Global Health & Medicine. 2025; 7(5):358-369. REVIEW
DOI: 10.35772/ghm.2025.01026

Research progress on intrinsic capacity in older adults: Concepts, epidemiology, assessments, influencing factors, adverse outcomes, and interventions

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Abstract: Intrinsic capacity (IC), introduced by the World Health Organization, is a core concept in the framework of healthy ageing. This study reviews the relevant concepts, epidemiology, assessments, influencing factors, adverse outcomes, and interventions concerning IC. IC refers to the composite of physical and mental capacities that an individual can draw on to live independently and thrive. Although IC is closely related to frailty and physiological reserve (PR), there are conceptual differences: IC represents the inherent functional reserve, frailty reflects the cumulative state of functional deficits, and physiological reserve emphasizes the ability to resist functional physical decline. IC assessments include comprehensive screening instruments of Integrated Care for Older People (ICOPE) and combinations of domain-specific scales; however, these approaches face challenges such as the inability to provide quantifiable results and the lack of standardized criteria, highlighting the urgent need to develop a standardized IC assessment system. Biomarkers may serve as supportive assessment tools, but their application is limited by cost and insufficient evidence, underscoring the need for future development of predictive models that integrate them. The main factors influencing IC include sociodemographic characteristics, physical health, psychosocial factors, and lifestyle. IC is strongly associated with health outcomes, serving as an effective predictor of several adverse outcomes. Interventions targeting IC primarily include ICOPE-guided multidomain interventions, along with other interventions such as multicomponent exercise, cognitive stimulation therapy, and dietary intervention; however, high-quality controlled trials remain limited, and the optimal timing and mechanisms of intervention require further investigation. This review offers important insights for clinical practice and research aimed at promoting healthy ageing among older populations.

***Keywords*:** older adults, intrinsic capacity (IC), review, healthy ageing

1. Introduction

The trend of the global population distribution shifting towards older age groups is steadily increasing, with population ageing reaching serious proportions worldwide. From 2020 to 2030, the global population of individuals aged 60 and older is expected to increase from 1 billion to 1.4 billion, accounting for approximately one-sixth of the total global population. By 2050, this demographic is expected to double in size, reaching 2.1 billion (*1*). With the growth of the elderly population and the extension of life expectancy, the issue of longevity without health has become increasingly prominent (*2*), making the promotion of health among older adults crucial in the process of population ageing.

Healthy ageing has been introduced as an important global strategy to proactively address population ageing, aiming to improve the health, functional ability, and quality of life of older adults (*3*). It is a multidimensional concept encompassing physiological, psychological, and social aspects, and is defined as "the process of developing and maintaining the functional ability that enables wellbeing in older age", where functional ability refers to the capabilities that enable individuals to be and do what they have reason to value (*4*). To help older adults maintain stable functional performance, the World Health Organization (WHO) first introduced the concept of "intrinsic capacity (IC)" in the World Report on Ageing and Health in 2015, aiming to help older adults maintain stable functional performance by

shifting the focus of elder care from a "disease-centered" to a 'function-centered' approach, improving physical function and quality of life, and thereby promoting healthy ageing (*3*). With advancing age, the functions of organs and tissues gradually decline, leading to reduced physical function and an increased risk of adverse health outcomes. IC can comprehensively reflect the overall status of older adults and serve as a predictor of adverse health outcomes (*5*).

Therefore, by understanding the relevant concepts of IC, utilizing IC assessments for dynamic functional monitoring, identifying critical risk transition points in older adults, and implementing early risk factor detection alongside personalized interventions, it is possible to delay functional decline, reduce adverse outcomes, enhance well-being and quality of life, and ultimately promote healthy ageing. Therefore, this study reviews the relevant concepts, epidemiology, assessments, influencing factors, adverse outcomes, and interventions concerning IC, aiming to provide a valuable reference for future studies on IC among older adults.

