

Original Article

Analyzing the Concept of Frailty and Applying Evidence-Based Measurement Indicators

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Abstract - Background: Aging populations are an important concern worldwide. This study aimed to introduce the implications and evidence-based measurement indicators of the concept of frailty. Methods: Following Walker & Avant's approach (2005), concept analysis was performed in this study. Four typical, marginal, related, and contrary cases are described based on conceptual analysis, along with the dictionary, conceptual, and operational definitions, and features of frailty, identifying a model case, identifying borderline, related, and contrary cases, identifying antecedents and consequences and defining empirical referents. Result: Based on our conceptual analysis of frailty in the elderly, the present study advocates the need to develop a more comprehensive standard for measurement instruments of frailty so that such instruments can be used for comparing information across relevant studies from other countries. Discussion: Precise evidence-based assessments can assist elderly individuals in making timely preparations to delay the onset of frailty and maintain optimum physical performance and independent lifestyles. Frailty's screening, prevention and management in the elderly, the occurrence of physiologic limitations and disability, and ultimately achieving successful aging, active aging in place, and excellent quality of life.

Keywords - Elderly, Frailty, Conceptual analysis, Frailty instrument.

1. Introduction

Aging populations are an important issue of concern worldwide. Due to the increasing global aging index, according to the 2022 revised edition of the United Nations World Population Prospects, the global population is expected to reach 8 billion by November 2022, 8.5 billion by 2030, and 10 billion by 2059 (United Nations, 2022). By 2030, the acceleration of aging in Taiwan will increase to 30%, comparable to Japan (Ministry of Health and Welfare, 2019). The elderly care market is expected to grow rapidly, highlighting the need for a greater number of professional caregivers to meet growing demands for long-term institutional care and in-home care (Chen, 2015).

Frailty not only increases medical expenses, in general, and the burden on the public healthcare system but is also regarded as a precursor to disability. Thus, it is important to develop frailty screening programs for elderly individuals living in the community. The prevalence of frailty among the Taiwanese elderly population is 5.4% (Lu, 2010), while the pre-frail elderly account for 41.5% of the elderly population (Wu, 2014). Thus, the workloads of healthcare providers and caregivers shall undoubtedly increase as the pre-frail elderly gradually become frail or disabled. Studies have shown that the term "frailty" is typically used to describe elderly individuals who are physically weak or impaired in

performing the activities of daily living (Chen, Huang, Cheng, Yang, 2015). While the concept of frailty is associated with both comorbidity and disability, these are distinct concepts. Frailty also includes multiple factors, such as dependence, dynamic processes, and injury proneness. Conceptual analyses on frailty in the elderly are a beneficial part of nursing practice, as they deepen nurses' understanding of the concept of frailty (Tseng, Shyu, 2008, Ke, 2013) and enable them to make more comprehensive assessments, develop nursing interventions and care measures, perform evidence-based research, and increase the quality of healthcare for elderly individuals (Sakamoto & Miura, 2016).

2. Definition of Frailty

The term frailty was first coined in 1978 by the National Council on Aging and is a common term used in geriatric medicine and geriatrics. This chapter further discusses frailty based on different definitions of the term, including dictionary, theoretical, therapeutic, practical and operational definitions.

2.1. Dictionary Definitions

2.1.1. The Merriam-Webster dictionary (2022) provides a concise and literal definition of frailty as follows:

- Physical weakness: the quality or state of being frail.



- Weakness of character causes a person to do things that are morally wrong.

2.1.2. The Oxford Dictionary (2022) Provides a Literal Definition of Frailty as follows

- The condition of being weak and delicate; the increasing frailty of old age.
- Weakness in character or morals.

2.1.3. The Far East Practical English-Chinese Dictionary translates frailty as *cuiruo*, which is characterized as being weak-willed or easily persuaded and with a lack of morale (Liang, 1993). The Encyclopedic Dictionary of the Chinese Language describes the term *cuiruo* as physically weak and feeble, in addition to possessing a low-status race or weak state (Chang, 2005). The definition of *cuiruo* is roughly similar in English dictionaries, English-Chinese dictionaries, or Chinese dictionaries. It describes an unhealthy physiological condition or status that affects an individual's quality of life.

