

Healthy aging, early screening, and interventions for frailty in the elderly

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SUMMARY With the intensification of population aging worldwide, the health problems of the elderly have become a particular concern. Functional disability is a prominent problem in the aging of this population, resulting in the decreased quality of life of senile people. Risk factors for functional disability in the elderly include geriatric syndromes and the associated diseases such as frailty. The influence of frailty on the health of the elderly has been a hot topic in recent years. As a dynamic and reversible geriatric syndrome, it has become one of the important public health problems emerging around the world. Frailty lies between self-reliance and the need for care and is reversible. Reasonable preventive interventions can restore the elderly to an independent life. If no interventions are implemented, the elderly will face a dilemma. There is no gold standard for frailty screening around the world. In order to alleviate frailty in the elderly, many countries have conducted early screening for frailty, mainly focusing on nutrition, physical activity, and social participation, in order to detect and prevent frailty earlier and to reduce the incidence of frailty. This topic provides an overview of the current status of frailty, early screening for frailty, and the interventions for frailty in most countries of the world.

Keywords frailty, aging, strategy, early screening, management

1. Introduction

Population aging is accelerating around the world, and this demographic change will have important impacts on all aspects of society. In Asia, Japan has taken the lead in becoming the country with the highest aging rate in the world. The figures released by the Japanese Government in 2022 showed that the population over 65 years of age has reached 36.21 million, accounting for 28.9% of the total population (*i.e.*, the aging rate) (1). Similarly, China has become the country with the largest number of elderly people. The seventh national census released by China's National Bureau of Statistics (2) reported that by the end of 2020, China's population age 60 and over reached 264 million, accounting for 18.7% of the total population. Of these, 191 million were age 65 or older, accounting for 13.5%. In 2025, the proportion of senile people age 65 and above is expected to reach 14% of the total population and 30% of the total population in 2050 (Figure 1). According to the survey statistics, the average life expectancy of Chinese residents has increased from 77.3 years in 2019 to 78.2 years in 2021, and the healthy life expectancy of Chinese residents was

68.7 years in 2018, which means that these residents would live with disease for an average of 8-9 years (3). According to the latest data released by the World Health Organization (WHO), chronic diseases account for 6 of the top 10 causes of death around the world (4). Notably, most elderly people in China have chronic diseases such as diabetes and hypertension; the prevalence of chronic diseases in this population is 43.6% (5). Obviously, chronic diseases not only shorten the healthy life span of the elderly but also make the elderly more vulnerable to the risk of disease. Serious chronic diseases may even markedly affect the daily living and quality of life of the elderly. At the same time, a variety of diseases increase the number of elderly outpatients and hospitalizations, resulting in a sharp increase in medical costs and consumption of a large amount of medical resources. Therefore, population aging poses great challenges to health care worldwide (6).

The world's population is aging, and the current demographic and health shifts are contributing to a rapid increase in the number of people experiencing disability or declines in functioning for substantially larger periods of their lives (7). Disability is a prominent challenge

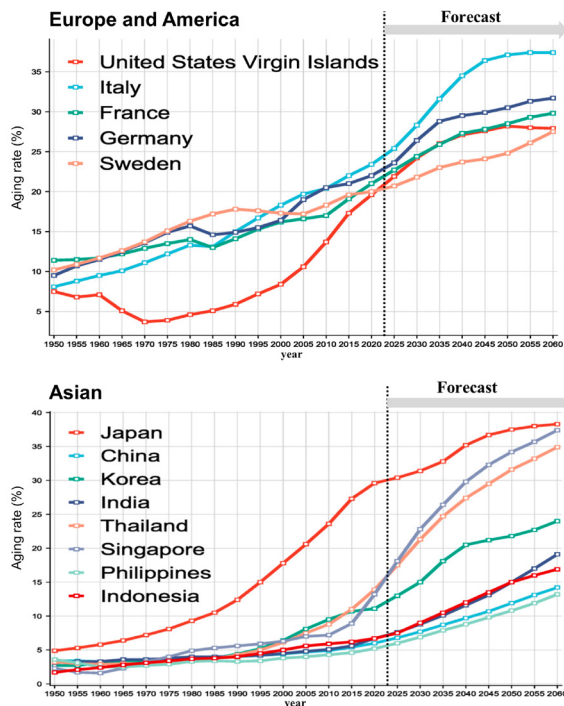


Figure 1. The aging rate of various countries in Europe, the US, and Asia (Source: United Nations, Department of Economic and Social Affairs, Population Division (2022). World Population Prospects 2022, Online Edition).