2. Relevant concepts of IC

2.1. IC

IC, which refers to the composite of all the physical and mental capacities that an individual can draw on to live independently and thrive, represents the inherent functional reserve and reflects the foundation of older adults' capabilities and health status (*4*). While there is no universally uniform definition of IC at present, Wu *et al.* (*6*) identified four key attributes in their conceptual analysis: being oriented towards achieving the goal of healthy ageing, the inherent physiological reserve of an individual, the richness and interaction of the dimensions, and a dynamic and reversible developmental trajectory. WHO conceptualizes IC as comprising five dimensions: vitality, locomotion, cognition, psychology, and sensation, all of which are interrelated and influence each other (*7*).

IC is closely linked to functional ability, with IC serving as the foundation for functional ability, while functional ability is the manifestation of IC in a given environment. Both decrease with age, but functional decline is more pronounced in individuals with lower IC levels. IC spans the entire life course and addresses health deficits in older adults from the perspective of functional reserve, which plays a crucial role in maintaining quality of life and promoting healthy ageing (*8*).

2.2. Frailty

Frailty is a clinical condition characterized by the individual's increased vulnerability to endogenous and exogenous stressors. Frailty and IC are closely related but conceptually distinct constructs (*9*), as illustrated in Table 1, both are derived from concepts rooted in the comprehensive assessment and management of older adults, with the shared goal of promoting a person-centered model of care. IC can be regarded as a refined conceptualization of frailty; its assessment helps predict frailty in older adults, and its enhancement contributes to delaying the onset of frailty (*10*). However, each has unique characteristics. Frailty represents the cumulative state of functional deficits, primarily applied in the cross-sectional assessment of elderly inpatients (*11*). In contrast, IC reflects an individual's physiological reserve, becomes increasingly impaired with advancing age, and is primarily used for longitudinal assessment of health status in older adults (*12*). Therefore, integrating both concepts can facilitate a more comprehensive understanding of ageing trajectories and support more targeted approaches to prevention and care.

2.3. Physical resilience

Physical resilience (PR) is defined as the ability to resist functional physical decline (*13*). Although PR is closely related to IC, with both representing the body's reserve capacity, their conceptual focus differs (*14*), as shown in Table 1, IC reflects an individual's overall health, encompassing physical, mental, and cognitive domains, whereas physical resilience refers to an adaptive, event-triggered ability to cope with and recover from physiological challenges. These concepts are complementary: strong physical resilience supports improved IC, while better IC can enhance physical resilience in older adults (*15*). IC and PR frameworks hold significant promise for transforming the geriatric medicine and ageing research. While IC represents only one of several determinants of PR, it constitutes a critical intervenable target for strengthening resilience in the older population (*16*).

3. Epidemiology of IC

Previous studies indicated that IC impairments are common among older adults. The prevalence of IC decline among older adults varies across regions and population characteristics (*17*). A systematic review and meta-analysis of 16 studies from four countries (*18*) found that the pooled detection rate of IC decline in older adults was 76.1%, with higher detection rates observed in developed countries, among women, and in hospital settings. Specifically, the pooled detection rate was 73.7% in China, with higher rates in mainland China and Hong Kong compared to Taiwan. An observational cohort study in China (*19*) examined the trajectory of IC in community-dwelling older adults, revealing a prevalence of IC impairment of 67.9%, which increased to 81.6% after two years. Among older adults with no IC impairment at baseline, 50.8% developed impairment

in at least one domain over two years. A study in Hong Kong (*20*) using the WHO ICOPE Brief Screening Instrument (Step 1) and Detailed Comprehensive Assessment (Step 2) found that 72.7% of participants exhibited IC impairment in Step 1, while 66.4% had impairments in at least one IC domain after Step 2. A study in Mexico (*21*) revealed that 87.8% of participants experienced impairment in at least one IC domain, with mobility being the most commonly affected at 47.6%. Furthermore, a survey conducted by Prince *et al.* across eight countries (*22*) revealed that only 30% of individuals maintained full capacity in all domains at baseline. These findings collectively suggest that the overall level of IC among older adults is poor, reflecting a concerning state of health.