2.2. Theoretical Definitions

2.2.1. Threshold Limit Model

Rockwood (1994) proposed that an individual's physical capacity and activity level will gradually decrease until they fall below a specific threshold value. Frailty is the proneness of physical injury with age; in particular, it is the imbalance between homeostasis and stress resistance (Walston & Fried, 1999). When an individual's physiologic reserve decreases and their risk of injury proneness increases, they are more likely to experience falls, suffer bone fractures, and become disabled and dependent on others. In addition, such individuals are at increased risk of cardiovascular disease, hypertension, and cancer. Therefore, frailty with aging is a symptom caused by an individual's decreased physiologic reserve and is affected by multiple factors leading to a decline in physiological functions (Fried, Tangen, Walston, 2001).

2.2.2. Dynamic Model

Hirsch et al. (2000) suggested that frailty results from dynamic interactions between multiple factors. Pre-frail is a condition in which there is an equilibrium between maintenance and decline of health and physical function. The symptoms are less apparent in this phase, and the individual's health problems typically go undetected. Rockwood et al. (2001) describe pre-frail as the condition of maintaining a homeostatic state between the various factors related to health maintenance (i.e., physical health, healthy attitudes, social resources) and health risks (i.e., disease, dependence on others, caregiver burden). Frailty is defined when the number of negative factors exceeds the number of positive factors. Medical specialists have suggested that frailty assessment should be based on the number of health-related problems (Robertson, 2013). The concept of a frailty index (Rockwood et al., 2002) was conceived as a result. It

calculated the proportion of the number of abnormal or declining assessment items to the total number of items. French researchers Harmand et al. (2017) performed a 12-year study on frailty in elderly individuals that demonstrated that Rockwood's frailty index (Clegg et al., 2013, Schoufour et al., 2014, Brinkman et al., 2018) is the optimal assessment instrument for predicting falls and disability and is highly correlated with rates of hospitalization. While this method has excellent predictive validity, it is time-consuming to carry out due to the large number of items that require assessment. Thus, it is not widely used in clinical practice. Moreover, based on the change in health status from being injury prone to displaying adverse outcomes, frailty is a dynamic and potentially reversible process that functions as a precursor to disability. Therefore, frailty should be detected in a timely manner so that interventional measures can be implemented (De Lepeleire, 2009) to delay the onset of frailty-induced health problems.

2.3. Practical and Operational Definitions

The practical and operational definition of frailty, according to a study by Fried et al. (2001), consists of several components, including unintentional weight loss (5% body weight loss within one year, or 10 lbs/4.54 kg); weakened grip strength (Jamar dynamometer measurement, with the three average grip strength measurements with the dominant hand 20% below the normal value, or below 40 kg and 27 kg for men and women, respectively); time to complete the up and go test, sit to stand test, short physical performance battery score, and 15 ft (4.57 m) walk test 20% below the normal value; a walking speed less than 1 m/s; self-reported poor endurance; and a decline in activity based on the Minnesota Leisure Time Activity Questionnaire (Richardson et al., 1994). Pre-frail is defined as meeting one or two of the five aforementioned criteria; frailty is defined as meeting three or more criteria.

Based on the definitions mentioned above, our comprehensive definition of frailty in the elderly is the following: a natural process marked by a continuous decline in the physiological functions of an individual's multiple capabilities, including changes in cognitive function and the need to partially or fully depend on assistance in completing the activities of daily living. The conceptual definition of frailty in the elderly includes: (1) A progressive process and status; (2) A multidimensional concept in which physical frailty results in at least one functional deficit that affects physical, psychological, cognitive, and social functions; and (3) The individual is susceptible to injury and adverse health outcomes.

Because frailty is a precursor of functional decline in elderly individuals, when affected individuals are in a state of functional decline, the emergence of a derived illness or the exacerbation of an existing illness may result in disuse and subsequent disability when rehabilitation activities are not

implemented in a timely and appropriate manner (Gobbens et al., 2010).