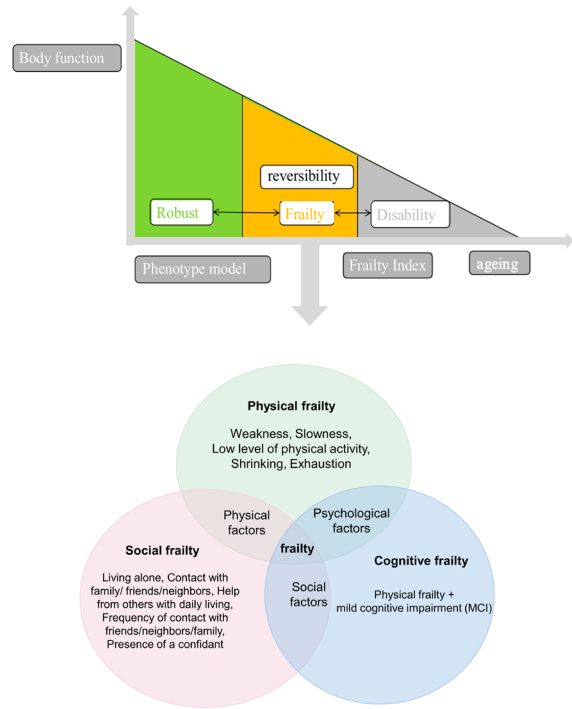


Figure 2. Diminished bodily functions and types. Frailty is a state between robust and disability. The probability of frailty increases with age and diminished physical functioning. Frailty can be determined by the Frailty Assessment Tools. Frailty consists of physical frailty, social frailty and cognitive frailty, which could individually or interact with each other to affect frailty by their respective counterpart factors.

in the process of population aging. One of the goals of the Healthy China action plan to promote the health of the elderly is to reduce the incidence of disability in the elderly. Moreover, the Core Message of Disability Prevention in Old Age (8) pointed out that risk factors for disability in the elderly include geriatric syndromes and diseases such as frailty. Frailty, a consequence of the interaction of the aging process and certain chronic diseases, compromises functional outcomes in the elderly and substantially increases their risk for developing disabilities and other adverse outcomes (9). Since frailty is a constantly evolving process, frailty in the elderly can be alleviated through certain interventions at an early stage. Consequently, actively promoting early screening and ascertaining effective interventions in frailty are of great significance to improving the quality of life of the elderly and reducing the public health burden.

2. The current status of frailty

Fried *et al.* provided the first standardized definition of the concept of frailty as a clinical syndrome with decreased internal stability and increased vulnerability due to the diminution of the functional reserves of multiple physiological systems (10). The course of frailty is a decline in functioning across multiple physiological systems, accompanied by an increased vulnerability to stressors. Being frail places a person at increased risk of adverse outcomes, including falls, hospitalization, and mortality (11). Although many

researchers have paid attention to the problem of senile weakness since the 1970s and many different definitions have been proposed, there is still no uniform definition for clinical use (12) (Figure 2). According to the definition based on a Chinese "expert consensus", about 10% of the community-dwelling elderly age 60 and above, 15% of the elderly age 75-84, and about 25% of the elderly age 85 and above suffer from frailty (13-15). About 30% of the elderly are hospitalized (16). The incidence of frailty in the elderly in Japan is 7.4-8.7%, and the incidence of pre-frailty in the elderly is 40.8-48.1% (17-18). One can thus infer that the frail elderly and the pre-frail elderly account for 50% of the total number of elderly. As aging accelerates, so does the incidence of frailty. Subsequently, the physical and mental health problems caused by frailty become a problem that cannot be ignored. Frailty may have a serious impact on the quality of life, health status, and prognosis of individuals, including the decline of various physical functions and less ability to perform daily activities. Loss of appetite and changes in eating habits may also occur, leading to insufficient nutrient intake and accelerating the development of malnutrition and even resulting in a decline in personal self-confidence, anxiety, depression, and other psychological problems. These conditions ultimately require more frequent medical treatment and care and increase the consumption of medical resources and the economic