4. Assessments of IC

Assessments for IC are currently limited worldwide, with two main methods commonly used:

i) The comprehensive screening instrument of Integrated Care for Older People (ICOPE) (*23*), which is based on the theoretical framework of the International Classification of Functioning Disability, and Health (ICF), consisting of nine domains. Individuals showing impairment in any domain are classified as having impaired IC. This is a brief yet highly focused preliminary assessment tool that enables rapid screening of the five core domains of IC in older adults and is currently widely used in large-scale cross-sectional studies. While this tool is easy to administer and efficiently identifies deficient areas, its inability to provide quantifiable results constrains its applicability in further research.

ii) WHO recommends assessment tools for each dimension of IC, which are combined to generate a composite IC score used to evaluate IC. Two main approaches are employed at present: aggregating scores through simple summation (*24*), arithmetic means (*25*), or Z-scores (*26*); and constructing a composite index based on domain-specific scores (*27*). The most commonly used tools include the gait speed test and chair stand test for locomotion; handgrip strength measurement and the Mini Nutritional Assessment (MNA) for vitality; Mini-Mental State Examination (MMSE) to evaluate cognition; Geriatric Depression Scale (GDS) and the Center for Epidemiological Studies Depression Scale (CES-D) for psychology; and self-reported vision and health questionnaires to assess sensation (*28*). While mature scales are available for the individual evaluation of the five domains of IC, there is notable inconsistency in the instruments used across studies. Due to the variation in assessment scales and procedures across different studies, it is difficult to merge data across dimensions, which complicates the scoring and judgment of IC. Future research should focus on developing a standardized IC assessment system, establishing IC unified scoring indices and standardized quantification procedures, and formulating an IC assessment scale for older adults to provide practical tools for primary health evaluation.

Previous studies have shown that certain biomarkers are strongly associated with IC, which can serve as supportive tools for assessment. Ma *et al.* (*29*) found that Tumor Necrosis Factor Receptor 1 (TNFR1) levels are independently associated with declined IC, suggesting that chronic inflammation may underlie IC decline. Similarly, Lu *et al.* (*30*) discovered that plasma biomarkers of inflammation and mitochondrial damage can differentiate older adults with multiple impairments in IC from those with stable capacity. Lee *et al.* (*31*) observed that chronic inflammation, hyperglycemia, and low Dehydroepiandrosterone sulfate (DHEA-S) were associated with reduced IC, with low DHEA-S and vitamin D deficiency potentially serving as biomarkers for rapid decline in IC. The aforementioned studies demonstrated that low IC may be closely linked to inflammation and nutritional status, with specific biomarkers serving as early predictors of IC decline. Biomarkers can help reduce measurement errors when constructing IC scores and provide valuable references for assessments. By timely detecting and intervening in these biomarkers, the decline of IC can be slowed to some extent. As biomarker-based assessments of IC require substantial time and financial costs, relevant studies are limited and lack clear evidence. Therefore, future research should focus on developing predictive models incorporating biomarkers to assess IC decline, enabling early identification of high-risk individuals for timely interventions to preserve functional capacity and enhance the quality of life for older adults. In summary, Table 2 provides a comparative overview of tools for assessing IC, including their description, advantages, disadvantages, and expected future directions.

5. Factors influencing IC

Previous studies (*32,33*) have summarized that the main factors influencing IC include sociodemographic characteristics, physical health, psychosocial factors, and lifestyle. Sociodemographic characteristics primarily include age, gender, marital status, educational level, and socioeconomic status. IC declines with age and is more likely to be impaired in women, unmarried older adults, and individuals with lower education or economic status. Poor physical health, such as memory decline, urinary incontinence, constipation, slowness, chronic obstructive pulmonary disease, and osteoarthritis were related to IC decline (*17*). A study involving older adults from six countries (*34*) revealed that grip strength is strongly associated with other indicators of IC, confirming it as a single most important measure of IC. Establishing optimal handgrip strength thresholds may facilitate the early identification of individuals at risk of impaired IC,

Table 1. Conceptual comparison of intrinsic capacity, frailty, and physical resilience

Aspect	IC	Frailty	PR
Definition	The composite of all physical and mental capacities an individual can draw upon to live independently and thrive.	A clinical condition characterized by the individual's increased vulnerability to endogenous and exogenous stressors.	The capacity to resist functional physical decline.
Focus	Overall capacity across five domains: vitality, locomotion, cognition, psychology, and sensation.	Functional impairment and vulnerability.	Coping and recovery ability under physiological challenges.
Core Characteristics	Multidimensional, dynamic, and reversible.	Cumulative, deficit-oriented.	Adaptive and event-triggered.
Application	Longitudinal monitoring of older adults' health status and early detection of declines in function.	Cross-sectional assessment in clinical or hospital settings.	Utilized in rehabilitation to assess individual adaptability and guide intervention design.
Interrelationship	Conceptual foundation for functional ability.	Conceptually related to IC, with a shared emphasis on promoting a person-centered model of care; may be predicted by a decline in IC.	Complementary to IC: strong PR supports improved IC, while better IC can enhance PR.