3. Defining Features of the Concept of Frailty

Discriminant definition: Based on the concept of frailty described above, the present study developed three discriminant definitions and defining features of frailty to describe our cases:

- A number of an individual's physiologic reserves have fallen below the threshold values.
- An individual's condition has impaired one or more of their functional capabilities (e.g., physical, psychological, and social).
- An individual's condition has resulted in subsequent physical impairment and increases their risk of other adverse outcomes and hazards.

Based on these discriminant definitions, we shall describe our four typical, marginal, related, and contrary cases:

3.1. Typical Case: A case that Meets all the Features of the Frailty Concept in Question

Mr. Zhao is an 83-year-old single veteran who lives alone in a home provided by the military. He has been diagnosed with chronic obstructive pulmonary disease, hypertension, osteoporosis, and liver cirrhosis. Most of his physiologic reserves have fallen below the threshold values. His neighbours reported that he used to be able to participate in activities of daily living on his own, but within the last six months, he seldom leaves his home and has become forgetful and anxious. He has lost more than 5 kg and becomes breathless, even though he walks slower than before. These behaviours suggest that his condition has affected one or more functional impairments (i.e., physical, psychological, and social). One morning, he fell in the bathroom and could not get up by himself. There was an obvious bruise on his left thigh, which became swollen and painful. His neighbours heard his cries for help and assisted him in seeking treatment. He was diagnosed with a hip bone fracture that required hip replacement surgery. Because he has no relatives living in Taiwan, he had to hire a foreign caregiver to assist him in off-bed rehabilitation exercises and use a walking aid. Thus, his initial injury resulted in subsequent physical impairment, and he is at risk for other adverse outcomes and hazards. He meets all three criteria, including the phenotype of frailty described by Fried et al. (2001), including frailty indicators such as unintentional weight loss, slower activity, and reduced physical activity. Overall, multiple factors contribute to his proneness to injury and his dynamic dependence on others.

3.2. Marginal case: A case that Partially Meets the Features of the Frailty Concept in Question

Mr. Hsieh is 82 years old and lives with his 76-year-old wife in a five-story apartment building. He has a 50-year habit of drinking kaoliang liquor before going to bed and a

history of hypertension, pancreatic cancer, and hypercholesterolemia. After experiencing several minor strokes five years ago, he was diagnosed with brain atrophy and vascular dementia, rendering him unable to respond to questions using full sentences or descriptions. He often staggers or falls due to his weakened left leg. He has a poor sense of direction and relies on his wife's reminders. He becomes extremely anxious and uneasy when she leaves the apartment to go shopping. These behaviours suggest that his condition has affected one or more functional impairments (i.e., physical, psychological, and social). For the last three months, he has experienced insomnia and would wander with his walking aid randomly. He also experienced uncontrollable rages or became agitated. His family had to place him in medical care after he attempted to climb out a window. He was diagnosed with delirium and was treated with drug therapy under the supervision of a psychiatrist while hospitalized. Due to her prolonged caregiving, his wife has insomnia and depression, for which she is being treated with drug therapy. She worries that she might not be able to take care of him by herself anymore and has discussed with her children the possibility of placing him in a nursing facility. The patient only meets one criterion, and multiple factors contribute to his dynamic dependence on others.

3.3. Related case: A Case that is Related to the Frailty Concept in Question but Does not Entirely Adhere to the Concept

Mr. Hsieh is 79 years old and lives with his 71-year-old wife and their children. He has hypertension, cataracts in both eyes (for which he has received intraocular lens implantation), type 2 diabetes, and chronic kidney failure. He attends dialysis sessions at the hospital thrice weekly because most of his physiologic reserves have decreased to below the threshold values. He has a long history of poor blood-glucose control and was involved in an accident two months ago, which left him with a severely infected and healing-impaired wound on his left calf. He has undergone debridement twice for this reason. Despite this intervention, the injury continued to ooze a foul-smelling greenish discharge, and he began to display sepsis symptoms, leading to an emergency amputation of his lower leg. The wound is currently healing well, but the patient is unwilling to learn how to treat and dress the residual limb and even asks his family to refuse visits from his relatives. He is unwilling to participate in rehabilitation exercises and has expressed that wearing a prosthetic limb is the same as being wheelchair-bound. This behaviour suggests that his injury has affected one or more functional impairments (i.e., physical, psychological, and social). Since he has always had a low body weight and low physical activity, he is dependent on his family when performing the activities of daily living. Although he meets two criteria, multiple factors contribute to his dynamic dependence on others. He is considered disabled and does not meet the definition or domains of frailty.