Table 1. Early screening characteristics in selected countries

Nation	Tools for early screening
China (25,26)	(1) clinical frailty scale (CFS), (2) frailty scale (FS), (3) Edmonton frailty scale (EFS), (4) Fried phenotype (FP), (5) Fried frailty phenotype (FFP), (6) frailty index (FI), (7) American frailty index (AFI), (8) Comprehensive Geriatric assessment (CGA), (9) Frailty Index-Comprehensive Geriatric assessment (FI-CGA), (10) Short Physical Performance Battery (SPPB), (11) Study of Osteoporotic Fractures (SOF).
US (27-29)	(1) frailty phenotype (FP), (2) Frail Scale (FS), (3) Study of Osteoporotic Fractures (SOF), (4) Short Physical Performance Battery (SPPB).
Canada (30,31)	(1) frailty index (FI), (2) clinical frailty scale (CFS), (3) Frailty Index-Comprehensive Geriatric assessment (FI-CGA), (4) Canadian Triage and Acuity Scale (CTAS), (5) Edmonton frailty scale (EFS), (6) The Canadian Study for Health and Aging Clinical Frailty Scale (CSHA-CSF).
Holland (32-34)	(1) Groningen Frailty Indicator (GFI), (2) Tilburg Frailty Indicator (TFI), (3) Comprehensive Frailty Assessment Instrument (CFAI).
Japan (35-38)	(1) Japan Frailty Scale (JFS), (2) Kihon Check-list (KCL), (3) frailty screening index (FSI), (4) frailty phenotype (FP).

burden. Early screening for frailty could protect the health and quality of life of the elderly, reduce the burden of medical care on the individual and his or her family, and promote the rational use of social resources to better meet the challenges of an aging society.

3. Screening for frailty

In recent years, the focus of medicine has shifted from the diagnosis and treatment of diseases to the early prevention of diseases in order to reduce and delay the development of diseases (19). The Task Force of the International Conference on Frailty and Sarcopenia Research (ICFSR) recommends that frailty be evaluated in all adults age 65 years and older by simple and effective assessment tools adapted to specific conditions. In addition, screening for possible vulnerability and evaluation of older adults in the early stages of frailty could help to reduce the likelihood of frailty (20). Comprehensive assessment of aging (CGA) is evaluated by physical function status, mental and psychological status, pain, sleep, and other items. Normally, it takes less than 5 minutes to complete all programs. These evaluations can be used in community health service centers and geriatric clinics to screen older adults with frailty-related risk factors. CGA allows for early detection of potential problems in the elderly and timely intervention, with the aim of promoting the health of the elderly and improving their quality of life (21-23). At present, there are around 67 frailty assessment tools available internationally and more are being developed (24). Table 1 shows that different countries have frailty assessment tools suited to their circumstances. The frailty phenotype and frailty screening index are also trusted assessment tools for frailty in all countries. A literature search of PubMed yielded frailty assessment tools, and these tools can be roughly divided into the following categories based on their use (Table 1): *i*) Assessment of frailty

biomarkers (such as those detected in serum including inflammatory factors and hormones); *ii*) Different or specific frailty assessment tools; *iii*) Frailty risk factor assessment tools; *iv*) Screening criteria for inclusion or exclusion of subjects; *v*) Evaluation of the prevalence of frailty; *vi*) A clinical decision guide to evaluate the eligibility of elderly patients for surgery and the prognosis; *vii*) Prognostic indices to determine the effectiveness of interventions; and *viii*) Predictors or risk factors for a variety of age-related adverse health outcomes, including disability and death.

The frailty screening tools vary in their consistency, applicability, and effectiveness (37,38). For example, some frailty measures are more appropriate for community health settings, while others may be most effective for frailty screening or diagnosis in a hospital setting (39). In addition, different frailty screening tools are used for different patients with various diseases (26). However, a "gold standard" for frailty has not yet been established, resulting in the fact that screening and assessment tools for frailty are often combined. That means that the requirements for screening and assessment tools for frailty are different (40). The basic requirements for valid screening tools are simplicity, speed, and sensitivity. Assessment tools need to be highly accurate, practical, and supported by reasonable biological theories. In the future, our aim is to distinguish the most common frailty scales for screening and assessment, effectively helping researchers and medical personnel to select frailty tools more accurately in order to identify elderly people at high risk of frailty in an early stage. Our objective is to achieve early detection, early diagnosis, early treatment, and prompt intervention (41). Studies have shown that frailty screening for disease may improve overall outcomes (42). In future frailty screening, researchers should fully consider the purpose of assessment, resources, priorities, characteristics of screenees, and feasibility. They should select appropriate frailty assessment tools in order to take effective

measures to alleviate the existing health problems of the elderly in advance, prevent the progression of frailty, improve quality of life, and ultimately live a healthy life in old age.