IC, intrinsic capacity; PR, physical resilience.

Table 2. Comparative overview of tools for assessing intrinsic capacity

Assessment Method	Description	Advantages	Disadvantages	Expected Future Directions
ICOPE Screening Tool	A brief and standardized instrument developed by WHO based on the ICF framework, it screens five core domains of IC using nine items.	• Rapid and easy to administer; • Widely implemented in large-scale population; • Efficient in identifying deficient areas.	• Lacks quantifiable results; • Limited for Longitudinal Monitoring; • Lacks domain-specific granularity.	• Develop quantifiable scoring versions; • Refine domain-specific assessments.
Combination of Domain-Specific Scales	IC domain-specific tools are used to generate a composite IC score *via* summation, arithmetic means, Z-scores, or a domain-based composite index.	• Enables quantitative tracking; • Flexibility in tool selection per domain; • Suitable for longitudinal cohort studies.	• Inconsistency in tools across studies; • Lack of standardized scoring procedures; • Difficulty in data integration; • Complicated judgment of IC levels.	• Develop standardized IC assessment systems; • Unify tools across studies; • Create unified scoring indices and quantification procedures.
Biomarker-Based Assessment	Incorporates biological markers linked to IC decline.	• Enables early detection of IC decline *via* biomarkers; • Helps reduce measurement errors in IC assessment; • Improves understanding of IC-related biological mechanisms.	• High time and financial cost; • Limited feasibility in routine clinical settings; • Lack of robust, standardized evidence and validation.	• Develop predictive models incorporating biomarkers; • Identify cost-effective biomarkers; • Validate biomarkers for clinical screening.

ICOPE, Integrated Care for Older People; WHO, World Health Organization; ICF, International Classification of Functioning, Disability and Health.

Table 3. Overview of influencing factors on intrinsic capacity

Authors	Year	Country	Factors influencing intrinsic capacity	*Ref.*
Wei *et al.*	2024	France, Costa, Rica, Mexico, Japan, Singapore, China, Belgium, Hong Kong, Latin, America, India	Age, sex, marital status, occupation status, education, income/wealth, chronic diseases, hypertension, diabetes, disability, smoking status, alcohol consumption, physical activity, biomarkers/inflammatory markers, ethnicity, residence, housing index, social engagement, multimorbidity, medication adherence, polypharmacy, hospitalization, sleep health, cardiovascular mortality, respiratory mortality, fragility fracture, life-space mobility, nursing home stay, incontinence, and sarcopenia.	(*33*)
Leung *et al.*	2022	Hong Kong	Age, sex, education level, marital status, grip strength, physical activity, smoking, drinking, self-care capacity, loneliness, and social engagement.	(*20*)
Chen *et al.*	2021	China	Age, residence, education, marital status, income, exercise, meat intake, insomnia, memory decline, urinary incontinence, constipation, slowness, chronic obstructive pulmonary disease, and osteoarthritis.	(*17*)
Gutiérrez-Robledo *et al.*	2021	Mexico	Age, sex, years in school, self-rated health, chronic diseases, number of visits to a physician in the last year, and ≥ 2 affected activities of daily living.	(*21*)
Arokiasamy *et al.*	2021	China, Ghana, India, Mexico, Russia, South Africa	Age, education, wealth quintiles, work status, residence, marital status, body mass index, chronic conditions, and self-rated health status.	(*34*)
Huang *et al.*	2021	Japan	Age, sex, educational level, body mass index, medical history, and social frailty.	(*36*)
Huang *et al.*	2021	Japan	Age, sex, education level, body mass index, smoking status, alcohol consumption, physical activity, energy intake, and dietary pattern.	(*37*)
Lu *et al.*	2021	Hong Kong	Age, sex, education, marital status, number of chronic diseases, percentage of green space, land use diversity, number of leisure facilities, number of public transport facilities, number of community centres, number of commercial facilities, and number of healthcare facilities.	(*39*)

