Journal of Geriatric Psychiatry*, *14*(10), 858-865. https://doi.org/10.1002/(sici)1099-1166(199910)14:10<858::aid-gps35>3.0.co;2-8

Amariglio, R. E., Becker, J. A., Carmasin, J., Wadsworth, L. P., Lorius, N., Sullivan, C., Maye, J. E., Gidicsin, C., Pepin, L. C., Sperling, R. A., Johnson, K. A., & Rentz, D. M. (2012). Subjective cognitive complaints and amyloid burden in cognitively normal older individuals. *Neuropsychologia*, *50*(12), 2880-2886. https://doi.org/10.1016/j.neuropsychologia.2012.08.011

Aoki, T., Nagai, S., Sonoda, S., Shintani, M., Wada, Y., Nobotachi, N., Osa, Y., & Imanishi, H. (2005). Validity and reliability of the flowchart-type questionnaire for scoring the FIM (Flow-FIM). *Sogo Rehabilitation*, *33*(4), 355-359. https://doi.org/10.11477/mf.1552100081

Araujo, L., Teixeira, L., Ribeiro, O., & Paul, C. (2018). Objective vs. Subjective Health in Very Advanced Ages: Looking for Discordance in Centenarians [Original Research]. *Front Med (Lausanne)*, *5*, 189. https://doi.org/10.3389/fmed.2018.00189

Atchley, R. C. (1989). A Continuity Theory of Normal Aging. *The Gerontologist*, *29*(2), 183-190. https://doi.org/10.1093/geront/29.2.183

Bäckman, L., Jones, S., Berger, A.-K., Laukka, E. J., & Small, B. J. (2005). Cognitive impairment in preclinical Alzheimer's disease: A meta-analysis. *Neuropsychology*, *19*(4), 520-531. https://doi.org/10.1037/0894-4105.19.4.520

Bailis, D. S., Chipperfield, J. G., & Perry, R. P. (2005). Optimistic social comparisons of older adults low in primary control: a prospective analysis of hospitalization and mortality. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association*, *24*(4), 393-401. https://doi.org/10.1037/0278-6133.24.4.393

Baltes, P. B. (1987). Theoretical propositions of life-span developmental psychology: On the dynamics between growth and decline. *Developmental Psychology*, *23*(5), 611-626. https://doi.org/10.1037/0012-1649.23.5.611

Baltes, P. B. (1997). On the incomplete architecture of human ontogeny: Selection, optimization, and compensation as foundation of developmental theory. *American Psychologist*, *52*(4), 366-380. https://doi.org/10.1037/0003-066X.52.4.366

Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. In *Successful aging: Perspectives from the behavioral sciences* (pp. 1-34). Cambridge University Press. https://psycnet.apa.org/record/1991-97212-001

Baltes, P. B., & Goulet, L. R. (1970). CHAPTER 1 - Status and Issues of a Life-Span Developmental Psychology. In L. R. Goulet & P. B. Baltes (Eds.), *Life-Span Developmental Psychology* (pp. 3-21). Academic Press. https://doi.org/10.1016/B978-0-12-293850-4.50007-8

Baltes, P. B., Reese, H. W., & Lipsitt, L. P. (1980). Life-Span Developmental Psychology. *Annual Review of Psychology*, *31*(Volume 31, 1980), 65-110. https://doi.org/10.1146/annurev.ps.31.020180.000433

Baltes, P. B., & Smith, J. (2003). New frontiers in the future of aging: from successful aging of the young old to the dilemmas of the fourth age. *Gerontology*, *49*(2), 123-135. https://doi.org/10.1159/000067946

Barker, W. W., Luis, C. A., Kashuba, A., Luis, M., Harwood, D. G., Loewenstein, D., Waters, C., Jimison, P., Shepherd, E., Sevush, S., Graff-Radford, N., Newland, D., Todd, M., Miller, B., Gold, M., Heilman, K., Doty, L., Goodman, I., Robinson, B.,…Duara, R. (2002). Relative Frequencies of Alzheimer Disease, Lewy Body, Vascular and Frontotemporal Dementia, and Hippocampal Sclerosis in the State of Florida Brain Bank. *Alzheimer Disease & Associated*

Disorders, *16*(4), 203-212. https://journals.lww.com/alzheimerjournal/fulltext/2002/10000/relative_frequencies_of_alzheimer_disease,_lewy.1.aspx

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is Stronger than Good. *Review of General Psychology*, *5*(4), 323-370. https://doi.org/10.1037/1089-2680.5.4.323

Bertrand, E., Landeira-Fernandez, J., & Mograbi, D. C. (2016). Metacognition and Perspective-Taking in Alzheimer's Disease: A Mini-Review. *Frontiers in Psychology*, *7*, 1812. https://doi.org/10.3389/fpsyg.2016.01812

Birren, J. E., & Cunningham, W. R. (1985). Research on the psychology of aging: Principles, concepts and theory. In *Handbook of the psychology of aging, 2nd ed.* (pp. 3-34). Van Nostrand Reinhold Co.

Blanchard-Fields, F. (2007). Everyday Problem Solving and Emotion:An Adult Developmental Perspective. *Current Directions in Psychological Science*, *16*(1), 26-31. https://doi.org/10.1111/j.1467-8721.2007.00469.x

Blazer, D., Hughes, D. C., & George, L. K. (1987). The epidemiology of depression in an elderly community population. *The Gerontologist*, *27*(3), 281-287. https://doi.org/10.1093/geront/27.3.281

Blazer, D. G. (2003). Depression in late life: review and commentary. *J Gerontol A Biol Sci Med Sci*, *58*(3), 249-265. https://doi.org/10.1093/gerona/58.3.m249

Boerner, K. (2004). Adaptation to Disability Among Middle-Aged and Older Adults: The Role of Assimilative and Accommodative Coping. *The Journals of Gerontology: Series B*, *59*(1), P35-P42. https://doi.org/10.1093/geronb/59.1.P35

Bondi, M. W., Edmonds, E. C., & Salmon, D. P. (2017). Alzheimer's Disease: Past, Present, and Future. *Journal of the International Neuropsychological Society*, *23*(9-10), 818-831. https://doi.org/10.1017/S135561771700100X

Brandtstädter, J., & Greve, W. (1994). The Aging Self: Stabilizing and Protective Processes. *Developmental Review*, *14*(1), 52-80. https://doi.org/10.1006/drev.1994.1003

Bruce, M. L. (2001). Depression and disability in late life: directions for future research. *Am J Geriatr Psychiatry*, *9*(2), 102-112. https://doi.org/10.1097/00019442-200105000-00003

Buchman, A. S., Schneider, J. A., Leurgans, S., & Bennett, D. A. (2008). Physical frailty in older persons is associated with Alzheimer disease pathology. *Neurology*, *71*(7), 499-504. https://doi.org/doi:10.1212/01.wnl.0000324864.81179.6a

Buchman, A. S., Wilson, R. S., Boyle, P. A., Bienias, J. L., & Bennett, D. A. (2007). Grip Strength and the Risk of Incident Alzheimer's Disease. *Neuroepidemiology*, *29*(1-2), 66-73. https://doi.org/10.1159/000109498

Buunk, B. P., Collins, R. L., Taylor, S. E., VanYperen, N. W., & Dakof, G. A. (1990). The affective consequences of social comparison: either direction has its ups and downs. *J Pers Soc Psychol*, *59*(6), 1238-1249. https://doi.org/10.1037//0022-3514.59.6.1238

Cacioppo, J. T., Berntson, G. G., Bechara, A., Tranel, D., & Hawkley, L. C. (2011). Could an aging brain contribute to subjective well-being? The value added by a social neuroscience perspective. In *Social neuroscience: Toward understanding the underpinnings of the social mind* (pp. 249-262). Oxford University Press. https://psycnet.apa.org/record/2011-02135-017

Campbell, S., Stephens, S., & Ballard, C. (2001). Dementia with Lewy Bodies. *Drugs & Aging*, *18*(6), 397-407. https://doi.org/10.2165/00002512-200118060-00002

Carstensen, L. L., & DeLiema, M. (2018). The positivity effect: a negativity bias in youth fades with age. *Current opinion in behavioral sciences*, *19*, 7-12. https://doi.org/10.1016/j.cobeha.2017.07.009

Carstensen, L. L., Fung, H. H., & Charles, S. T. (2003). Socioemotional Selectivity Theory and the Regulation of Emotion in the Second Half of Life. *Motivation and Emotion*, *27*(2), 103-123. https://doi.org/10.1023/A:1024569803230

Carstensen, L. L., Isaacowitz, D. M., & Charles, S. T. (1999). Taking time seriously. A theory of socioemotional selectivity. *Am Psychol*, *54*(3), 165-181. https://doi.org/10.1037//0003-066x.54.3.165

Carstensen, L. L., Turan, B., Scheibe, S., Ram, N., Ersner-Hershfield, H., Samanez-Larkin, G. R., Brooks, K. P., & Nesselroade, J. R. (2011). Emotional experience improves with age: evidence based on over 10 years of experience sampling. *Psychology and Aging*, *26*(1), 21-33. https://doi.org/10.1037/a0021285

Caselli, R. J., Langlais, B. T., Dueck, A. C., Chen, Y., Su, Y., Locke, D. E. C., Woodruff, B. K., & Reiman, E. M. (2020). Neuropsychological decline up to 20 years before incident mild cognitive impairment. *Alzheimer's & Dementia*, *16*(3), 512-523. https://doi.org/10.1016/j.jalz.2019.09.085

Chapman, B. P., Duberstein, P. R., Sörensen, S., & Lyness, J. M. (2006). Personality and Perceived Health in Older Adults: The Five Factor Model in Primary Care. *The Journals of Gerontology: Series B*, *61*(6), P362-P365. https://doi.org/10.1093/geronb/61.6.P362

Charles, S. T. (2010). Strength and Vulnerability Integration (SAVI): A Model of Emotional Well-Being Across Adulthood. *Psychological bulletin*, *136*(6), 1068-1091. https://doi.org/10.1037/a0021232

Charles, S. T., & Carstensen, L. L. (2007). Emotion Regulation and Aging. In *Handbook of emotion regulation.* (pp. 307-327). The Guilford Press.

Charles, S. T., & Carstensen, L. L. (2010). Social and Emotional Aging. *Annual Review of Psychology*, *61*(Volume 61, 2010), 383-409. https://doi.org/10.1146/annurev.psych.093008.100448

Charles, S. T., & Luong, G. (2013). Emotional experience across adulthood: The theoretical model of strength and vulnerability integration. *Current Directions in Psychological Science*, *22*(6), 443-448. https://doi.org/10.1177/0963721413497013

Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General*, *132*(2), 310-324. https://doi.org/10.1037/0096-3445.132.2.310

Charles, S. T., Reynolds, C. A., & Gatz, M. (2001). Age-related differences and change in positive and negative affect over 23 years. *J Pers Soc Psychol*, *80*(1), 136-151. https://doi.org/10.1037/0022-3514.80.1.136

Cheng, S. T., Fung, H., & Chan, A. (2007). Maintaining Self-Rated Health Through Social Comparison in Old Age. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *62*(5), P277-P285. https://doi.org/10.1093/geronb/62.5.P277

Chipperfield, J. G. (1993). Incongruence between Health Perceptions and Health Problems:Implications for Survival among Seniors. *Journal of Aging and Health*, *5*(4), 475-496. https://doi.org/10.1177/089826439300500404

Cohen-Mansfield, J., Skornick-Bouchbinder, M., & Brill, S. (2017). Trajectories of End of Life: A Systematic Review. *The Journals of Gerontology: Series B*, *73*(4), 564-572. https://doi.org/10.1093/geronb/gbx093

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences, 3rd ed*. Lawrence Erlbaum Associates Publishers. https://psycnet.apa.org/record/2002-18109-000

Conradsson, M., Rosendahl, E., Littbrand, H., Gustafson, Y., Olofsson, B., & Lovheim, H. (2013). Usefulness of the Geriatric Depression Scale 15-item version among very old people with and without cognitive impairment. *Aging & Mental Health*, *17*(5), 638-645. https://doi.org/10.1080/13607863.2012.758231

Cronin-Golomb, A. (2011). Visuospatial Function in Alzheimer's Disease and Related Disorders. In *The Handbook of Alzheimer's Disease and Other Dementias* (pp. 457-482). https://doi.org/10.1002/9781444344110.ch15

DeTure, M. A., & Dickson, D. W. (2019). The neuropathological diagnosis of Alzheimer's disease. *Molecular Neurodegeneration, 14*(1), 32. https://doi.org/10.1186/s13024-019-0333-5

Diegelmann, M., Schilling, O. K., & Wahl, H.-W. (2016). Feeling blue at the end of life: Trajectories of depressive symptoms from a distance-to-death perspective. *Psychology and Aging, 31 7*, 672-686.