3.4. Contrary case: A Case that is Completely the Opposite of the Frailty Concept in Question

Mr. Wang is a 77-year-old widower who did not remarry after his wife died. His adult children work elsewhere and have their own families. Since being discharged from the military, he has lived alone in a townhouse that he purchased. He is financially well-off as he rents the first floor to a private telecom operator as a business outlet and receives his monthly military pension. He has a history of hypertension and has undergone surgery for benign prostatic hypertrophy. Last year, after completing a self-paid health examination, he learned that he had coronary artery calcifications and occlusion, and two vascular stents were installed. At present, he regularly returns for follow-up visits and is treated with prescribed medication. He usually wakes at 5 a.m., walks approximately 5,000 steps, and volunteers at the community activity centre in the afternoon. Because he does not exhibit any of the previously mentioned symptoms or features of frailty, he is regarded as a contrary case.

4. Antecedents and Consequences of Frailty

4.1. Antecedents

Antecedents are conditions or scenarios that pre-exist the occurrence of a concept of frailty. When elderly individuals become increasingly dependent on others for daily living activities and use additional family support systems and social welfare resources, supportive factors are highlighted. Moreover, it is necessary to understand and assess the financial capability and spiritual care needs of frail elderly individuals when their living environment changes.

4.2. Consequences

Consequences are the situations or outcomes that arise from the occurrence of a concept of frailty. The focus of care for pre-frail elderly individuals is to predict the possibility of the need for institutional care. The focus of care for frail elderly individuals includes the possibility of receiving institutional care at a nursing home or retirement home, the readmission rate, the need for caregivers, and quality-of-life indicators. When the extent of an elderly individual's frailty increases, so does the number of evaluation criteria they meet, and the more likely they are to be disabled or injured (such as from accidental falls and bone fractures) or suffer from bedsores due to being bedridden for a prolonged period. Some individuals might even begin to experience an altered cognitive state and develop incontinence and confusion, which often increases their mortality risk (Malaguarnera et al., 2013).

5. Frailty Assessment and Measurement Instruments/Application of Evidence-Based Indicators

Although experts in many countries have developed a wide range of measurement instruments, there is no international consensus on the evaluation criteria for frailty

to date. The following describes common measurement instruments or indicators developed by scholars from various countries:

5.1. Frailty Scale

This scale was developed by a Canadian team led by Rockwood et al. (1999) and considered psychological, intellectual, and social functioning aspects. The measurement criteria include functional impairment, disability, and incontinence. An elderly person is considered frail when they meet any two of these three criteria. The scale categorizes four types of elderly individuals based on their scale score: 0 points indicates that the individual requires no assistance in walking, can complete the activities of daily living on their own, and has neither urinary/bowel incontinence nor cognitive decline; 1 point indicates that only urinary/bowel incontinence is present; 2 points indicate that the individual either requires assistance in completing the activities of daily living, has urinary/bowel incontinence, or cognitive decline (but no dementia); 3 points indicate that the individual meets any two of the three criteria: requires assistance in completing activities of daily living, has urinary/bowel incontinence, or diagnosed with dementia.

5.2. Clinical Frailty Scale (CFS)

The CFS was also introduced by Rockwood et al. (2005) and updated to version 2.0 in 2020 (Rockwood and Theou, 2020). The scale categorizes nine levels of geriatric health, from aging healthily to terminally ill, with the risk of a poor prognosis increasing with each higher level. The Clinical Frailty Scale (CFS) is a judgement-based frailty tool that evaluates specific domains, including comorbidity, function, and cognition, to generate a frailty score ranging from 1 (very fit) to 9 (terminally ill). The Clinical Frailty Scale is also commonly used as a triage tool to make important clinical decisions, such as allocating scarce healthcare resources for COVID-19 management; therefore, it is important to use the scale appropriately.