4. Frailty interventions and management

4.1. Non-drug interventions and management

4.1.1. Exercise

Exercise is the first choice for the prevention and treatment of frailty. It can improve the physical functions, mental state, and activities of daily living (ADL) of the elderly, alleviate depressive symptoms, and reduce the risk of falling to effectively prevent frailty. There are many types of traditional exercises in China, including Tai chi, Five Animal Exercises, and sitting Baduanjin. Sitting Baduanjin can effectively prevent frailty in elderly patients, and especially psychological frailty and social frailty (43,44). Tai chi combined with resistance training also help to alleviate symptoms of frailty in the elderly (45). Among the exercises suitable for frail elderly, aerobic exercise is the foundation; strength training is the core; explosive strength training and flexibility training are auxiliary; and balance training and virtual training are complementary. A multi-component exercise intervention strategy using a variety of training methods is the best choice for prevention and treatment of asthenic syndrome in the elderly (46).

4.1.2. Nutrition

Nutrition plays a crucial role in the development and progression of frailty. The intake of a series of nutrients such as energy, protein, lipids, and vitamins decreases with age, resulting in undernutrition. Nutrition targets for healthy elderly people are as follows: *i*) Energy: The guiding value for energy intake in the general elderly population is recommended to be 20-30 kcal/kg. For elderly patients with malnutrition, low body weight, and stress, it can be increased to 30-40 kcal/kg (47); *ii*) Protein: According to data from the Health, Aging, and Body Composition study in the US, dietary total and animal protein intake were associated with an increase in lean mass in older people. Compared to American people, Japanese people consume a lower amount of dietary animal protein (8.9% for men and 8.8% women in Japan, and 10.2% for men and 10.1% for women in the US) (48). The better approach is to focus on quality protein, such as fish, milk, and eggs; *iii*) Carbohydrates: The recommended carbohydrate intake is 50-65% of total energy (49); *iv*) Fat: The standard daily fat intake per person is 8.22-12.50 g, and the standard daily animal fat intake per person is 25.40-36.80 g (50); *v*) Dietary fiber: The recommended intake is 17-19 g/d (51); *vi*), Microelements and vitamins: Fruits and vegetables are

rich in microelements such as vitamins, and the lower limit of vegetable intake for the elderly is 300-500 g/d, and the lower limit of fruit intake is 200-350 g/d (52).

4.1.3. Social environment

Seclusion and lack of communication with the outside world are phenomena of social frailty (53). Social frailty also affects physical frailty. In contrast to physical frailty, social frailty is associated with the subjective mindset of the elderly. A study has suggested that loneliness in general is not what affects frailty but actively engaging in activities. Therefore, preventing frailty by implementing interventions that promote older adults' active engagement may improve their quality of life (54).

In response to the COVID-19 pandemic, people are going out less often and have fewer opportunities to communicate with others. As information technology has continued to advance in recent years, VR technology mainly using a desktop computer, a large screen, and goggles is widely used in post-stroke cognitive rehabilitation training and balance and walking ability training for the elderly (55,56). As one benefit, it can solve the physical frailty caused by the inconvenience of going out. As another benefit, information technology can also alleviate social isolation caused by reduced human interaction in order to bring people closer together *via* remote means. Use of VR technology in the assessment and rehabilitation treatment of the elderly can both provide personalized and accurate care to improve the health status of the elderly and also offer health education support to the elderly to reduce their anxiety and mental depression.

4.2. Drug interventions and management

4.2.1. Polypharmacy and frailty

A hierarchical diagnosis and treatment policy is gradually being implemented in China. Since the establishment of the family doctor system in Shanghai in 2011, residents' trust and recognition of family doctors have gradually increased. Family doctors can promptly and comprehensively ascertain chronic diseases in the elderly and their medication status, which is conducive to avoiding redundant medication and over-dosage (57). Other important approaches are to enhance community medical centers, continuing to pay attention to the status of chronic diseases in the elderly in the community, tracking health status and medication, and making full use of the Internet and chronic disease management platforms. Moreover, timely health education, targeted treatment, and regular follow-up are also of great importance. The elderly should follow the doctor's advice so that medication is "reduced and more precise". A multidisciplinary geriatric medicine team can be

set up to participate in the multi-drug management of chronic comorbidities in the elderly it can further evaluate drug safety and efficacy in patients, promptly identify problems with drug treatment, and implement effective interventions (58). Senile patients should be advised to avoid self-treatment based on feelings and life experience and to reduce the abuse of non-prescription drugs, "folk remedies" and "secret recipes", and various health products. The elderly is encouraged to have regular health check-ups and seek medical attention whenever they notice new symptoms.