Djernes, J. K. (2006). Prevalence and predictors of depression in populations of elderly: a review. *Acta Psychiatr Scand, 113*(5), 372-387. https://doi.org/10.1111/j.1600-0447.2006.00770.x

Duberstein, P. R., Sörensen, S., Lyness, J. M., King, D. A., Conwell, Y., Seidlitz, L., & Caine, E. D. (2003). Personality is associated with perceived health and functional status in older primary care patients. *Psychology and Aging, 18*(1), 25-37. https://doi.org/10.1037/0882-7974.18.1.25

Dunne, E., Wrosch, C., & Miller, G. E. (2011). Goal disengagement, functional disability, and depressive symptoms in old age. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association, 30*(6), 763-770. https://doi.org/10.1037/a0024019

Ehlenbach, W. J., Hough, C. L., Crane, P. K., Haneuse, S. J., Carson, S. S., Curtis, J. R., & Larson, E. B. (2010). Association between acute care and critical illness hospitalization and cognitive function in older adults. *JAMA, 303*(8), 763-770. https://doi.org/10.1001/jama.2010.167

Ericsson, K., Forssell, L., Amberla, K., Holmén, K., Viitanen, M., & Winblad, B. (1991). Graphic skills used as an instrument for detecting higher cortical dysfunctions in old age. *Human Movement Science, 10*(2), 335-349. https://doi.org/10.1016/0167-9457(91)90011-L

Ericsson, K., Forssell, L. G., Holmén, K., Viitanen, M., & Winblad, B. (1996). Copying and handwriting ability in the screening of cognitive dysfunction in old age. *Archives of Gerontology and Geriatrics, 22*(2), 103-121. https://doi.org/10.1016/0167-4943(95)00685-0

Evans, D. L., Charney, D. S., Lewis, L., Golden, R. N., Gorman, J. M., Krishnan, K. R., Nemeroff, C. B., Bremner, J. D., Carney, R. M., Coyne, J. C., Delong, M. R., Frasure-Smith, N., Glassman, A. H., Gold, P. W., Grant, I., Gwyther, L., Ironson, G., Johnson, R. L., Kanner, A. M.,…Valvo, W. J. (2005). Mood

disorders in the medically ill: scientific review and recommendations. *Biol Psychiatry*, *58*(3), 175-189. https://doi.org/10.1016/j.biopsych.2005.05.001

Fiske, A., Wetherell, J. L., & Gatz, M. (2009). Depression in older adults. *Annu Rev Clin Psychol*, *5*(1), 363-389. https://doi.org/10.1146/annurev.clinpsy.032408.153621

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*, *12*(3), 189-198. https://doi.org/10.1016/0022-3956(75)90026-6

Forsell, Y., & Winblad, B. (1999). Incidence of major depression in a very elderly population. *International Journal of Geriatric Psychiatry*, *14*(5), 368-372. https://doi.org/10.1002/(sici)1099-1166(199905)14:5<368::Aid-gps919>3.0.Co;2-y

Franceschi, C., Garagnani, P., Morsiani, C., Conte, M., Santoro, A., Grignolio, A., Monti, D., Capri, M., & Salvioli, S. (2018). The Continuum of Aging and Age-Related Diseases: Common Mechanisms but Different Rates [Review]. *Frontiers in Medicine*, *5*. https://doi.org/10.3389/fmed.2018.00061

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology. The broaden-and-build theory of positive emotions. *Am Psychol*, *56*(3), 218-226. https://doi.org/10.1037//0003-066x.56.3.218

French, D. J., Sargent-Cox, K., & Luszcz, M. A. (2012). Correlates of Subjective Health Across the Aging Lifespan:Understanding Self-Rated Health in the Oldest Old. *Journal of Aging and Health*, *24*(8), 1449-1469. https://doi.org/10.1177/0898264312461151

Freund, A. M. (2008). Successful Aging as Management of Resources: The Role of Selection, Optimization, and Compensation. *Research in Human Development*, *5*(2), 94-106. https://doi.org/10.1080/15427600802034827

Frieswijk, N., Buunk, B. P., Steverink, N., & Slaets, J. P. (2004). The effect of social comparison information on the life satisfaction of frail older persons. *Psychology and Aging*, *19*(1), 183-190. https://doi.org/10.1037/0882-7974.19.1.183

Fukuhara, S., & Suzukamo, Y. (2004). *Manual of the SF-8 Japanese version*. Institute for Health Outcomes & Process Evaluation Research.

Gaestel, Y., Amieva, H., Letenneur, L., Dartigues, J.-F., & Fabrigoule, C. (2005). Cube Drawing Performances in Normal Ageing and Alzheimer's Disease: Data from the PAQUID Elderly Population-Based Cohort. *Dementia and Geriatric Cognitive Disorders*, *21*(1), 22-32. https://doi.org/10.1159/000089216

Gainotti, G., Quaranta, D., Vita, M. G., & Marra, C. (2014). Neuropsychological Predictors of Conversion from Mild Cognitive Impairment to Alzheimer's Disease. *Journal of Alzheimer's Disease*, *38*, 481-495. https://doi.org/10.3233/JAD-130881

Gauthier, S., Reisberg, B., Zaudig, M., Petersen, R. C., Ritchie, K., Broich, K., Belleville, S., Brodaty, H., Bennett, D., Chertkow, H., Cummings, J. L., de Leon, M., Feldman, H., Ganguli, M., Hampel, H., Scheltens, P., Tierney, M. C., Whitehouse, P., Winblad, B., & International Psychogeriatric Association Expert Conference on mild cognitive, i. (2006). Mild cognitive impairment. *Lancet*, *367*(9518), 1262-1270. https://doi.org/10.1016/S0140-6736(06)68542-5

Gerstorf, D., Ram, N., Estabrook, R., Schupp, J., Wagner, G. G., & Lindenberger, U. (2008a). Life satisfaction shows terminal decline in old age: longitudinal evidence from the German Socio-Economic Panel Study (SOEP). *Dev Psychol*, *44*(4), 1148-1159. https://doi.org/10.1037/0012-1649.44.4.1148

Gerstorf, D., Ram, N., Estabrook, R., Schupp, J., Wagner, G. G., & Lindenberger, U. (2008b). Life satisfaction shows terminal decline in old age: Longitudinal evidence from the German Socio-Economic Panel Study (SOEP). *Developmental Psychology*, *44*(4), 1148-1159. https://doi.org/10.1037/0012-1649.44.4.1148

Gerstorf, D., Ram, N., Lindenberger, U., & Smith, J. (2013). Age and time-to-death trajectories of change in indicators of cognitive, sensory, physical, health, social, and self-related functions. *Dev Psychol*, *49*(10), 1805-1821. https://doi.org/10.1037/a0031340

Gerstorf, D., Ram, N., Mayraz, G., Hidajat, M., Lindenberger, U., Wagner, G. G., & Schupp, J. (2010). Late-life decline in well-being across adulthood in Germany, the United Kingdom, and the United States: Something is seriously wrong at the end of life. *Psychology and Aging*, *25*(2), 477-485. https://doi.org/10.1037/a0017543

Gerstorf, D., Ram, N., Rocke, C., Lindenberger, U., & Smith, J. (2008). Decline in life satisfaction in old age: longitudinal evidence for links to distance-to-death. *Psychology and Aging*, *23*(1), 154-168. https://doi.org/10.1037/0882-7974.23.1.154

Gibbons, F. X. (1999). Social comparison as a mediator of response shift. *Social Science & Medicine*, *48*(11), 1517-1530. https://doi.org/10.1016/S0277-9536(99)00046-5

Gibbons, F. X., & Gerrard, M. (1991). Downward comparison and coping with threat. In *Social comparison: Contemporary theory and research* (pp. 317-345).

Lawrence Erlbaum Associates, Inc. https://psycnet.apa.org/record/1991-97036-012

Gondo, Y., Nakagawa, T., & Masui, Y. (2013). A new concept of successful aging in the oldest old: Development of gerotranscendence and its influence on the psychological well-being. In *Annual review of gerontology and geriatrics, Vol 33: Healthy longevity: A global approach* (pp. 109-132). Springer Publishing Company. https://psycnet.apa.org/record/2013-41254-006

Gross, J. J., & Levenson, R. W. (1997). Hiding feelings: The acute effects of inhibiting negative and positive emotion. *Journal of Abnormal Psychology*, *106*(1), 95-103. https://doi.org/10.1037/0021-843X.106.1.95

Guyer, J. J., & Vaughan-Johnston, T. I. (2018). Social Comparisons (Upward and Downward). In V. Zeigler-Hill & T. K. Shackelford (Eds.), *Encyclopedia of Personality and Individual Differences* (pp. 1-5). Springer International Publishing. https://doi.org/10.1007/978-3-319-28099-8_1912-1

Hansen, L., Salmon, D., Galasko, D., Masliah, E., Katzman, R., DeTeresa, R., Thal, L., Pay, M. M., Hofstetter, R., Klauber, M., Rice, V., Butters, N., & Alford, M. (1990). The Lewy body variant of Alzheimer's disease. *Neurology*, *40*(1), 1-1. https://doi.org/doi:10.1212/WNL.40.1.1

Hart, S. L., & Charles, S. T. (2013). Age-related patterns in negative affect and appraisals about colorectal cancer over time. *Health Psychology*, *32*(3), 302-310. https://doi.org/10.1037/a0028523

Heckhausen, J. (1997). Developmental regulation across adulthood: primary and secondary control of age-related challenges. *Dev Psychol*, *33*(1), 176-187. https://doi.org/10.1037//0012-1649.33.1.176

Heckhausen, J., Dixon, R. A., & Baltes, P. B. (1989). Gains and losses in development throughout adulthood as perceived by different adult age groups. *Developmental Psychology*, *25*(1), 109-121. https://doi.org/10.1037/0012-1649.25.1.109

Heckhausen, J., & Krueger, J. (1993). Developmental expectations for the self and most other people: Age grading in three functions of social comparison. *Developmental Psychology*, *29*(3), 539-548. https://doi.org/10.1037/0012-1649.29.3.539

Heckhausen, J., & Schulz, R. (1993). Optimisation by Selection and Compensation: Balancing Primary and Secondary Control in Life Span Development. *International Journal of Behavioral Development*, *16*(2), 287-303. https://doi.org/10.1177/016502549301600210

Heckhausen, J., & Schulz, R. (1995). A life-span theory of control. *Psychological Review*, *102*(2), 284-304. https://doi.org/10.1037/0033-295x.102.2.284

Heckhausen, J., Wrosch, C., & Schulz, R. (2010). A motivational theory of life-span development. *Psychological Review*, *117*(1), 32-60. https://doi.org/10.1037/a0017668

Henchoz, K., Cavalli, S., & Girardin, M. (2008). Health perception and health status in advanced old age: A paradox of association. *Journal of Aging Studies*, *22*(3), 282-290. https://doi.org/10.1016/j.jaging.2007.03.002

Hoeymans, N., Feskens, E. J., van den Bos, G. A., & Kromhout, D. (1997). Age, time, and cohort effects on functional status and self-rated health in elderly men. *American Journal of Public Health*, *87*(10), 1620-1625. https://doi.org/10.2105/ajph.87.10.1620

Idler, E. L. (1993). Age differences in self-assessments of health: age changes, cohort differences, or survivorship? *Journal of Gerontology*, *48*(6), S289-300. https://doi.org/10.1093/geronj/48.6.s289

Idler, E. L., & Benyamini, Y. (1997). Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies. *Journal of Health and Social Behavior*, *38*(1), 21-37. https://doi.org/10.2307/2955359

Idler, E. L., Hudson, S. V., & Leventhal, H. (1999). The Meanings of Self-Ratings of Health:A Qualitative and Quantitative Approach. *Research on Aging*, *21*(3), 458-476. https://doi.org/10.1177/0164027599213006

Idler, E. L., & Kasl, S. V. (1995). Self-Ratings of Health: Do they also Predict change in Functional Ability? *The Journals of Gerontology: Series B*, *50B*(6), S344-S353. https://doi.org/10.1093/geronb/50B.6.S344

Idler, E. L., Kasl, S. V., & Lemke, J. H. (1990). Self-evaluated health and mortality among the elderly in New Haven, Connecticut, and Iowa and Washington counties, Iowa, 1982-1986. *Am J Epidemiol*, *131*(1), 91-103. https://doi.org/10.1093/oxfordjournals.aje.a115489

Isaacowitz, D. M. (2022). What Do We Know About Aging and Emotion Regulation? *Perspectives on Psychological Science*, *17*(6), 1541-1555. https://doi.org/10.1177/17456916211059819

Isaacowitz, D. M., & Blanchard-Fields, F. (2012). Linking Process and Outcome in the Study of Emotion and Aging. *Perspectives on Psychological Science*, *7*(1), 3-17. https://doi.org/10.1177/1745691611424750

Isaacowitz, D. M., & Riediger, M. (2011). When age matters: Developmental perspectives on “cognition and emotion” [Article]. *Cogn Emot*, *25*(6), 957-967. https://doi.org/10.1080/02699931.2011.561575

Jack Jr., C. R., Bennett, D. A., Blennow, K., Carrillo, M. C., Dunn, B., Haeberlein, S. B., Holtzman, D. M., Jagust, W., Jessen, F., Karlawish, J., Liu, E., Molinuevo, J.