5.3. Canadian Study of Health and Aging Clinical Frailty Scale (CSHA-CFS)

This scale was designed in accordance with studies on frailty, health, and aging. CSHA-CFS is a way to summarize an older adult's overall fitness or frailty after being evaluated by an experienced clinician (Rockwood et al., 2005). It primarily assesses four domains: mobility, vitality, physical activity, and functioning. Whereas the original CSHA-CFS categorizes seven levels of frailty, the recently revised CFS-09 includes two additional levels: Level 8 (very severely frail), in which the patient is completely unable to care for themselves nor recover from any illness, and Level 9 (terminally ill), in which the patient is approaching the end of life and has a life expectancy of fewer than six months. Because of its effectiveness and simplicity, the CSHA-CFS is often used to assess acute geriatric illnesses, assist healthcare professionals in identifying a patient's condition as soon as possible, and provide interventional care plans.

5.4. Edmonton Frail Scale (EFS)

The EFS was developed by Rolfson (2006) at the University of Alberta, Edmonton. It primarily assesses the dynamic state of frailty in elderly individuals. It has a score range of 0 to 17 points, in which a score of 8 and above indicates an increasingly severe level of frailty. Its main advantage is that non-geriatric health specialists can use it as a simple health-screening instrument. Many cross-sectional and longitudinal studies have demonstrated the EFS's excellent construct validity and reliability, making it a popular instrument in the UK, Australia, and Brazil. It is significantly correlated with the Barthel scale. It is suitable for rapidly screening outpatients and inpatients for frailty due to its applicability in various healthcare settings and short assessment time of fewer than five minutes.

5.5. The Frailty Phenotype

The frailty phenotype was developed by an American research team (Desquilbet et al. 2009) and is based on risk assessments and screening results on hospitalized and community-dwelling elderly individuals. Frailty is defined primarily by the physical dimension; the presence of three of five domains (unintentional weight loss, weakness, poor endurance, slow walking speed, and decreased physical activity) constitutes frailty, and the presence of two domains indicates pre-frailty. In contrast, the absence of all domains indicates non-frail. To date, many studies refer to these features to define frailty, but the cutoff point remains inconsistent across studies from different countries. The frailty indicators proposed by Fried et al. (2000) and primarily emphasize the mobility domain (particularly lower limb function and gait impairment), muscle weakness, poor stamina during exercise, gait instability, and physical factors (i.e., unintentional weight loss, malnutrition, sarcopenia). Sarcopenia is defined as a reduction in an elderly person's appendicular muscle mass that is two standard deviations below the average appendicular muscle mass of a young adult (Frisoli et al., 2011). However, recent sarcopenia assessments emphasize muscle function, suggesting that the five clinical features of sarcopenia are assessed differently but produce the same result.

5.6. Tilburg Frailty Indicator (TFI)

The TFI was developed by Gobbens et al. (2010) at Tilburg University in the Netherlands and is used to assess the frailty status of community-dwelling elderly individuals. It has two subscales that encompass the latent determinants and constituents of frailty. All items are rated as either 0 points or 1 point, with a score range of 0 to 15 points. A score of 5 points or above suggests an increasing severity of frailty. Translated versions of the TFI have been used in Danish, Brazilian, and Portuguese studies, with the results demonstrating strong validity and reliability, cross-cultural applicability, and practicality. With an assessment time of fewer than 15 minutes, it is extremely suitable for surveying the health of community-dwelling elderly individuals. TFI is

also suitable for intervention studies in specific target groups, such as patients in the hospital or admitted to an emergency department (Gobbens et al., 2017).

5.7. Groningen Frailty Indicator (GFI)

The GFI was developed by the Dutch researcher Schuurmans at the University of Groningen in 2001 (Steverink et al., 2001). It is applicable to elderly individuals who live alone or with their family or spouse. The GFI has 15 items that assess physical, cognitive, psychological, and social functioning, with a score range of 0 to 15 points. Frailty is defined as having a score of 4 points or above, with a higher score indicating a more severe level of frailty and an increasing need for medical care. Schuurmans also suggests an initial FI screening in routine healthcare data, followed by a GFI questionnaire for patients with a high FI score or otherwise at high risk, as the preferred two-step frailty screening process in primary care (Drubbel et al., 2013). The GFI's simplistic design, applicability, and high internal consistency and construct validity have made it a popular instrument in the Netherlands, Sweden, and Romania.