Table 4. Overview of adverse outcomes of intrinsic capacity

Authors	Year	Country	Adverse outcomes of intrinsic capacity	Ref.
Yang *et al.*	2024	China, Japan, Korea, Singapore, Malaysia, Thailand, India, United States, Netherlands, Italy, Spain, United Kingdom, Australia	● Physiological function: frailty, pneumonia onset, memory impairment, polypharmacy, incontinence, poor/fair self-rated health; ● Clinical outcomes: IADL disability, ADL disability, mortality, falls, autonomy decline, incident dependence; ● Resource utilization: hospitalization, nursing home stays, polypharmacy healthcare costs, emergency department visits; ● Other domains: poor quality of life.	(*41*)
Zhao *et al.*	2024	China, United Kingdom, France, Japan, India, Australia, Belgium, Finland, Singapore	Disability, falls, hospitalisation, mortality, frailty, incontinence, polypharmacy, poor/fair self-rated health, nursing home stay, pneumonia, ADL disability, and IADL disability.	(*5*)
Zhou *et al.*	2023	China, India, Mexico, Latin America, United Kingdom, Belgium, France, Spain, Netherlands, Norway, United States, New Zealand	Physical function, frailty, falls, mortality, quality of life, and other adverse outcomes (hospitalization, pneumonia incidence, nursing home stays, emergency department visits, and prognosis in acute coronary syndrome).	(*42*)
Yu *et al.*	2021	China	Incident disability, recurrent falls, hospitalization, emergency department visits, and poor quality of life.	(*43*)
Charles *et al.*	2020	Belgium	Mortality, falls, repeated falls, and autonomy decline.	(*44*)
Pagès *et al.*	2022	France	Higher healthcare costs.	(*46*)

IADL, instrumental activities of daily living; ADL, activities of daily living.

thereby supporting its use as a convenient tool for IC evaluation (*35*). In terms of psychosocial factors, Huang *et al.* (*36*) found a longitudinal association between social frailty and IC and its subdomains, with socially frail men being more prone than women to declines in psychological and cognitive functions. Similarly, Leung *et al.* (*20*) reported that older adults with reduced social engagement exhibited significantly IC.

The differences in lifestyle can impact the IC of older adults, as Chen *et al.* (*17*) found that poor lifestyle habits, such as smoking, alcohol consumption, lack of exercise, low meat intake, and insomnia, were negatively correlated with IC. It is worth mentioning that dietary patterns significantly impact the IC of older adults. In particular, dietary patterns rich in fruits, vegetables, and animal-based protein were linked to positive changes in IC, while dietary patterns high in sugar and fat were negatively associated with IC changes (*37*). Moreover, the association between dietary patterns and IC was found to be stronger in men than in women, suggesting that strategies to improve diet should consider gender differences (*38*). Lu *et al.* (*39*) reported that a favorable neighborhood physical environment, including green spaces, land use diversity, and accessible facilities, is positively associated with higher IC. This may be attributed to the fact that a favorable neighborhood physical environment encourages positive lifestyle habits, such as regular physical activity, independent mobility, and social engagement; meanwhile, exposure to natural environments helps alleviate stress and improve sleep quality, all of which contribute to enhancing the IC of older adults. Since lifestyle is the most easily modifiable among all influencing factors, efforts to improve IC should focus on correcting these unhealthy lifestyle-related behaviors. Table 3 presents an overview of influencing factors on IC.

Exploring the factors influencing IC can help guide interventions to maintain or improve it, thereby promoting health and enhancing the quality of life for older adults. At present, studies on the etiology and pathophysiological mechanisms of IC impairment are limited; most studies use cross-sectional designs to explore influencing factors, which cannot establish causal relationships. Therefore, future research should adopt prospective designs and focus on the underlying mechanisms and pathophysiological basis of IC decline to deepen exploration in this field.