4.2.2. Chronic disease management and frailty

Around the world, the "big 5" chronic diseases are diabetes mellitus, cardiovascular disease, chronic respiratory disease, cancer, and stroke (59). The elderly often have chronic diseases such as diabetes and high blood pressure. A point worth noting is that chronic diseases are often poorly managed, resulting in debilitating phenomena. Improper management of diabetes in the elderly can easily lead to severe hypoglycemia. Severe hypoglycemia increases the risk of cognitive impairment, heart and muscle infarction, and stroke. To control hyperglycemia in the elderly, the Gerontological Society of America has made the following recommendations: *i*) The goal of blood sugar control varies according to the age, cognitive function, physical condition, and other attributes of different elderly people. *ii*) Selection of hypoglycemic drugs. Drugs with a low risk of hypoglycemia and few adverse reactions should be selected, following individualized selection. *iii*) Non-drug treatment. Hazuda *et al.* (62) noted that early lifestyle interventions had more advantages than taking metformin in preventing faltering in elderly patients with diabetes. Japanese researchers noted that nutritional management of elderly diabetic patients should transition from the prevention of metabolic syndrome to prevention of frailty (63). A varied diet and adequate energy intake are important to preventing frailty in diabetic patients (64). In addition, a study has shown that Baduanjin combined with cognitive training can slow the decline of cognitive function, alleviate frailty, and reduce the blood sugar level in elderly diabetic patients, and this exercise is suitable for clinical and community promotion (65).

The current relevant guidelines on elderly hypertension do not provide clear goals for reducing blood pressure in the frail population (66). The guidelines issued by the International Association of Hypertension (ISH) in 2020 recommended that for elderly people age 65 and above, if they can tolerate antihypertensive treatment, blood pressure should be reduced to 140/90 mmHg. However, personalized antihypertensive therapies need to be developed according to the specific conditions of patients; frailty, the ability to live independently and other aspects need

to be assessed; and no clear target values for reducing blood pressure are suggested (67). Of particular concern is excessive lowering of blood pressure, which increases the risk of falls (68). The initiation of drug therapy and the target value for lowering blood pressure are individualized for patients with hypertension.

Chronic respiratory diseases (CRDs) had a high prevalence, a high rate of disability, a long course, and high treatment costs. Chronic Obstructive Pulmonary Disease (COPD) is particularly harmful. According to survey statistics, there are 212.3 million patients with COPD (200.4-225.1), and COPD was the primary cause of deaths from CRDs, accounting for 3.3 million (2.9-3.6) deaths (69). Multiple global initiatives have been developed over the past few decades to improve respiratory care, undoubtedly contributing to the global decline in the age-standardized burden of CRDs. The Practical Approach to Lung health (PAL) was another tool created by the WHO to improve the management of respiratory patients in primary healthcare settings, and especially in countries with weak health systems (70). In addition, other global initiatives focusing on COPD (GOLD) (71) have been developed to increase awareness and improve prevention, management, and access to effective treatments. A study in the UK has shown that frailty was associated with mortality from respiratory diseases, while healthy behavior was able to mediate frailty to a certain extent. Therefore, promotion of a healthy lifestyle may be able to substantially attenuate the contribution of frailty to mortality from respiratory diseases (72).

When a patient has a tumor, his or her body is invaded by the tumor, and the patient faces a series of stressors such as surgery, chemo radiotherapy, and psychology; in such cases, frailty is particularly common, with an incidence of 6-86% (73). The following recommendations are given for the management of cancer patients in China: no smoking, not drinking excessively, maintaining a normal weight, engaging in proper physical exercise, and eating more vegetables and fruits to significantly reduce the incidence of cancer. Maintaining a healthy lifestyle has significant public health benefits (74). The most effective measures for preventing and controlling malignant tumors are primary prevention targeting risk factors and etiology (75). Early screening for disease plays a crucial role in detecting frailty. Prevention of frailty differs in different countries, and approaches focus on different psychological, physical, and social aspects (Table 2).