5.8. Chinese In-Person Interview Version of the CSHA-CFS

This instrument is a Chinese-language validation of the CSHA-CFS and can be implemented by trained healthcare professionals who are not physicians (Chan, 2010). The instrument's evaluation results are similar to those obtained from consultation with a physician. Since it is a fast, reliable, and effective instrument for screening community-dwelling elderly individuals, it is currently one of the most common scales used in Taiwanese geriatric studies.

6. Conclusion

Based on our conceptual analysis of frailty in the elderly, the present study advocates the need to develop a more comprehensive standard for measurement instruments of frailty so that such instruments can be used for comparing information across relevant studies from other countries. Additionally, the diagnosis and evidence-based detection of frailty objectively reflect the extent of functional decline in pre-frail and frail individuals. Therefore, weak elderly individuals should receive interventions as soon as possible to delay the onset of the disability and to reduce the care and financial burdens on family and society. Following the implementation of a three-phase, frailty-oriented preventive concept and program in hospital discharge and community care, we expect that with excellent healthcare protection, alongside robust and holistic health promotion strategies, elderly individuals will be able to sustain their health and handle disability and diminished capacities with dignity. Furthermore, providing them with excellent interventional rehabilitation therapies in a timely manner will enable affected individuals to maintain optimal health status and quality of life.