L., Montine, T., Phelps, C., Rankin, K. P., Rowe, C. C., Scheltens, P., Siemers, E., Snyder, H. M.,…Silverberg, N. (2018). NIA-AA Research Framework: Toward a biological definition of Alzheimer's disease. *Alzheimer's & Dementia*, *14*(4), 535-562. https://doi.org/https://doi.org/10.1016/j.jalz.2018.02.018

Javeed, A., Dallora, A. L., Berglund, J. S., Ali, A., Ali, L., & Anderberg, P. (2023). Machine Learning for Dementia Prediction: A Systematic Review and Future Research Directions. *Journal of Medical Systems*, *47*(1), 1-25. https://doi.org/10.1007/s10916-023-01906-7

Jessen, F. (2014). Subjective and objective cognitive decline at the pre-dementia stage of Alzheimer's disease. *European Archives of Psychiatry and Clinical Neuroscience*, *264*(1), 3-7. https://doi.org/10.1007/s00406-014-0539-z

Jessen, F., Wiese, B., Bachmann, C., Eifflaender-Gorfer, S., Haller, F., Kolsch, H., Luck, T., Mosch, E., van den Bussche, H., Wagner, M., Wollny, A., Zimmermann, T., Pentzek, M., Riedel-Heller, S. G., Romberg, H. P., Weyerer, S., Kaduszkiewicz, H., Maier, W., Bickel, H., Dementia in Primary Care Patients Study, G. (2010). Prediction of dementia by subjective memory impairment: effects of severity and temporal association with cognitive impairment. *Archives of General Psychiatry*, *67*(4), 414-422. https://doi.org/10.1001/archgenpsychiatry.2010.30

Johnson, D. K., Storandt, M., Morris, J. C., & Galvin, J. E. (2009). Longitudinal Study of the Transition From Healthy Aging to Alzheimer Disease. *Archives of Neurology*, *66*(10), 1254-1259. https://doi.org/10.1001/archneurol.2009.158

Jopp, D., & Rott, C. (2006). Adaptation in very old age: exploring the role of resources, beliefs, and attitudes for centenarians' happiness. *Psychology and Aging*, *21*(2), 266-280. https://doi.org/10.1037/0882-7974.21.2.266

Jopp, D. S., Park, M.-K. S., Lehrfeld, J., & Paggi, M. E. (2016). Physical, cognitive, social and mental health in near-centenarians and centenarians living in New York City: findings from the Fordham Centenarian Study. *BMC Geriatrics*, *16*(1), 1. https://doi.org/10.1186/s12877-015-0167-0

Jylhä, M. (2009). What is self-rated health and why does it predict mortality? Towards a unified conceptual model. *Social Science & Medicine*, *69*(3), 307-316. https://doi.org/10.1016/j.socscimed.2009.05.013

Karantzoulis, S., & Galvin, J. E. (2011). Distinguishing Alzheimer's disease from other major forms of dementia. *Expert Review of Neurotherapeutics*, *11*(11), 1579-1591. https://doi.org/10.1586/ern.11.155

Karr, J. E., Graham, R. B., Hofer, S. M., & Muniz-Terrera, G. (2018). When does cognitive decline begin? A systematic review of change point studies on

accelerated decline in cognitive and neurological outcomes preceding mild cognitive impairment, dementia, and death. *Psychology and Aging*, *33*(2), 195-218. https://doi.org/10.1037/pag0000236

Katon, W., Lin, E. H., & Kroenke, K. (2007). The association of depression and anxiety with medical symptom burden in patients with chronic medical illness. *Gen Hosp Psychiatry*, *29*(2), 147-155. https://doi.org/10.1016/j.genhosppsych.2006.11.005

Kessler, E.-M., Bowen, C. E., Baer, M., Froelich, L., & Wahl, H.-W. (2012). Dementia worry: a psychological examination of an unexplored phenomenon. *European Journal of Ageing*, *9*(4), 275-284. https://doi.org/10.1007/s10433-012-0242-8

Kim, E. S., Hagan, K. A., Grodstein, F., DeMeo, D. L., De Vivo, I., & Kubzansky, L. D. (2017). Optimism and Cause-Specific Mortality: A Prospective Cohort Study. *Am J Epidemiol*, *185*(1), 21-29. https://doi.org/10.1093/aje/kww182

Kivinen, P., Halonen, P., Eronen, M., & Nissinen, A. (1998). Self-rated health, physician-rated health and associated factors among elderly men: the Finnish cohorts of the Seven Countries Study. *Age Ageing*, *27*(1), 41-47. https://doi.org/10.1093/ageing/27.1.41

Knopman, D. S., Mastri, A. R., Frey, W. H., Sung, J. H., & Rustan, T. (1990). Dementia lacking distinctive histologie features. *Neurology*, *40*(2), 251-251. https://doi.org/doi:10.1212/WNL.40.2.251

Koenig, H. G., Meador, K. G., Cohen, H. J., & Blazer, D. G. (1988). Depression in elderly hospitalized patients with medical illness. *Archives of Internal Medicine*, *148*(9), 1929-1936. http://www.ncbi.nlm.nih.gov/pubmed/3415405

Koepsell, T. D., & Monsell, S. E. (2012). Reversion from mild cognitive impairment to normal or near-normal cognition. *Risk factors and prognosis*, *79*(15), 1591-1598. https://doi.org/10.1212/WNL.0b013e31826e26b7

Kunzmann, U., Little, T. D., & Smith, J. (2000). Is age-related stability of subjective well-being a paradox? Cross-sectional and longitudinal evidence from the Berlin Aging Study. *Psychology and Aging*, *15*(3), 511-526. https://doi.org/10.1037//0882-7974.15.3.511

Leinonen, R., Heikkinen, E., & Jylhä, M. (2002). Changes in health, functional performance and activity predict changes in self-related health: A 10-year follow-up study in older people. *Archives of Gerontology and Geriatrics*, *35*(1), 79-92. https://doi.org/10.1016/S0167-4943(02)00017-1

Lenze, E. J., Rogers, J. C., Martire, L. M., Mulsant, B. H., Rollman, B. L., Dew, M. A., Schulz, R., & Reynolds, C. F., 3rd. (2001). The association of late-life depression and anxiety with physical disability: a review of the literature and

prospectus for future research. *Am J Geriatr Psychiatry*, *9*(2), 113-135. https://doi.org/10.1097/00019442-200105000-00004

Levkoff, S. E., Cleary, P. D., & Wetle, T. (1987). Differences in the appraisal of health between aged and middle-aged adults. *Journal of Gerontology*, *42*(1), 114-120. https://doi.org/10.1093/geronj/42.1.114

Levy, B. R. (2003). Mind matters: cognitive and physical effects of aging self-stereotypes. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *58*(4), P203-211. https://doi.org/10.1093/geronb/58.4.p203

Liu, M., Sonoda, S., & Domen, K. (1997). Stroke Impairment Assessment Set (SIAS) and Functional Independence Measure (FIM) and their practical use. In: Chino N, ed. Functional Assessment of Stroke Patients: Practical Aspects of SIAS and FIM. Tokyo. In *In: Chino N, ed. Functional Assessment of Stroke Patients: Practical Aspects of SIAS and FIM* (pp. 17-139). SplingerVerlag.

Lunney, J. R., Lynn, J., Foley, D. J., Lipson, S., & Guralnik, J. M. (2003). Patterns of Functional Decline at the End of Life. *JAMA*, *289*(18), 2387-2392. https://doi.org/10.1001/jama.289.18.2387

Maddox, G. L., & Douglass, E. B. (1973). Self-assessment of health: a longitudinal study of elderly subjects. *J Health Soc Behav*, *14*(1), 87-93. https://doi.org/10.2307/2136940

Maddox, G. L., & Douglass, E. B. (1973). Self-Assessment of Health: A Longitudinal Study of Elderly Subjects. *Journal of Health and Social Behavior*, *14*(1), 87-93. https://doi.org/10.2307/2136940

Mather, M. (2012). The emotion paradox in the aging brain. *Annals of the New York Academy of Sciences*, *1251*(1), 33-49. https://doi.org/10.1111/j.1749-6632.2012.06471.x

Mather, M. (2016). The Affective Neuroscience of Aging. *Annu Rev Psychol*, *67*(1), 213-238. https://doi.org/10.1146/annurev-psych-122414-033540

Mather, M., Canli, T., English, T., Whitfield, S., Wais, P., Ochsner, K., John, D. E. G., & Carstensen, L. L. (2004). Amygdala Responses to Emotionally Valenced Stimuli in Older and Younger Adults. *Psychological Science*, *15*(4), 259-263. https://doi.org/10.1111/j.0956-7976.2004.00662.x

Mather, M., & Carstensen, L. L. (2003). Aging and Attentional Biases for Emotional Faces. *Psychological Science*, *14*(5), 409-415. https://doi.org/10.1111/1467-9280.01455

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: the positivity effect in attention and memory. *Trends Cogn Sci*, *9*(10), 496-502. https://doi.org/10.1016/j.tics.2005.08.005

Mather, M., & Knight, M. (2005). Goal-directed memory: the role of cognitive control in older adults' emotional memory. *Psychology and Aging*, *20*(4), 554-570. https://doi.org/10.1037/0882-7974.20.4.554

Mathew, R., Renjith, N., & Mathuranath, P. S. (2018). A new scoring system and norms for, and the performance of cognitively-unimpaired older adults on the cube copying test. *Neurology India*, *66*(6), 1644-1648. https://doi.org/10.4103/0028-3886.246242

McKeith, I. G., Dickson, D. W., Lowe, J., Emre, M., O'Brien, J. T., Feldman, H., Cummings, J., Duda, J. E., Lippa, C., Perry, E. K., Aarsland, D., Arai, H., Ballard, C. G., Boeve, B., Burn, D. J., Costa, D., Del Ser, T., Dubois, B., Galasko, D.,…Yamada, M. (2005). Diagnosis and management of dementia with Lewy bodies. *Neurology*, *65*(12), 1863-1872. https://doi.org/doi:10.1212/01.wnl.0000187889.17253.b1

McKhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D., & Stadlan, E. M. (1984). Clinical diagnosis of Alzheimer's disease. *Neurology*, *34*(7), 939-939. https://doi.org/doi:10.1212/WNL.34.7.939

McKhann, G. M., Albert, M. S., Grossman, M., Miller, B., Dickson, D., & Trojanowski, J. Q. (2001). Clinical and Pathological Diagnosis of Frontotemporal Dementia: Report of the Work Group on Frontotemporal Dementia and Pick's Disease. *Archives of Neurology*, *58*(11), 1803-1809. https://doi.org/10.1001/archneur.58.11.1803

Mehlsen, M., Mikkelsen, M. B., Andersen, C. M., & Ollars, C. (2019). Does Aging and Disease Increase the Importance of Cognitive Strategies? Social and Temporal Comparisons in Healthy Younger and Older Adults and in Younger and Older Cancer Patients. *The International Journal of Aging and Human Development*, *88*(1), 60-81. https://doi.org/10.1177/0091415017748366

Mendez, M. F., Mendez, M. A., Martin, R., Smyth, K. A., & Whitehouse, P. J. (1990). Complex visual disturbances in Alzheimer's disease. *Neurology*, *40*(3_part_1), 439-439. https://doi.org/doi:10.1212/WNL.40.3_Part_1.439

Miller, T. R., & Wolinsky, F. D. (2007). Self-Rated Health Trajectories and Mortality Among Older Adults. *The Journals of Gerontology: Series B*, *62*(1), S22-S27. https://doi.org/10.1093/geronb/62.1.S22

Mitchell, A. J., Beaumont, H., Ferguson, D., Yadegarfar, M., & Stubbs, B. (2014). Risk of dementia and mild cognitive impairment in older people with subjective memory complaints: meta-analysis. *Acta Psychiatr Scand*, *130*(6), 439-451. https://doi.org/10.1111/acps.12336

Morese, R., Stanziano, M., & Palermo, S. (2018). Commentary: Metacognition and Perspective-Taking in Alzheimer's Disease: A Mini-Review [General Commentary]. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.02010

Mossey, J. M., & Shapiro, E. (1982). Self-rated health: a predictor of mortality among the elderly. *Am J Public Health*, *72*(8), 800-808. https://doi.org/10.2105/ajph.72.8.800

Mroczek, D. K., & Kolarz, C. M. (1998). The effect of age on positive and negative affect: a developmental perspective on happiness. *J Pers Soc Psychol*, *75*(5), 1333-1349. https://doi.org/10.1037//0022-3514.75.5.1333

Mulsant, B. H., Ganguli, M., & Seaberg, E. C. (1997). The relationship between self-rated health and depressive symptoms in an epidemiological sample of community-dwelling older adults. *J Am Geriatr Soc*, *45*(8), 954-958. https://doi.org/10.1111/j.1532-5415.1997.tb02966.x

Nashiro, K., Sakaki, M., & Mather, M. (2011). Age Differences in Brain Activity during Emotion Processing: Reflections of Age-Related Decline or Increased Emotion Regulation. *Gerontology*, *58*(2), 156-163. https://doi.org/10.1159/000328465

Ostir, G. V., Berges, I. M., Ottenbacher, M. E., Clow, A., & Ottenbacher, K. J. (2008). Associations between positive emotion and recovery of functional status following stroke. *Psychosomatic Medicine*, *70*(4), 404-409. https://doi.org/10.1097/PSY.0b013e31816fd7d0

Ostir, G. V., Markides, K. S., Black, S. A., & Goodwin, J. S. (2000). Emotional well-being predicts subsequent functional independence and survival. *J Am Geriatr Soc*, *48*(5), 473-478. https://doi.org/10.1111/j.1532-5415.2000.tb04991.x

Ostir, G. V., Ottenbacher, K. J., & Markides, K. S. (2004). Onset of frailty in older adults and the protective role of positive affect. *Psychology and Aging*, *19*(3), 402-408. https://doi.org/10.1037/0882-7974.19.3.402