6. Adverse outcomes of IC

The level of IC in older adults is strongly associated with health outcomes: higher IC in older adults reduces the risk of adverse outcomes, while its decline increases the risk of poor outcomes (*40*). A scoping review (*41*) that included 25 studies identified 17 adverse outcomes associated with IC, which were categorized into four domains: *i*) physiological function domain

Table 5. Overview of interventions for intrinsic capacity

Authors	Year	Country	Interventions for intrinsic capacity	*Ref.*
Liu *et al.*	2024	France, India, China, Vietnam, Japan, Korea, Thailand, Italy, Spain, Belgium, Germany, Netherlands, Portugal, Turkey, United Kingdom, Brazil, Chile, Colombia, Mexico	ICOPE-guided multidomain interventions: integrated care intervention, tailored interventions, physical activity interventions, cognitive training, psychological interventions, multidomain interventions, person-centred care, community-based integrated care, nutritional interventions, medication review, health education, function-oriented care, comprehensive geriatric assessment, goal-oriented care, remote monitoring, nurse-led care, and follow-up care.	(*50*)
Lee *et al.*	2024	Taiwan	ICOPE-guided multidomain intervention: physical activities, cognitive training, nutrition advice based on national dietary guidance for older adults, lectures on healthy aging, lifestyle modification, the management of chronic conditions, comprehensive geriatric assessment and allied health care services, and personalized care plans.	(*51*)
Yan Wang *et al.*	2024	China	ICOPE-guided multidomain intervention: in-home visits, tele-care sessions, health education, care coaching, living environment adaptation, rehabilitative therapies, nursing services, coordination of social care resources, personalised goal setting and care planning, comprehensive, person-centred assessment, screening for declines in intrinsic capacity, care plan execution and monitoring, referrals, engaging communities, supporting caregivers, use of decision support algorithms, online support system, training of integrated care managers, and quality assurance team reviews.	(*52*)
Blancafort *et al.*	2021	Spain	ICOPE-guided AMICOPE intervention: adapted physical activity, dietary advice, cognitive behavioral therapy, problem-solving, behavioral activation, life review, strengthening social support/staying socially connected, self-management, and behavior change strategies.	(*54*)
Huang *et al.*	2021	Japan	Aerobic training, resistance training, combined training, group training program, self-paced home training, and lectures about health promotion.	(*25*)
Sánchez-Sánchez *et al.*	2022	Spain	Twelve-week home-based individualised Vivifrail multicomponent physical exercise program (resistance, balance, flexibility, endurance, and gait retraining exercises).	(*58*)
Merchant *et al.*	2024	Singapore	Exercise 6 months, and cognitive stimulation therapy 3 months with Exercise 6 months.	(*59*)
Lim *et al.*	2022	Taiwan	Healthy eating intervention (nutrition education, group activities, use of customized dishware, encouragement of correct servings of six food groups based on the Taiwanese daily food guide for the elderly).	(*61*)

ICOPE , Integrated Care for Older People; AMICOPE, Aptitude Multi domain group based intervention to improve and/or maintain Intrinsic Capacity in Older People.

included frailty, pneumonia onset, memory impairment, polypharmacy, incontinence, and poor or fair self-rated health; *ii*) clinical outcomes domain comprised instrumental activities of daily living (IADL) disability, activities of daily living (ADL) disability, mortality, falls, autonomy decline, and incident dependence; *iii*) resource utilization domain covered hospitalization, nursing home stays, healthcare costs related to polypharmacy, and emergency department visits; *iv*) other domain primarily referred to poor quality of life. Another scoping review (*42*) that included fifteen longitudinal studies evaluated a range of adverse health outcomes, including physical function, frailty, falls, mortality, quality of life, and other adverse health outcomes.