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References

- [1] Stef Brinkman et al., "The Association Between Lifestyle and Overall Health Using the Frailty Index," *Archives of Gerontology and Geriatrics*, vol. 76, pp. 85–91, 1999. *Crossref*, <https://doi.org/10.1016/j.archger.2018.02.006>
- [2] Ding-Cheng (Derrick) Chan et al., "Validation of the Chinese-Canadian Study of Health and Aging Clinical Frailty Scale (CSHA-CFS) Telephone Version," *Archives of Gerontology and Geriatrics*, vol. 50, no. 3, pp. e74-e80, 2010. *Crossref*, <https://doi.org/10.1016/j.archger.2009.06.004>
- [3] Andrew Clegg et al., "Frailty in Elderly People," *The Lancet*, vol. 381, no. 9868, pp. 752–762, 2013. *Crossref*, [https://doi.org/10.1016/s0140-6736\(12\)62167-9](https://doi.org/10.1016/s0140-6736(12)62167-9)
- [4] Chang, *The Encyclopedic Dictionary*, Taipei City: Chinese Culture University, 2005.
- [5] Chen H.C et al., "Nutritional Management for Senile Frailty," *Formosan J Med*, vol. 19, no. 5, pp. 137-148, 2015.
- [6] Chen C.Y., "Research and Application of Geriatric Frailty in Taiwan," *The Journal of Long-Term Care*, vol. 19, no. 2, pp. 137-148, 2015.
- [7] Jan De Lepeleire et al., "Frailty: an Emerging Concept for General Practice," *British Journal of General Practice*, vol. 59, no. 562, pp. e177-e182, 2009. *Crossref*, <https://doi.org/10.3399/bjgp09x420653>
- [8] Dictionary by Merriam-Webster, 2022. [Online]. Available: <https://www.merriam-webster.com>
- [9] Loic Desquilbet et al., "Relationship Between a Frailty-Related Phenotype and Progressive Deterioration of the Immune System in HIV-Infected Men," *Journal of Acquired Immune Deficiency Syndromes*, vol. 50, no. 3, pp. 299–306, 2009. *Crossref*, <https://doi.org/10.1097/qai.0b013e3181945eb0>
- [10] Irene Drubbel et al., "Identifying Frailty: do the Frailty Index and Groningen Frailty Indicator Cover Different Clinical Perspectives? A Cross-Sectional Study," *BMC Family Practice*, vol. 14, no. 64, 2017. *Crossref*, <https://doi.org/10.1186%2F1471-2296-14-64>
- [11] L.P. Fried et al., "Preclinical Mobility Disability Predicts Incident Mobility Disability in Older Women," *Journal of Gerontology-Series a Biological Sciences Medical Sciences*, vol. 55, no. 1, pp. M43-M52, 2000. *Crossref*, <https://doi.org/10.1093/gerona/55.1.m43>
- [12] L.P. Fried et al., "Frailty in Older Adults: Evidence for a Phenotype," *Journal of Gerontology-Series a Biological Sciences Medical Sciences*, vol. 56, no. 3, pp. M146-156, 2001. *Crossref*, <https://doi.org/10.1093/gerona/56.3.m146>
- [13] Linda P. Fried et al., "Nonlinear Multisystem Physiological Dysregulation Associated with Frailty in Older Women: Implications for Etiology and Treatment," *The Journals of Gerontology-Series a Biological Sciences Medical Sciences*, vol. 64A, no. 10, pp. 1049–1057, 2009. *Crossref*, <https://doi.org/10.1093/gerona/glp076>
- [14] Alberto Frisoli Jr et al., "Severe Osteopenia and Osteoporosis, Sarcopenia, and Frailty Status in Community-Dwelling Older Women: Results from the Women's Health and Aging Study (WHAS) II," *Bone*, vol. 48, no. 4, pp. 952-957, 2011. *Crossref*, <https://doi.org/10.1016/j.bone.2010.12.025>
- [15] Robbert J Gobbens et al., "Toward a Conceptual Definition of Frail Community Dwelling Older People," *Nursing Outlook*, vol. 58, no. 2, pp. 76-86, 2010. *Crossref*, <https://doi.org/10.1016/j.outlook.2009.09.005>
- [16] Robbert J Gobbens, Jos Mga Schols, and Marcel Alm van Assen, "Exploring the efficiency of the Tilburg Frailty Indicator: A Review," *Clinical Interventions in Aging*, vol. 12, pp. 1739–1752, 2017. *Crossref*, <https://doi.org/10.2147/CIA.S130686>
- [17] Magali Gonzalez-Colaço Harmand et al., "Comparing the Predictive Value of Three Definitions of Frailty: Results from the Three-City Study," *Archives of Gerontology and Geriatrics*, vol. 72, pp. 153–163, 2017. *Crossref*, <https://doi.org/10.1016/j.archger.2017.06.005>
- [18] H. Rhrisch, X Liu, and T. M Witten, "Mortality-Rate Crossovers and Maximum Lifespan in Advantaged and Disadvantaged Populations: Accelerated-mortality and Sudden-death Models," *Journal of Theoretical Biology*, vol. 205, no. 2, pp. 171-180, 2000. *Crossref*, <https://doi.org/10.1006/jtbi.2000.2063>
- [19] Li-Shan Ke, "Frailty in the Elderly: A Concept Analysis," *Journal of Nursing*, vol. 60, no. 1, pp. 105-130, 2013. *Crossref*, <https://doi.org/10.6224/JN.60.1.105>
- [20] Liang Shih-Chiu, *Far East Practical English-Chinese Dictionary*, 2nd Edition, Taipei: The Far East Book CO, 1993.
- [21] Longman Editorial Department, *Longman Dictionary*, 3rd Edition, Hong Kong: Pearson, 2004.
- [22] B.L Lu et al., "Frailty Status and Associated Factors in Outpatient Older People with Chronic Disease," *Taiwan Geriatr Gerontol*, vol. 5, no. 1, pp. 36-49, 2010.
- [23] Michele Malaguarnera et al., "What is the Frailty in Elderly? Value and Significance of the Multidimensional Assessments," *Archives of Gerontology and Geriatrics*, vol. 56, no. 1, pp. 23–26, 2013. *Crossref*, <https://doi.org/10.1016/j.archger.2011.09.017>
- [24] Ministry of Health and Welfare, *Healthy People 2020*, Taipei: Ministry of Health and Welfare, R.O.C. (Taiwan), pp. 216-221, 2019.