Paganini-Hill, A., & Clark, L. J. (2006). Preliminary Assessment of Cognitive Function in Older Adults by Clock Drawing, Box Copying and Narrative Writing. *Dementia and Geriatric Cognitive Disorders*, *23*(2), 74-81. https://doi.org/10.1159/000097097

Palmqvist, S., Hansson, O., Minthon, L., & Londos, E. (2008). The Usefulness of Cube Copying for Evaluating Treatment of Alzheimer's Disease. *American Journal of Alzheimer's Disease & Other Dementias*, *23*(5), 439-446. https://doi.org/10.1177/1533317508320084

Palmqvist, S., Hansson, O., Minthon, L., & Londos, E. (2009). Practical suggestions on how to differentiate dementia with Lewy bodies from Alzheimer's disease with common cognitive tests. *International Journal of Geriatric Psychiatry, 24*(12), 1405-1412. https://doi.org/10.1002/gps.2277

Pantelaki, E., Maggi, E., & Crotti, D. (2021). Mobility impact and well-being in later life: A multidisciplinary systematic review. *Research in Transportation Economics, 86*, 100975. https://doi.org/10.1016/j.retrec.2020.100975

Parsey, C. M., & Schmitter-Edgecombe, M. (2011). Quantitative and Qualitative Analyses of the Clock Drawing Test in Mild Cognitive Impairment and Alzheimer Disease: Evaluation of a Modified Scoring System. *Journal of geriatric psychiatry and neurology, 24*(2), 108-118. https://doi.org/10.1177/0891988711402349

Paul, C., Ayis, S., & Ebrahim, S. (2007). Disability and psychosocial outcomes in old age. *Journal of Aging and Health, 19*(5), 723-741. https://doi.org/10.1177/0898264307304301

Petersen, R. C. (2004). Mild cognitive impairment as a diagnostic entity. *Journal of Internal Medicine, 256*(3), 183-194. https://doi.org/10.1111/j.1365-2796.2004.01388.x

Petersen, R. C. (2011). Mild Cognitive Impairment. *New England Journal of Medicine, 364*(23), 2227-2234. https://doi.org/doi:10.1056/NEJMcp0910237

Petersen, R. C., Doody, R., Kurz, A., Mohs, R. C., Morris, J. C., Rabins, P. V., Ritchie, K., Rossor, M., Thal, L., & Winblad, B. (2001). Current Concepts in Mild Cognitive Impairment. *Archives of Neurology, 58*(12), 1985-1992. https://doi.org/10.1001/archneur.58.12.1985

Pinquart, M. (2001). Correlates of subjective health in older adults: A meta-analysis. *Psychology and Aging, 16*(3), 414-426. https://doi.org/10.1037/0882-7974.16.3.414

Plugge, M. (2021). Successful ageing in the oldest old: objectively and subjectively measured evidence from a population-based survey in Germany. *Eur J Ageing, 18*(4), 537-547. https://doi.org/10.1007/s10433-021-00609-7

Quental, N. B. M., Brucki, S. M. D., & Bueno, O. F. A. (2009). Visuospatial function in early Alzheimer's disease: Preliminary study. *Dementia & Neuropsychologia, 3*(3), 234-240. https://doi.org/10.1590/s1980-57642009dn30300010

Rabbitt, P., Lunn, M., & Wong, D. (2005). Neglect of Dropout Underestimates Effects of Death in Longitudinal Studies. *The Journals of Gerontology: Series B, 60*(2), P106-P109. https://doi.org/10.1093/geronb/60.2.P106

Rakowski, W., & Cryan, C. D. (1990). Associations among health perceptions and health status within three age groups. *Journal of Aging and Health*, *2*(1), 58-80. https://doi.org/10.1177/089826439000200105

Reed, A. E., Chan, L., & Mikels, J. A. (2014). Meta-analysis of the age-related positivity effect: age differences in preferences for positive over negative information. *Psychology and Aging*, *29*(1), 1-15. https://doi.org/10.1037/a0035194

Reid, L. M., & Maclullich, A. M. (2006). Subjective memory complaints and cognitive impairment in older people. *Dement Geriatr Cogn Disord*, *22*(5-6), 471-485. https://doi.org/10.1159/000096295

Rejc, E., Floreani, M., Taboga, P., Botter, A., Toniolo, L., Cancellara, L., Narici, M., Šimunič, B., Pišot, R., Biolo, G., Passaro, A., Rittweger, J., Reggiani, C., & Lazzer, S. (2018). Loss of maximal explosive power of lower limbs after 2 weeks of disuse and incomplete recovery after retraining in older adults. *The Journal of Physiology*, *596*(4), 647-665. https://doi.org/10.1113/JP274772

Roth, K., Pemula, L., Zepeda, J., Scholkopf, B., Brox, T., Gehler, P., & Ieee Comp, S. O. C. (2022, Jun 18-24). Towards Total Recall in Industrial Anomaly Detection.*IEEE Conference on Computer Vision and Pattern Recognition* [2022 ieee/cvf conference on computer vision and pattern recognition (cvpr)]. IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), New Orleans, LA.

Rothbaum, F., Weisz, J. R., & Snyder, S. S. (1982). Changing the world and changing the self: A two-process model of perceived control. *Journal of Personality and Social Psychology*, *42*(1), 5-37. https://doi.org/10.1037/0022-3514.42.1.5

Rowe, J. W., & Kahn, R. L. (1997). Successful Aging1. *The Gerontologist*, *37*(4), 433-440. https://doi.org/10.1093/geront/37.4.433

Ruengchaijatuporn, N., Chatnuntawech, I., Teerapittayanon, S., Sriswasdi, S., Itthipuripat, S., Hemrungrojn, S., Bunyabukkana, P., Petchlorlian, A., Chunamchai, S., Chotibut, T., & Chunharas, C. (2022). An explainable self-attention deep neural network for detecting mild cognitive impairment using multi-input digital drawing tasks. *Alzheimer's Research & Therapy*, *14*(1), 111. https://doi.org/10.1186/s13195-022-01043-2

Ruthig, J. C., & Chipperfield, J. G. (2007). Health incongruence in later life: Implications for subsequent well-being and health care. *Health Psychology*, *26*(6), 753-761. https://doi.org/10.1037/0278-6133.26.6.753

Salimi, S., Irish, M., Foxe, D., Hodges, J. R., Piguet, O., & Burrell, J. R. (2019). Visuospatial dysfunction in Alzheimer's disease and behavioural variant

frontotemporal dementia. *Journal of the Neurological Sciences*, *402*, 74-80. https://doi.org/10.1016/j.jns.2019.04.019

Salmon, D. P., Galasko, D., Hansen, L. A., Masliah, E., Butters, N., Thal, L. J., & Katzman, R. (1996). Neuropsychological Deficits Associated with Diffuse Lewy Body Disease. *Brain and Cognition*, *31*(2), 148-165. https://doi.org/10.1006/brcg.1996.0039

Samanez-Larkin, G. R., & Carstensen, L. L. (2011). Socioemotional functioning and the aging brain. In *The Oxford handbook of social neuroscience* (pp. 507-521). Oxford University Press. https://psycnet.apa.org/record/2013-01017-034

Scheibe, S., & Carstensen, L. L. (2010). Emotional aging: recent findings and future trends. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *65B*(2), 135-144. https://doi.org/10.1093/geronb/gbp132

Schilling, O. K., Deeg, D. J. H., & Huisman, M. (2018). Affective well-being in the last years of life: The role of health decline. *Psychology and Aging*, *33*(5), 739-753. https://doi.org/10.1037/pag0000279

Schilling, O. K., Wahl, H.-W., Horowitz, A., Reinhardt, J. P., & Boerner, K. (2011). The adaptation dynamics of chronic functional impairment: What we can learn from older adults with vision loss. *Psychology and Aging*, *26*(1), 203-213. https://doi.org/10.1037/a0021127

Schnittker, J. (2005a). Chronic illness and depressive symptoms in late life. *Soc Sci Med*, *60*(1), 13-23. https://doi.org/10.1016/j.socscimed.2004.04.020

Schnittker, J. (2005b). When mental health becomes health: age and the shifting meaning of self-evaluations of general health. *Milbank Q*, *83*(3), 397-423. https://doi.org/10.1111/j.1468-0009.2005.00407.x

Schoenfeld, D. E., Malmrose, L. C., Blazer, D. G., Gold, D. T., & Seeman, T. E. (1994). Self-rated health and mortality in the high-functioning elderly: A closer look at healthy individuals: MacArthur Field Study of Successful Aging. *Journal of Gerontology*, *49*(3), M109-M1115. https://doi.org/10.1093/geronj/49.3.M109

Schulz, R., Heckhausen, J., & Locher, J. L. (1991). Adult Development, Control, and Adaptive Functioning. *Journal of Social Issues*, *47*(4), 177-196. https://doi.org/10.1111/j.1540-4560.1991.tb01841.x

Sevigny, J., Chiao, P., Bussière, T., Weinreb, P. H., Williams, L., Maier, M., Dunstan, R., Salloway, S., Chen, T., Ling, Y., O'Gorman, J., Qian, F., Arastu, M., Li, M., Chollate, S., Brennan, M. S., Quintero-Monzon, O., Scannevin, R. H., Arnold, H. M.,…Sandrock, A. (2016). The antibody aducanumab reduces Aβ plaques in Alzheimer's disease. *Nature*, *537*(7618), 50-56. https://doi.org/10.1038/nature19323

Siegler, I. C. (1975). The terminal drop hypothesis: fact or artifact? *Exp Aging Res, 1*(1), 169-185. https://doi.org/10.1080/03610737508257957

Singer, E., Garfinkel, R., Martin Cohen, S., & Srole, L. (1976). Mortality and mental health: Evidence from the Midtown Manhattan restudy. *Social Science & Medicine (1967), 10*(11), 517-525. https://doi.org/10.1016/0037-7856(76)90019-6

Smith, J., Borchelt, M., Maier, H., & Jopp, D. (2002). Health and Well–Being in the Young Old and Oldest Old. *Journal of Social Issues*, *58*(4), 715-732. https://doi.org/10.1111/1540-4560.00286

Smith, J., Fleeson, W., Geiselmann, B., Settersten Jr, R. A., & Kunzmann, U. (1999). Sources of well-being in very old age. In *The Berlin Aging Study: Aging from 70 to 100.* (pp. 450-471). Cambridge University Press.

Sperling, R. A., Aisen, P. S., Beckett, L. A., Bennett, D. A., Craft, S., Fagan, A. M., Iwatsubo, T., Jack Jr., C. R., Kaye, J., Montine, T. J., Park, D. C., Reiman, E. M., Rowe, C. C., Siemers, E., Stern, Y., Yaffe, K., Carrillo, M. C., Thies, B., Morrison-Bogorad, M.,…Phelps, C. H. (2011). Toward defining the preclinical stages of Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia, 7*(3), 280-292. https://doi.org/10.1016/j.jalz.2011.03.003

Sprangers, M. A. G., & Schwartz, C. E. (1999). Integrating response shift into health-related quality of life research: a theoretical model. *Social Science & Medicine, 48*(11), 1507-1515. https://doi.org/10.1016/S0277-9536(99)00045-3

Staios, M., Nielsen, T. R., Kosmidis, M. H., Papadopoulos, A., Kokkinias, A., Velakoulis, D., Tsiaras, Y., March, E., & Stolwyk, R. J. (2022). Validity of Visuoconstructional Assessment Methods within Healthy Elderly Greek Australians: Quantitative and Error Analysis. *Archives of Clinical Neuropsychology*, *38*(4), 598-607. https://doi.org/10.1093/arclin/acac091

Stenback, A. (1964). Physical Health and Physical Disease as Objective Fact and Subjective Experience. *Archives of General Psychiatry, 11*(3), 290-301. https://doi.org/10.1001/archpsyc.1964.01720270062008

Steptoe, A., Deaton, A., & Stone, A. A. (2015). Subjective wellbeing, health, and ageing. *Lancet*, *385*(9968), 640-648. https://doi.org/10.1016/S0140-6736(13)61489-0

Steward, K. A., Kennedy, R., Erus, G., Nasrallah, I. M., & Wadley, V. G. (2019). Poor awareness of IADL deficits is associated with reduced regional brain volume in

older adults with cognitive impairment. *Neuropsychologia*, *129*, 372-378. https://doi.org/10.1016/j.neuropsychologia.2019.04.023

Stolz, E., Mayerl, H., Hoogendijk, E. O., Armstrong, J. J., Roller-Wirnsberger, R., & Freidl, W. (2021). Acceleration of health deficit accumulation in late-life: evidence of terminal decline in frailty index three years before death in the US Health and Retirement Study. *Annals of Epidemiology*, *58*, 156-161. https://doi.org/10.1016/j.annepidem.2021.03.008

Sunderaraman, P., & Cosentino, S. (2017). Integrating the Constructs of Anosognosia and Metacognition: a Review of Recent Findings in Dementia. *Current neurology and neuroscience reports*, *17*(3), 27. https://doi.org/10.1007/s11910-017-0734-1

Suzuki, H., & Fujiwara, Y. (2010). *Instruction manual of Japanese version of Montreal Cognitive Assessment (MoCA-J)*. Retrieved June 4, 2024 from https://s50b45448262f1812.jimcontent.com/download/version/1558490455/module/11363501891/name/MoCA-Instructions-Japanese_2010.pdf

Taylor, S. E. (1983). Adjustment to threatening events: A theory of cognitive adaptation. *American Psychologist*, *38*(11), 1161-1173. https://doi.org/10.1037/0003-066x.38.11.1161