IC, as an independent and emerging construct, is a highly effective predictor of several health outcomes, facilitating the early identification of high-risk populations (*5*). Previous studies have confirmed the predictive value of the multidimensional structure of IC for adverse outcomes. Yu *et al.* (*43*) reported that cognitive decline, limited mobility, visual impairment, and depressive symptoms predicted incident disability; visual impairment predicted recurrent falls; cognitive decline and limited mobility predicted emergency department visits; limited mobility predicted poor quality of life. Charles *et al.* (*44*) found that each one-point increase in balance performance and nutritional scores reduced mortality risk by 12% (Hazard ratio [HR] = 0.88; 95% confidence interval [CI]: 0.78–0.99) and 4% (HR = 0.96; 95% CI: 0.93–0.99), respectively. A one-point improvement in balance performance (HR = 0.87, 95% CI: 0.79–0.96) and nutritional status (HR = 0.96, 95% CI: 0.93–0.98) was associated with a reduced risk of falls. Lower nutritional scores were linked to higher autonomy decline risk (OR = 0.86; 95% CI: 0.77–0.96). Giudici *et al.* (*45*) reported that individuals with low vitality were 2.0 to 6.1 times more likely to accumulate frailty components over time. In addition, impairments in IC are linked to increased healthcare costs, with visual impairment significantly associated with increased immediate healthcare expenses (Cost Ratio [CR] = 1.48; 95% CI: 1.16–1.89), and persistent impairments in locomotor (CR = 1.27; 95% CI: 1.01–1.60) and psychological capacity (CR = 1.28; 95% CI: 1.03–1.59) related to higher annual healthcare expenditures (*46*). The adverse outcomes of IC are outlined in detail in Table 4. Therefore, regular assessment and monitoring of IC in older adults, combined with targeted interventions, can effectively enhance IC and reduce the risk of adverse health outcomes, and simultaneously lower healthcare costs.

7. Interventions for IC

Interventions targeting IC are primarily ICOPE-guided multidomain interventions, which are comprehensive intervention plans designed and implemented following the systematic screening and individualized assessment of the five key domains of IC in older adults: cognitive, psychological, nutritional, physical, and sensory functions (*47*). This approach emphasizes multidomain integration, individualized care planning, community and family involvement, and dynamic evaluation with continuous adjustment, aiming to delay functional decline, preserve or enhance IC, improve quality of life, and promote healthy ageing (*48*). In addition to the aforementioned interventions, other interventions include multicomponent exercise, cognitive stimulation therapy, and dietary intervention. These interventions are summarized in Table 5.

ICOPE-guided multidomain interventions have been demonstrated to be an effective approach for enhancing IC in older adults. A systematic review incorporating 25 randomized controlled trials (*49*) suggested that multi-domain interventions can help maintain IC in older adults and are also effective for those experiencing a decline in self-care abilities. Liu *et al.* (*50*) reported that ICOPE is a potentially effective approach for improving IC in older adults, with significant potential for enhancing cognition function and alleviating depressive symptoms in particular. Lee *et al.* (*51*) indicated that incorporating multidisciplinary interventions into primary health care significantly enhanced IC in older adults. A randomized controlled trial conducted in Beijing (*52*) demonstrated the feasibility of localizing and implementing the WHO's ICOPE approach in regions with fragmented resources such as China.

The first global pilot programs began in 2020 across four countries — China, France, Andorra, and India — progressing through three phases: preparation, setup, and implementation. In 2022, the WHO summarized the pilot program's outcomes for implementing ICOPE in the integrated care of older adults (*53*). A study conducted in Spain (*54*) described the development of a group-based, multi-domain intervention for community-dwelling older adults, which resulted in the creation of the Aptitude Multi domain group based intervention to improve and/or maintain Intrinsic Capacity in Older People (AMICOPE) intervention based on the ICOPE framework. The intervention included vivifrail exercise training, nutritional and dietary guidance, psychological group therapy, and cognitive stimulation. This study represents the initial phase of the UK Medical Research Council framework for designing and assessing complex interventions.

Physical activity is associated with higher IC in older adults, exerts significant positive effects on the domains of locomotion, cognition, psychology and vitality (*55,56*), and is widely recognized as a key intervention for promoting and maintaining IC (*57*). A single-blind randomized controlled trial (*25*) comparing the effects of aerobic training (AT), resistance training (RT), and combined training (AT+RT) on IC in older adults. Participants in the intervention group received

a 26-week group training program and self-paced home training, while the control group attended health promotion lectures. Findings indicated that a 26-week program of AT and RT with self-paced home training can enhance IC in community-dwelling older adults experiencing subjective memory concerns, although the benefits diminished over time. Multicomponent exercise is considered a potential intervention for maintaining/improving IC in older adults. Building on this, a study from Spain (*58*) found that the 12-week Vivifrail multicomponent exercise program effectively improves IC, particularly in the locomotion, cognition, and vitality domains among community-dwelling older adults with pre-frailty or frailty and mild cognitive impairment or mild dementia, compared with usual care.