- [25] Arnold B. Mitnitski, Alexander J. Mogilner, and Kenneth Rockwood, "Accumulation of Deficits as a Proxy Measure of Aging," *The Scientific World Journal*, vol. 1, 2001. *Crossref*, <https://doi.org/10.1100/tsw.2001.58>
- [26] Arnold B Mitnitski et al., "The Mortality Rate as a Function of Accumulated Deficits in a Frailty Index," *Mechanisms of Ageing and Development*, vol. 123, no. 11, pp. 1457-1460, 2022. *Crossref*, [https://doi.org/10.1016/s0047-6374\(02\)00082-9](https://doi.org/10.1016/s0047-6374(02)00082-9)
- [27] Oxford Learner's Dictionaries, 2022. [Online]. Available: <https://www.oxfordlearnersdictionaries.com/>
- [28] M T Richardson et al., "Comprehensive Evaluation of the Minnesota Leisure Time Physical Activity Questionnaire," *Journal of Clinical Epidemiology*, vol. 47, no. 3, pp. 271-81, 1994. *Crossref*, [https://doi.org/10.1016/0895-4356\(94\)90008-6](https://doi.org/10.1016/0895-4356(94)90008-6)
- [29] Deirdre A Robertson, George M Savva, and Rose Anne Kenny, "Frailty and Cognitive Impairment -A Review of the Evidence and Causal Mechanisms," *Ageing Research Reviews*, vol. 12, no. 4, pp. 840– 851, 2013. *Crossref*, <https://doi.org/10.1016/j.arr.2013.06.004>
- [30] K Rockwood et al., "Frailty in Elderly People: An Evolving Concept," *Canadian Medical Association Journal*, vol. 150, no. 4, pp. 489–495, 1994.
- [31] Kenneth Rockwood, and Olga Theou, "Using the Clinical Frailty Scale in Allocating Scarce Health Care Resources," *Canadian Geriatrics Journal*, vol. 23, no. 3, pp. 210–215, 2020. *Crossref*, <https://doi.org/10.5770/cgj.23.463>
- [32] Darryl B Rolfson et al., "Validity and Reliability of the Edmonton Frail Scale," *Age and Ageing*, vol. 35, no. 5, pp. 526–529, 2006. *Crossref*, <https://doi.org/10.1093/ageing/af1041>
- [33] Ryota Sakamoto, and Yasushi Miura, "The Effect of Exercise Intervention on Frail Elderly in Need of Care: Half-Day Program in a Senior Day-Care Service Facility Specializing in Functional Training," *The Journal of Physical Therapy Science*, vol. 28, no. 7, pp. 1957-1963, 2016. *Crossref*, <https://doi.org/10.1589/jpts.28.1957>
- [34] Josje D.Schoufour et al., "Predicting Disabilities in Daily Functioning in Older People with Intellectual Disabilities Using a Frailty Index," *Research in Developmental Disabilities*, vol. 35, no. 10, pp. 2267–2277, 2014. *Crossref*, <https://doi.org/10.1016/j.ridd.2014.05.022>
- [35] N Steverink et al., "Measuring Frailty: Developing and Testing the GFI (Groningen Frailty Indicator)," *Gerontologist*, vol. 41, no. S1, pp. 236, 2001.
- [36] Ming Yueh Tseng, and Yea-Ing Lotus Shyu, "A Concept Analysis of Frailty in the Elderly," *The Journal of Nursing*, vol. 55, no. 6, pp. 80-85, 2008.
- [37] Lorraine Walker, and Kay Avant, *Strategies for Theory Construction in Nursing*, 4th Edition, NJ: Pearson Prentice Hall, 2005.
- [38] J Walston, and L P Fried, "Frailty and the Older Man," *Medical Clinics of North America*, vol. 83, no. 5, pp. 1173-1194, 1999. *Crossref*, [https://doi.org/10.1016/s0025-7125\(05\)70157-7](https://doi.org/10.1016/s0025-7125(05)70157-7)
- [39] Wu, Y.J., Chou, Y.C., and Chan, D.C. "Review: Sarcopenia and Frailty," *Journal of Internal Medicine of Taiwan*, vol. 25, pp. 131- 136, 2014.
- [40] United Nations, Global Issues: Ageing, World Population Prospects 2022, 2022. [Online]. Available: <https://population.un.org/wpp/>