Taylor, S. E. (1991). Asymmetrical effects of positive and negative events: The mobilization-minimization hypothesis. *Psychological bulletin*, *110*(1), 67-85. https://doi.org/10.1037/0033-2909.110.1.67

Taylor, S. E., & Brown, J. D. (1988). Illusion and well-being: a social psychological perspective on mental health. *Psychological bulletin*, *103*(2), 193-210. https://doi.org/10.1037/0033-2909.103.2.193

Taylor, S. E., & Lobel, M. (1989). Social comparison activity under threat: Downward evaluation and upward contacts. *Psychological Review*, *96*(4), 569-575. https://doi.org/10.1037/0033-295X.96.4.569

Tornstam, L. (1975). Health and Self-Perception: A Systems Theoretical Approach. *The Gerontologist*, *15*(3), 264-270. https://doi.org/10.1093/geront/15.3.264

Tornstam, L. (1989). Gero-transcendence: A reformulation of the disengagement theory. *Aging Clinical and Experimental Research*, *1*(1), 55-63. https://doi.org/10.1007/BF03323876

Tornstam, L. (1997). Gerotranscendence: The contemplative dimension of aging. *Journal of Aging Studies*, *11*(2), 143-154. https://doi.org/10.1016/S0890-4065(97)90018-9

Trojano, L., & Gainotti, G. (2016). Drawing Disorders in Alzheimer's Disease and Other Forms of Dementia. *Journal of Alzheimer's Disease, 53*, 31-52. https://doi.org/10.3233/JAD-160009

Tsuji, T., Sonoda, S., Domen, K., Saitoh, E., Liu, M., & Chino, N. (1995). ADL structure for stroke patients in Japan based on the functional independence measure. *American Journal of Physical Medicine & Rehabilitation, 74*(6), 432-438. https://doi.org/10.1097/00002060-199511000-00007

Tully-Wilson, C., Bojack, R., Millear, P. M., Stallman, H. M., Allen, A., & Mason, J. (2021). Self-perceptions of aging: A systematic review of longitudinal studies. *Psychology and Aging*, *36*(7), 773-789. https://doi.org/10.1037/pag0000638

Turner, R. J., & McLean, P. D. (1989). Physical disability and psychological distress. *Rehabilitation Psychology*, *34*(4), 225-242. https://doi.org/10.1037/h0091727

Turner, R. J., & Noh, S. (1988). Physical disability and depression: a longitudinal analysis. *J Health Soc Behav, 29*(1), 23-37. https://doi.org/10.2307/2137178

Urry, H. L., & Gross, J. J. (2010). Emotion Regulation in Older Age. *Current Directions in Psychological Science*, *19*(6), 352-357. https://doi.org/10.1177/0963721410388395

Vaish, A., Grossmann, T., & Woodward, A. (2008). Not all emotions are created equal: the negativity bias in social-emotional development. *Psychological bulletin*, *134*(3), 383-403. https://doi.org/10.1037/0033-2909.134.3.383

Verbrugge, L. M., & Jette, A. M. (1994). The disablement process. *Soc Sci Med, 38*(1), 1-14. https://doi.org/10.1016/0277-9536(94)90294-1

von Faber, M., Bootsma-van der Wiel, A., van Exel, E., Gussekloo, J., Lagaay, A. M., van Dongen, E., Knook, D. L., van der Geest, S., & Westendorp, R. G. (2001). Successful aging in the oldest old: Who can be characterized as successfully aged? *Archives of Internal Medicine*, *161*(22), 2694-2700. https://doi.org/10.1001/archinte.161.22.2694

Wang, L., Larson, E. B., Bowen, J. D., & van Belle, G. (2006). Performance-Based Physical Function and Future Dementia in Older People. *Archives of Internal Medicine, 166*(10), 1115-1120. https://doi.org/10.1001/archinte.166.10.1115

Weintraub, S., Wicklund, A. H., & Salmon, D. P. (2012). The Neuropsychological Profile of Alzheimer Disease. *Cold Spring Harbor Perspectives in Medicine, 2*(4). https://doi.org/10.1101/cshperspect.a006171

Wettstein, M., Schilling, O. K., Reidick, O., & Wahl, H.-W. (2015). Four-year stability, change, and multidirectionality of well-being in very-old age. *Psychology and Aging, 30*(3), 500-516. https://doi.org/10.1037/pag0000037

Wilcox, V. L., Kasl, S. V., & Idler, E. L. (1996). Self-Rated Health and Physical Disability in Elderly Survivors of a Major Medical Event. *The Journals of Gerontology: Series B, 51B*(2), S96-S104. https://doi.org/10.1093/geronb/51B.2.S96

Wood, J. V. (1989). Theory and research concerning social comparisons of personal attributes. *Psychological bulletin*, *106*(2), 231-248. https://doi.org/10.1037/0033-2909.106.2.231

Wood, J. V., Taylor, S. E., & Lichtman, R. R. (1985). Social comparison in adjustment to breast cancer. *Journal of Personality and Social Psychology*, *49*(5), 1169-1183. https://doi.org/10.1037//0022-3514.49.5.1169

Wrosch, C., Heckhausen, J., & Lachman, M. E. (2000). Primary and secondary control strategies for managing health and financial stress across adulthood. *Psychology and Aging*, *15*(3), 387-399. https://doi.org/10.1037//0882-7974.15.3.387

Wurm, S., Tomasik, M. J., & Tesch-Römer, C. (2008). Serious health events and their impact on changes in subjective health and life satisfaction: the role of age and a positive view on ageing. *European Journal of Ageing*, *5*(2), 117-127. https://doi.org/10.1007/s10433-008-0077-5

Yamada, Y., Kobayashi, M., Shinkawa, K., Nemoto, M., Ota, M., Nemoto, K., & Arai, T. (2022). Characteristics of drawing process differentiate Alzheimer's disease and dementia with Lewy bodies. *Journal of Alzheimer's Disease*, *90*(2), 693-704. https://doi.org/10.3233/JAD-220546

Yesavage, J. A., & Sheikh, J. I. (2008). 9/Geriatric Depression Scale (GDS). *Clinical Gerontologist*, *5*(1-2), 165-173. https://doi.org/10.1300/J018v05n01_09

Appendix

入院前状態

社会的スタイルとライフスタイルの評価

患者様についてご記入ください。

以下のそれぞれの設問に対して、6～0のうち、あてはまる数字を○で囲んで下さい。

Ⅰ 社会的背景

(1)結婚されていますか
- 3. 結婚し配偶者も健在
- 2. 死別した
- 1. 離婚した
- 0. 未婚

(2)同居していますか
- 3. 子供または親と同居
- 2. 配偶者と二人暮らし
- 1. 独り暮らし
- 0. その他(兄弟姉妹、孫、親類、他人)

(3)経済状況を教えてください
- 3. 子供や他人に援助するくらい余裕がある
- 2. 自分たちの生活だけは困らない
- 1. 一部援助が必要
- 0. 全面的援助が必要

(4)職業は何をされていましたか　(　　)

(5)現在利用されているものはどれですか
- 6. なし
- 5. グループホームの利用
- 4. 老人保健施設等への入所
- 3. ショートステイ　頻度 (　　)
- 2. デイケア　　回／週
- 1. デイサービス　　回／週
- 0. ホームヘルパー　回／週　1回　時間程度