4.2.3. Frailty and novel coronavirus

In late October 2020, a paper in the Journal of the American Geriatrics Society compiled data from patients with COVID-19 and found that the determining factor of death was not age but the degree of frailty

Table 2. Interventions for and management of frailty around the world

Nation	Frailty prevention strategy
China (78)	1. Conduct systematic health education, 2. Raise the level of social support and strengthen health management for the elderly, 3. Regular comprehensive geriatric assessment, 4. A healthy lifestyle, 5. Personalized nutrition interventions, 6. Healthy exercise, 7. Cognitive training, 8. Fall prevention, 9. Mental health, 10. Management of comorbidities and polypharmacy.
Japan (79)	An integrated community-based care system, with nutrition (food and oral function), physical activity (activities of daily life, sports, <i>etc.</i>) and social engagement (social activity) as the three pillars of frailty prevention, paralleled by polypharmacy and chronic disease management.
South Korea (80)	In South Korea, where research on frailty prevention began in 2014, there have been fewer studies focusing on the mental and social aspects and more on the physical aspects. Research mainly concerns two aspects of frailty prevention, food and exercise. In the future, attention needs to be paid to the physical aspects as well as the mental and social aspects.
US (81)	Mainly concerning the three major aspects of frailty prevention (psychological, physical, and social), but also through the intake of nutritious food to reduce the possibility of frailty.
Canada (82)	Frail or pre-frail elderly people adopt nutritional strategies (protein-fortified foods and supplements, vitamin D) and comprehensive physical activity (aerobic exercise, resistance exercise, balance exercise, flexibility exercise, and muscle strengthening exercise), and rehabilitation training is recommended for frail elderly people to achieve the combination of physical activity and nutrition.
Singapore (83)	The elderly are encouraged to participate in society, and the infirm should be given group exercises, including aerobic, resistance, balance, and strength training. At the same time, increase nutritional intake.
Spain (84)	Effective interventions in Spain include exercise, nutrition, cognitive training, geriatric assessment management, and rehabilitation. Among them, exercise interventions varied in duration, frequency, and type of exercise, but all were effective in reducing the degree of weakness.
Holland (85)	The prevalence of frailty was reduced by enhancing physical exercise, nutritional supplementation, cognitive training, and combination therapy.
Germany (86)	More attention needs to be paid to ways to improve physical activity and muscle strength, as well as to the emergence of depressive symptoms, the prevention of falls, and the control of polypharmacy.

and disability (85-87). Weakness also reduces the protection from COVID-19 vaccines in humans (88). That same year, a study in the UK also confirmed that frailty was associated with a higher risk of death from severe pneumonia infections (89-91). The Journal of the European Geriatric Society also pointed out that the mortality rate of COVID-19 patients is closely related to frailty (92-94). The Brazilian Journal of Medicine reported that the increased frailty often associated with COVID-19 also increases the risk of death (95,96). Frailty has been recognized as a risk factor for severe and post-critical outcomes of COVID-19 (97,98).

5. Healthy aging

As aging occurs globally, the health of the elderly has become a hot issue. However, there are no universal or set indicators of frailty. A set of simple and feasible frailty indices would be conducive to identifying more frail patients. Taking Japan as an example, the life problems of the elderly are addressed through a comprehensive pension policy and pension system. The "integrated community-based care system" was developed as a national policy. The "integrated community-based care system" is a comprehensive guarantee of medical care, nursing, preventive care,

housing, and livelihood maintenance. For example, enhanced medical collaboration, 24-hour home care, enhanced visiting nursing, and rehabilitation training are included. Care includes home visits, shopping, food delivery, and shower assistance. In the face of the increasing number of elderly people living alone or as couples, the construction and maintenance of barrier-free housing for the elderly and the disabled is also a guarantee for frail elderly.

In recent years, China has begun to implement a hierarchical diagnosis and treatment policy based on the medical experiences of other countries. The contracted family doctor service is the foundation for promoting the creation of a hierarchical diagnosis and treatment system, and it plays a positive role in promoting the continuous treatment of elderly patients. At present, this is only a pilot program in a few cities in China, but hopes are to establish a nationwide medical system to provide better living conditions for the elderly to help them enjoy their old age.

Various countries have taken active measures to prevent frailty mainly related to the three aspects of physical, psychological and social conditions as well as nutritional intake. As part of future global measures to prevent frailty, a set of systematic policies to prevent frailty should be formulated to deal with frailty globally,

to reduce the risk of frailty and the rate of admission and readmission in the elderly, and to improve their quality of life.

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