In terms of cognitive stimulation therapy, previous studies have shown significant benefits for IC among older adults. A study conducted in Singapore (*59*) examined the effects of exercise (Ex) and cognitive stimulation therapy (CST) on the IC of community-dwelling pre-frail older adults. Participants were divided into a control group, an Ex group, and an Ex+CST group, with the combined group receiving CST during the first three months of the six-month intervention. Results showed that both Ex and Ex+CST significantly improved the composite IC score, particularly in the locomotion, vitality, and psychological domains. Notably, the Ex+CST group demonstrated greater improvements in the cognition domain. These benefits were sustained up to 12 months after the intervention. The study concluded that incorporating cognitive stimulation therapy into exercise-based interventions may be a more effective strategy for enhancing IC, especially in supporting cognitive function.

Dietary pattern has been shown to have a strong association with IC (*37,60*). A prospective single-group interventional quasi-experimental study in Taiwan (*61*) implemented a four-month texture-modified plant-based dietary intervention among 59 functional independent older adults residing in retirement homes to explore the intervention effects of improved dietary quality on IC. The findings revealed that participants with high adherence to the intervention experienced significant improvements in vitality (cardiorespiratory endurance, $p = 0.009$) and locomotion (gait speed, $p = 0.034$), despite declines in locomotion (chair-stand test, $p < 0.001$) and cognitive functions (Mini-Mental State Examination, $p = 0.022$). Enhanced IC further contributed to improvements in activities of daily living ($p = 0.034$). This study suggests that healthy eating can enhance vitality and locomotion domains of IC thus improving the functional ability of older adults.

An umbrella review encompassing 6,407 articles (*62*) identified mobility-focused interventions as the most studied among the seven domains of IC, highlighting the effectiveness of mobility/muscle strength training in improving locomotor function in frail older adults or those with functional decline. Nevertheless, there is a lack of robust evidence for interventions addressing other domains of IC, especially sensory function and continence. Future research should prioritize high-quality trials in these underrepresented areas to support the development of evidence-based guidelines aimed at enhancing overall IC and promoting healthy ageing.

Taken together, multidisciplinary interventions based on the ICOPE framework are an effective approach to addressing IC decline. They hold promise as a strategy for improving IC in older adults and should be advocated as a feasible approach to promoting healthy ageing. However, there are few controlled intervention studies on IC, as well as insufficient exploration of the optimal timing for intervention and the underlying reasons for significant changes in IC This underscores the necessity for clinical longitudinal studies to examine the effects of interventions on IC in the future, and the continuous development and improvement of strategies to address the decline of IC in older adults.

8. Conclusion

This study reviews the relevant concepts, epidemiology, assessments, influencing factors, adverse outcomes, and interventions concerning IC, aiming to offer a reference for further research on IC in older adults. By understanding the relevant concepts of IC, utilizing IC assessments for dynamic functional monitoring, identifying critical risk transition points in older adults, and implementing early risk factor detection alongside personalized interventions, it is possible to delay functional decline, reduce adverse outcomes, enhance well-being and quality of life, and ultimately promote healthy ageing.

Funding: This study was supported by National Nature Science Foundation of China [grant number 72474092, 72274087], Development Program of Gansu Province [grant number 23YFFA0006], Fundamental Research Funds for the Central Universities [grant number lzujbky-2024-it61, lzujbky-2024-ou12], and Nature Science Foundation of Gansu Province [grant number 22JR5RA218, 24JRRA596].

Conflict of Interest: The authors have no conflicts of interest to disclose.

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Received March 12, 2025; Revised July 30, 2025; Accepted September 8, 2025.

Released online in J-STAGE as advance publication September 18, 2025.

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