Ⅱ ライフスタイル

(1)仕事、農作業などをしていますか
- 3. 毎日する
- 2. 週に1回程度する
- 1. かなりの介助がいる
- 0. まったくしない

(2)散歩・運動などをしていますか
- 3. 毎日する
- 2. 週に1回程度する
- 1. かなりの介助がいる
- 0. まったくしない

(3)老人クラブなどの社会活動に参加しますか
- 3. 積極的に参加
- 2. ときどき参加
- 1. ほとんど参加しない
- 0. まったく参加しない

(4)お酒を飲みますか
- 3. 飲まない
- 2. ときどき飲む
- 1. ほぼ毎日(2合以内／日)
- 0. 1日3合以上

(5)たばこを吸いますか
- 3. 吸わない
- 2. 過去に吸っていた
- 1. 吸う(20本／日まで)
- 0. 1日20本以上吸う

(6)医師から薬をもらっていますか
- 3. もらっていない
- 2. ごくたまにもらう
- 1. もらうがときどきしか飲まない
- 0. 毎日服用

(7)夜よく眠れますか
- 3. 眠れる
- 2. ときどき眠れない
- 1. 眠れないことが多く苦になる
- 0. 毎日いつも眠れない

(8)昼寝の時間はどれくらいですか
- 3. 昼寝はしない
- 2. 少し寝る(3時間以内)
- 1. よく寝る(3時間以上)
- 0. ほとんど寝ている

フローチャート式ＦＩＭ

Flow－FIM

2012.4.1 version　　藤田保健衛生大学七栗サナトリウム

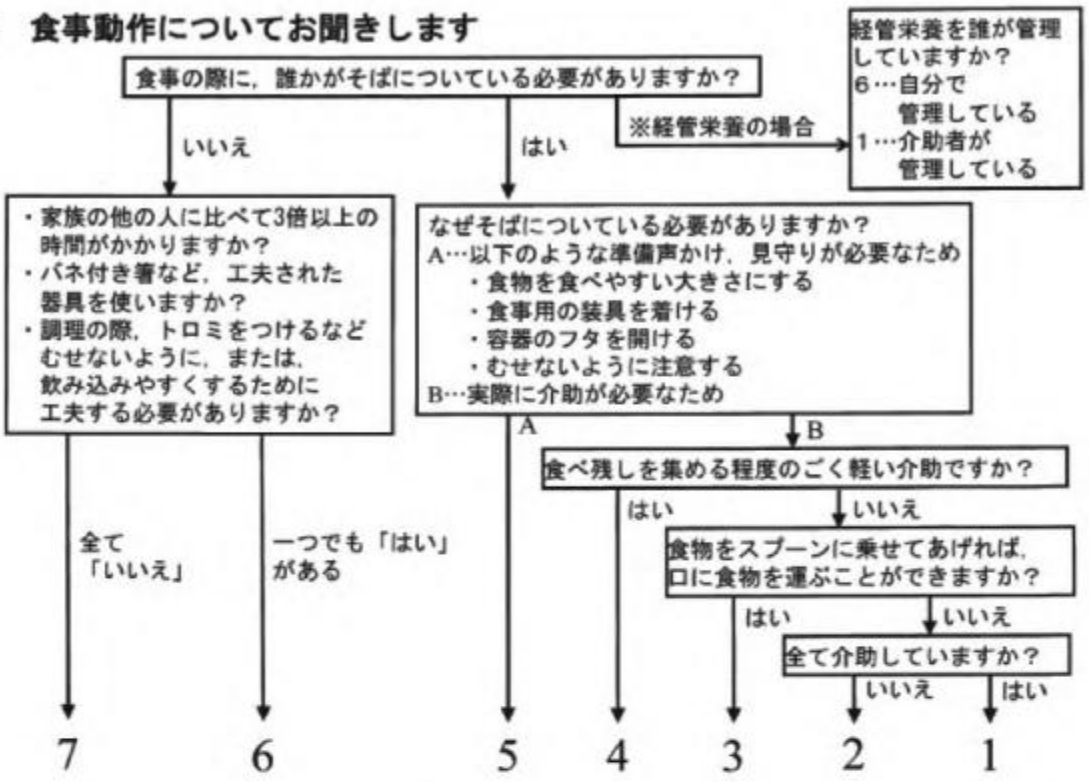
◎ **採点時の注意点**

・環境が変わったとしても、そのとき「している」状態で採点してください。

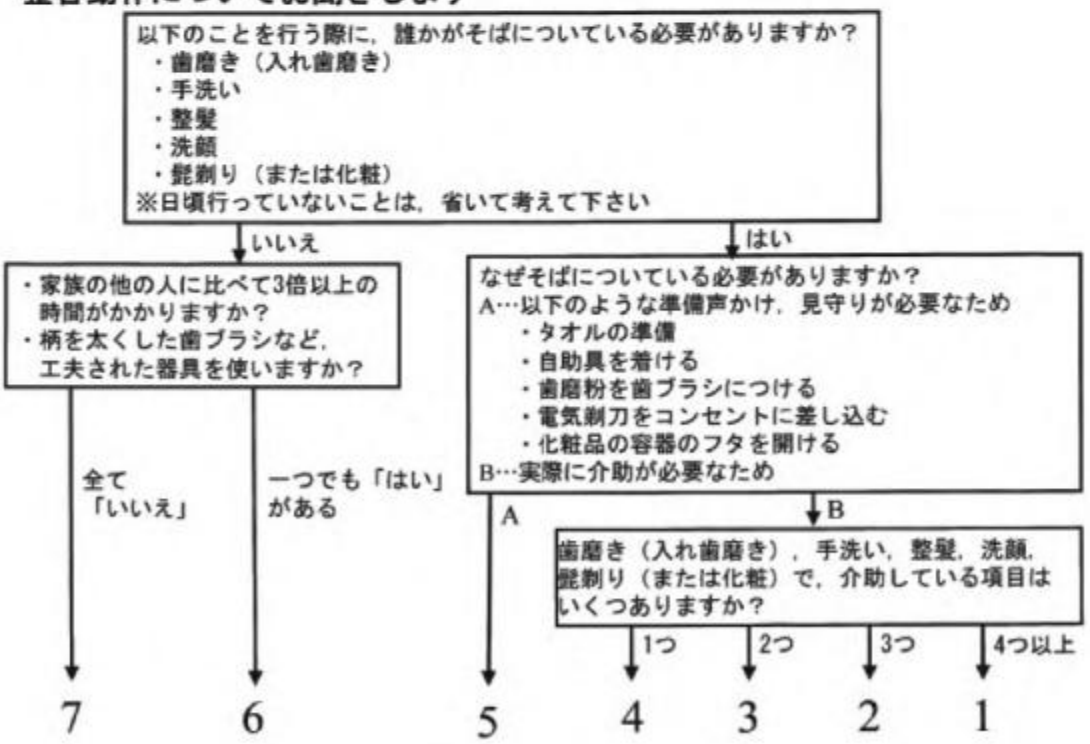
・一日の中で変動するときは、低い(できない)ほうの状態で採点します。

・更衣の項目は風呂でないときの更衣で採点してください。

1　食事動作についてお聞きします

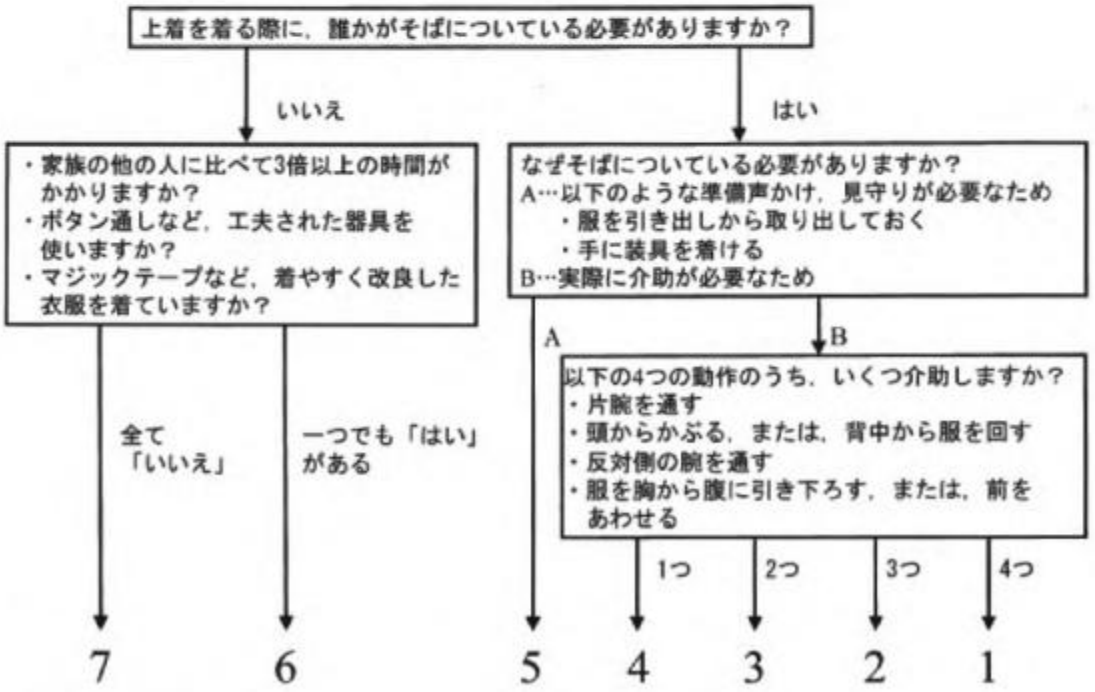


2　整容動作についてお聞きします

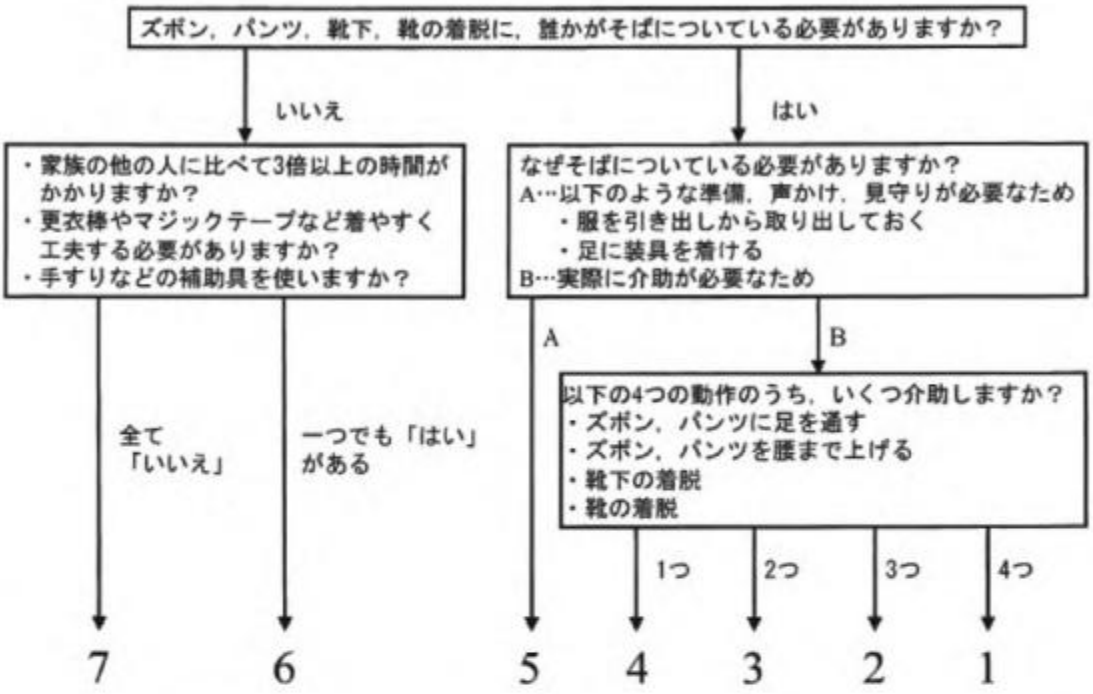


3　清拭動作についてお聞きします

4　更衣（上半身）動作についてお聞きします

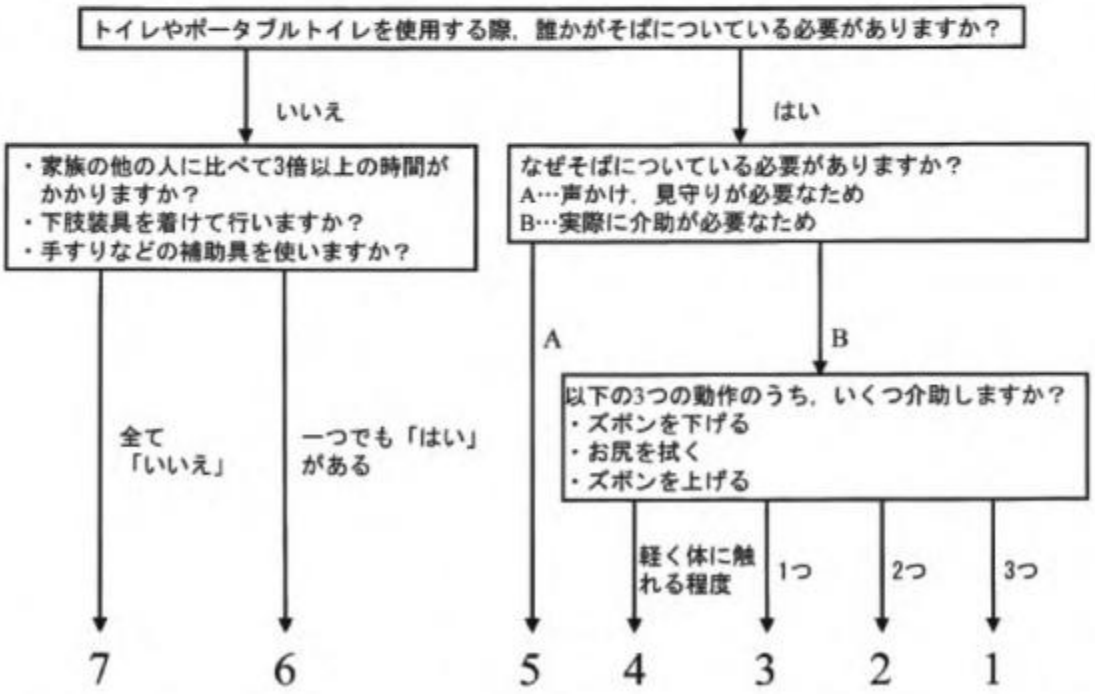


5 更衣（下半身）動作についてお聞きします

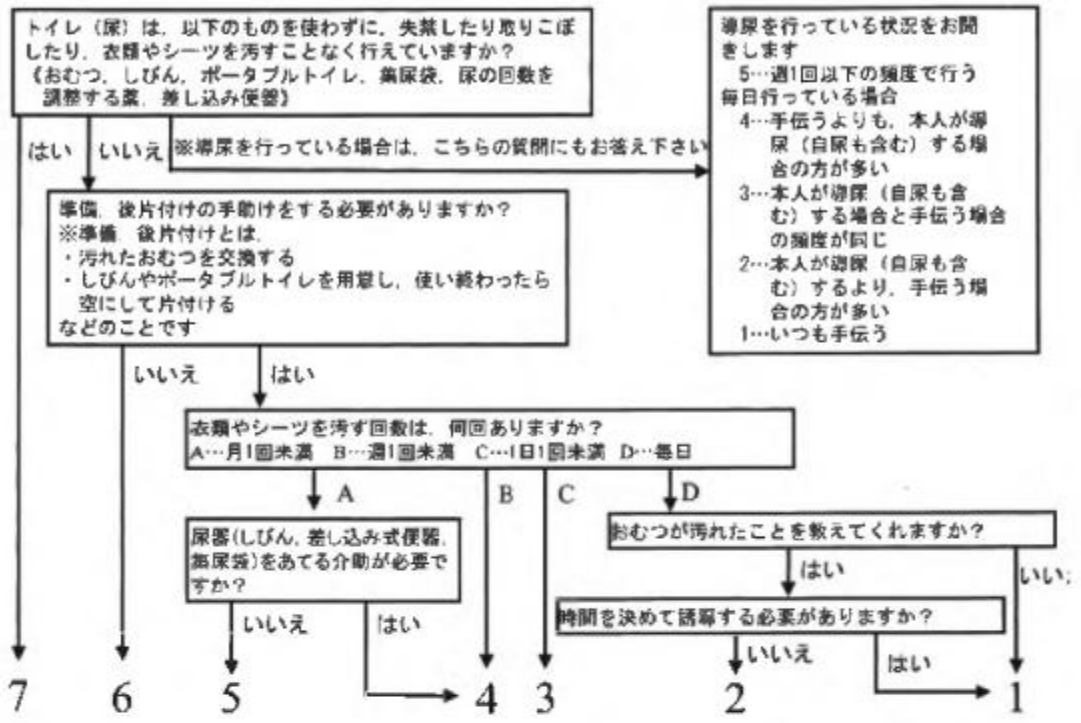


---

6 トイレの際のズボンの上げ下ろし，拭く動作についてお聞きします



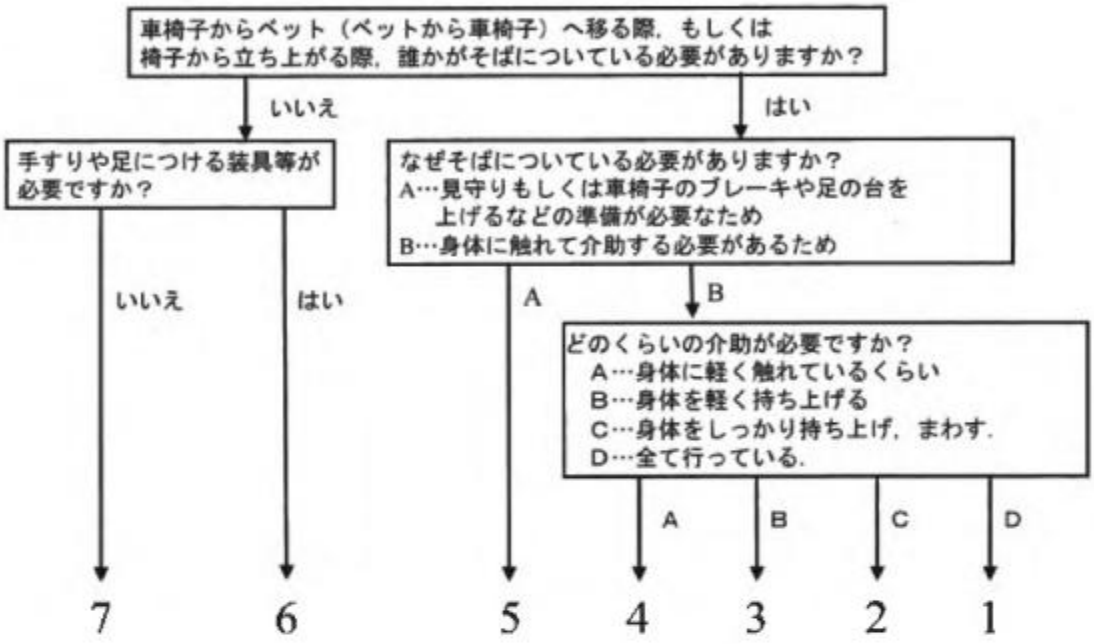
7　トイレ（尿）についてお聞きします



8　トイレ（便）についてお聞きします

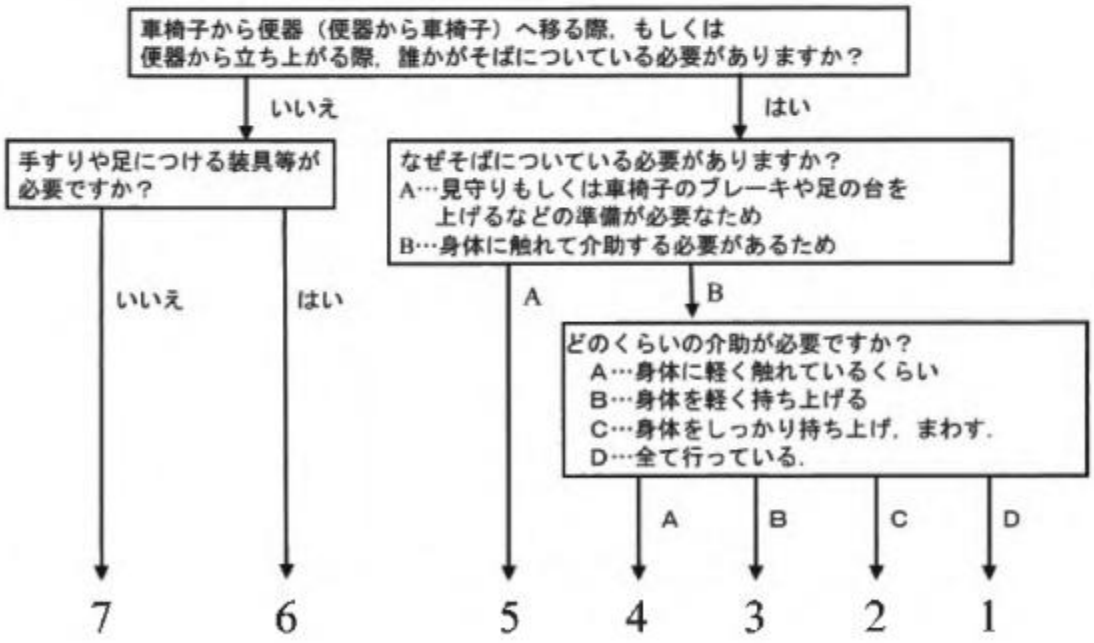
9　車椅子からベット（ベットから車椅子）へ移る動作，もしくは椅子から立ち上がる動作についてお聞きします．

※車椅子を使用していない方も回答をお願いします



10　車椅子から便器（便器から車椅子）へ移る動作，もしくは便器から立つ動作についてお聞きします．

※車椅子を使用していない方も回答をお願いします



11 浴そうに出入りするまたはシャワーチェアーに移る動作についてお聞きします

※主に使用している方に、○をつけてください

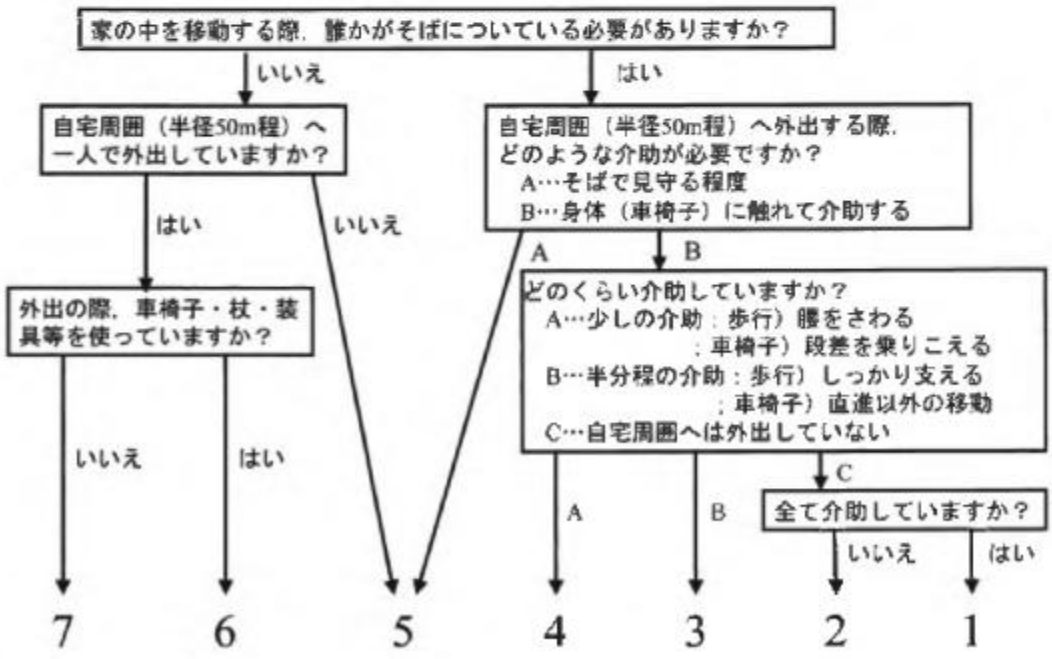
1.浴槽 2.シャワー

---

12 移動（車椅子または歩行）に関してお聞きします

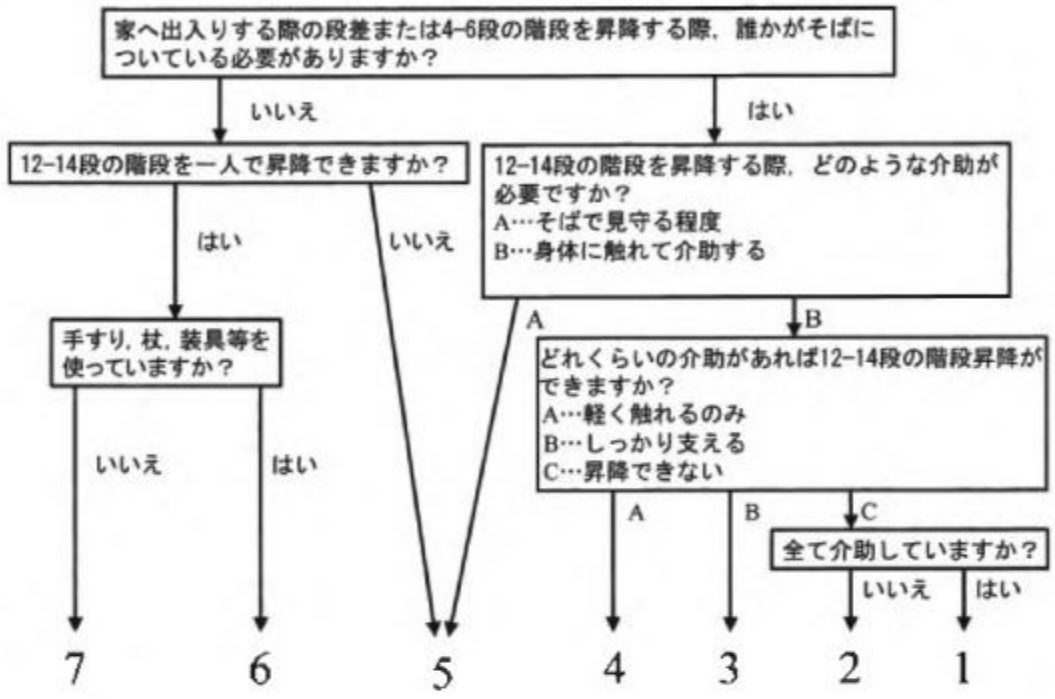
※主な移動手段に○をつけてください　1.車椅子 2.歩行

また、○をつけた方で解答してください



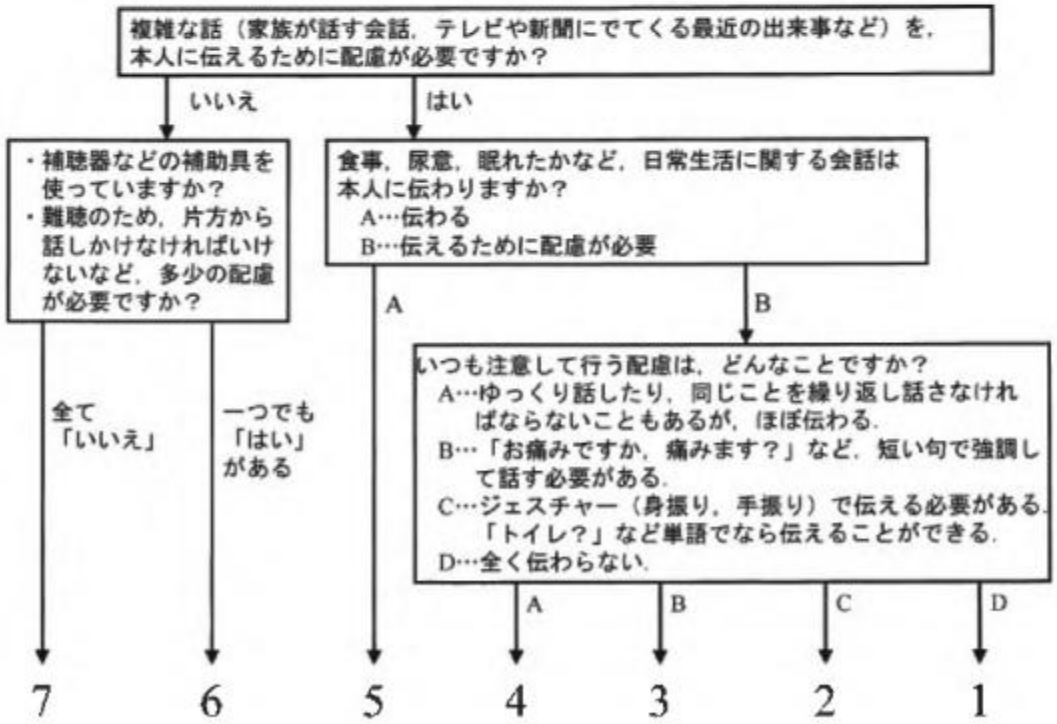
13 階段の昇り降りについてお聞きします

※この項目のみ実際に行っていない場合は，行ってみたとしてお答えください．

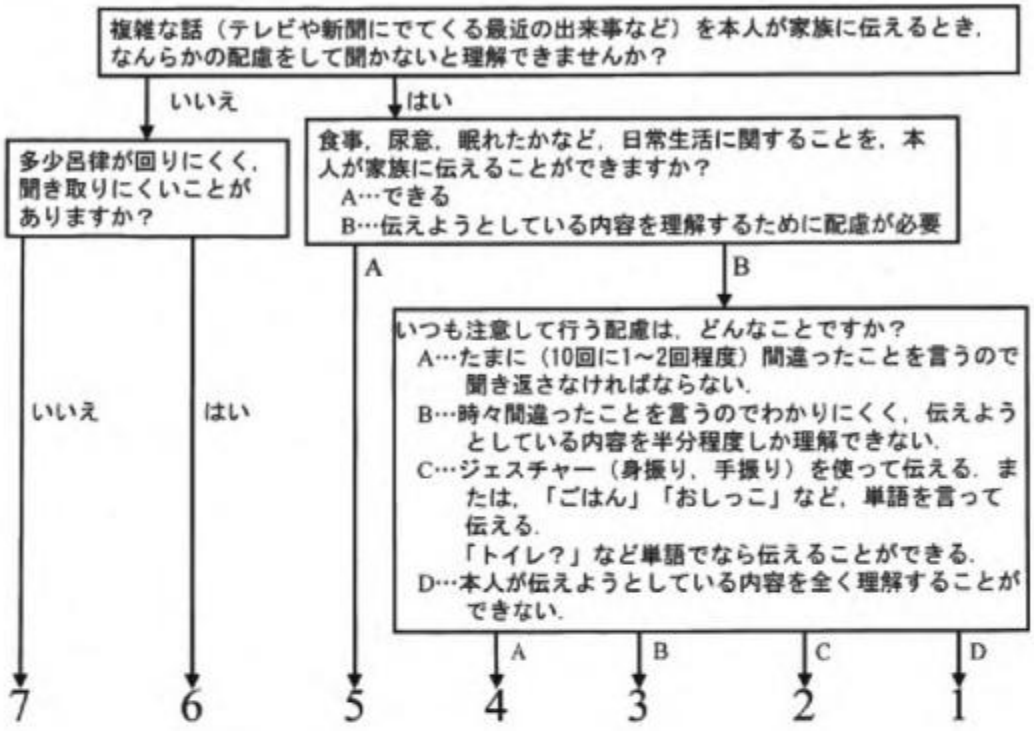


---

14 家族からの話しや声かけを理解できるかお聞きします．



15　ご本人が言いたいことを家族に伝えることができるかお聞きします.

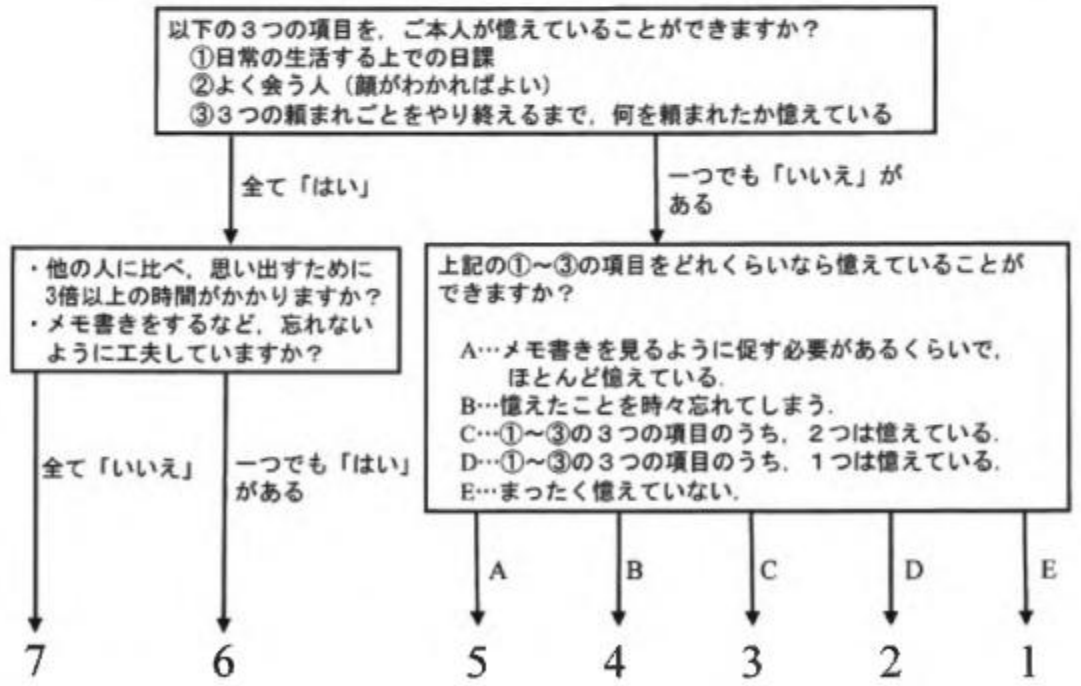


16　社会の場において他人と交流する能力についてお聞きします.

17 金銭面，社会的，個人的なできごとを解決する能力についてお聞きします．

---

18 社会および日常生活において，必要なことを憶えている能力をお聞きします



flow-FIMの評価表

ID　　名前

大項目	中項目	小項目	年月日
1. 運動項目	1) セルフケア	① 食事	
		② 整容	
		③ 掃拭(入浴)	
		④ 更衣(上半身)	
		⑤ 更衣(下半身)	
		⑥ トイレ動作	
	2) 排泄コントロール	⑦ 排尿管理	
		⑧ 排便管理	
	3) 移　乗	⑨ ベッド・椅子・車椅子	
		⑩ トイレ	
		⑪ 浴槽・シャワー	
		(浴槽かシャワーか)	(□浴　□シ)
	4) 移　動	⑫ 歩行・車椅子	歩＝
		(主な移動手段)	車＝
		⑬ 階段	(□歩　□車)
2. 認知項目	5) コミュニケーション	⑭ 理解*	
		⑮ 表出*	
	6) 社会的認知	⑯ 社会的交流	
		⑰ 問題解決	
		⑱ 記憶	
合計点			

*⑭の(□聴覚　□視覚), ⑮の(□音声　□非音声)は省略した

転入時状態

あなたの健康について

このアンケートはあなたがご自分の健康をどのように考えているかをおうかがいするものです。あなたが毎日をどのように感じ、日常の活動をどのくらい自由にできるかを知るうえで参考になります。お手数をおかけしますが、何卒ご協力のほど宜しくお願い申し上げます。

以下のそれぞれの質問について、一番よくあてはまるものに印（☑）をつけてください。

1. 全体的にみて、過去１ヵ月間のあなたの健康状態はいかがでしたか。

最高に良い	とても良い	良い	あまり良くない	良くない	ぜんぜん良くない
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

2. 過去１ヵ月間に、体を使う日常活動（歩いたり階段を昇ったりなど）をすることが身体的な理由でどのくらい妨げられましたか。

ぜんぜん妨げられなかった	わずかに妨げられた	少し妨げられた	かなり妨げられた	体を使う日常活動ができなかった
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

3. 過去１ヵ月間に、いつもの仕事（家事も含みます）をすることが、身体的な理由でどのくらい妨げられましたか。

ぜんぜん妨げられなかった	わずかに妨げられた	少し妨げられた	かなり妨げられた	いつもの仕事ができなかった
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

4. 過去１ヵ月間に、体の痛みはどのくらいありましたか。

ぜんぜんなかった	かすかな痛み	軽い痛み	中くらいの痛み	強い痛み	非常に激しい痛み
▼	▼	▼	▼	▼	▼
□ 1	□ 2	□ 3	□ 4	□ 5	□ 6

5. 過去１ヵ月間、どのくらい元気でしたか。

非常に元気だった	かなり元気だった	少し元気だった	わずかに元気だった	ぜんぜん元気でなかった
▼	▼	▼	▼	▼
□ 1	□ 2	□ 3	□ 4	□ 5

6. 過去１ヵ月間に、家族や友人とのふだんのつきあいが、身体的あるいは心理的な理由で、どのくらい妨げられましたか。

ぜんぜん妨げられなかった	わずかに妨げられた	少し妨げられた	かなり妨げられた	つきあいができなかった
▼	▼	▼	▼	▼
□ 1	□ 2	□ 3	□ 4	□ 5

7. 過去１ヵ月間に、心理的な問題（不安を感じたり、気分が落ち込んだり、イライラしたり）に、どのくらい悩まされましたか。

ぜんぜん悩まされなかった	わずかに悩まされた	少し悩まされた	かなり悩まされた	非常に悩まされた
▼	▼	▼	▼	▼
□ 1	□ 2	□ 3	□ 4	□ 5

8. 過去１ヵ月間に、日常行う活動（仕事、学校、家事などのふだんの行動）が、心理的な理由で、どのくらい妨げられましたか。

ぜんぜん妨げられなかった	わずかに妨げられた	少し妨げられた	かなり妨げられた	日常行う活動ができなかった
▼	▼	▼	▼	▼
□ 1	□ 2	□ 3	□ 4	□ 5

ご協力、ありがとうございました。

調査日　　年　　月　　日（　）

被調査者氏名/番号

年齢　　歳　性別（男・女）

GDS15

以下の質問に対し、「はい」か「いいえ」のどちらかに○をつけてください

1．毎日の生活に満足していますか ……はい　いいえ

2．毎日の活動力や周囲に対する興味が低下したと思いますか ……はい　いいえ

3．生活が空虚だと思いますか ……はい　いいえ

4．毎日が退屈だと思うことが多いですか ……はい　いいえ

5．大抵は機嫌よく過ごすことが多いですか ……はい　いいえ

6．将来の漠然とした不安に駆られることが多いですか ……はい　いいえ

7．多くの場合は自分が幸福だと思いますか ……はい　いいえ

8．自分が無力だなあと思うことが多いですか ……はい　いいえ

9．外出したり何か新しいことをするよりも家にいたいと思いますか ‥はい　いいえ

10．なによりもまず、物忘れが気になりますか ……はい　いいえ

11．いま生きていることが素晴しいと思いますか ……はい　いいえ

12．生きていても仕方ないと思う気持ちになることがありますか ……はい　いいえ

13．自分が活気にあふれていると思いますか ……はい　いいえ

14．希望がないと思うことがありますか ……はい　いいえ

15．周りの人があなたより幸せそうに見えますか ……はい　いいえ

GDS15	点

（Yesavage JA et al：Development and validation of a geriatric depression screening scale：A preliminary report. ***J Psychiat Res 17***：37,1983. より引用改変）

調査実施者氏名／役職

備　考

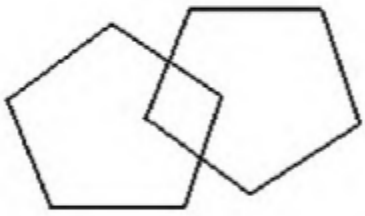
MMSE ＋ 野菜想起

施行日＿＿＿＿　患者名＿＿＿＿＿＿＿＿　年齢＿＿＿＿	
年齢	
年 月 日 曜日 季節	0／1 0／1 0／1 0／1 0／1　　／5点
今いるところは？	
ここは 何県 何市 何病院 何階 何地方	 0／1 0／1 0／1 0／1 0／1　　＿／5点
復唱「みんなで、力を合わせて綱をひきます。」	0／1
3単語 「桜／猫／電車」・「梅／イヌ／自動車」	0／1／2／3 ＿／3点
100から順に7を引く（5回まで）	93・86・79 ・72・65　＿／5点
3単語復唱	0／1／2／3 ＿／3点
物品名　時計／鉛筆	0／1／2
3段階命令 右手にその紙をもち／半分にたたんで／机の上においてください	0／1／2／3 ＿／3点
文をよみそのとおりにしてください 「眼を閉じなさい」	 0／1
何か文章を書いてください	0／1
図形模写 	0／1
MMSE合計	／30
知っている野菜の名をできるだけ多く言ってください。 1＿　2＿　3＿　4＿　5＿ 6＿　7＿　8＿　9＿　10＿	0-5）　0点、 6）1点、 7）2点、 8）3点、 9）4点、 10）5点

眼を閉じてください

文章を書いてください

同じ絵を描いてください



FIMの評価表

ID　　名前

大項目	中項目	小項目	年月日
1. 運動項目	1) セルフケア	① 食事	
		② 整容	
		③ 掃拭(入浴)	
		④ 更衣(上半身)	
		⑤ 更衣(下半身)	
		⑥ トイレ動作	
	2) 排泄コントロール	⑦ 排尿管理	
		⑧ 排便管理	
	3) 移　乗	⑨ ベッド・椅子・車椅子	
		⑩ トイレ	
		⑪ 浴槽・シャワー	
		(浴槽かシャワーか)	(□浴　□シ)
	4) 移　動	⑫ 歩行・車椅子	歩＝
		(主な移動手段)	車＝
		⑬ 階段	(□歩　□車)
2. 認知項目	5) コミュニケーション	⑭ 理解*	
		⑮ 表出*	
	6) 社会的認知	⑯ 社会的交流	
		⑰ 問題解決	
		⑱ 記憶	
合計点			

*⑭の(□聴覚　□視覚), ⑮の(□音声　□非音声)は省略した

得 点	運動項目	認知項目
7	自立	自立
6	修正自立 (用具の使用, 安全性の配慮, 時間がかかる)	軽度の困難, または補助具の使用
5	監視・準備	90%以上している
4	75%以上, 100%未満している	75%以上, 90%未満している
3	50%以上, 75%未満している	50%以上, 75%未満している
2	25%以上, 50%未満している	25%以上, 50%未満している
1	25%未満しかしていない	25%未満しかしていない

退院後状態

退院後の状態に関するアンケート

患者様の名前：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

記載日：　　年　　月　　日

記入いただいた方：　家族　・　本人　・　その他

地域包括ケア病棟退院後約 3 か月後（　　月　　日ごろ）の患者様のご様子について　ご家族様から見た状態を記載してください。
（独居の方は　ご本人が記載をお願いします）

１．現在の生活場所

□　自宅
□　施設入所　　（　施設名：　　）
□　病院入院中　（入院の主な病名：　　）

２．現在の介護保険サービス利用状況について

訪問サービス

訪問介護（ホームヘルプ）；　0：あり　/　1：なし
訪問入浴；　0：あり　/　1：なし
訪問看護；　0：あり　/　1：なし
訪問リハビリ；　0：あり　/　1：なし

施設利用

デイサービス；　0：あり　/　1：なし
通所リハビリ（デイケア）；　0：あり　/　1：なし
ショートステイ；　0：あり　/　1：なし
その他の施設利用　（　　）

３．食事量について

退院してからの 3 か月に、食欲がない、吐き気や下痢、便秘、かんだり飲み込んだりの問題で、食べ物を食べる量が減りましたか？

0：　著しい食事量の減少
1：　中等量の食事量の減少
2：　食事量の減少なし

４．　体重変化について

退院してからの３か月で体重の減少がありましたか？

0：　３kg以上の減少
1：　わからない
2：　1～３kgの減少
3：　体重減少なし

（現在の体重　　ｋｇ）

５．歩行能力

Ａ　現在自力で歩けますか？

0：寝たきりまたは車いすを常時使用
1：ベッドや車いすを離れられるが、歩いて外出はできない
2：自由に歩いて外出できる

Ｂ 歩ける方は以下を記載ください

歩行能力は　地域包括ケア病棟入院前と比べ、

0: 改善
1: 不変
2: 悪化

歩行能力は退院直後と比べ、

0: 改善
1: 不変
2: 悪化

６．転倒について

退院してから現在までに転ぶことがありましたか

0:　あり
1:　なし

７．　骨折について

退院してから現在までに新たに骨折がありましたか

0:　あり　（部位：　　）

1:　なし

８．退院してからの３か月で新たな急性疾患や精神的なストレスの経験がありますか

0：はい

1：いいえ

９．家族から見た患者様の（自発的の物事を行おうとする）意欲は、

退院直後と比べ、

0: 改善

1: 不変

2: 悪化

１０．家族から見た全般的な患者様の様子(元気さ）は、

入院前と比べ、

0: 元気である

1:　不変

2:　元気がなくなった

退院直後と比べ、

0: 元気である

1:　不変

2:　元気がなくなった

ご協力ありがとうございました。以下のものとともに、郵送をお願いいたします。

別紙につきチェックをお願いします。

フローチャート式ＦＩＭ:　ご家族が記載してください

生活の質　（ＳＦ－８）:　患者様ご本人が記載してください