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Review

The vitality domain of intrinsic capacity: A scoping review of conceptual frameworks and measurements

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ABSTRACT

Background: Intrinsic capacity (IC) is a composite indicator of physical and mental capacities that are critical for healthy aging. IC comprises five domains, with "vitality" gaining most attention due to its potential impact on functional and physiological reserves with increasing age. The World Health Organization 2022 framework redefined vitality as an underlying physiological determinant of IC. However, the concept and measurement of vitality and its empirical validation are not well defined.

Objectives: This scoping review aims to: (1) map the conceptual frameworks underpinning vitality within the IC domain and (2) identify existing measures used to assess vitality.

Methods: A systematic search of MEDLINE, PubMed, Embase, Web of Science, and WHO databases (2003–2023) using Arksey and O'Malley's framework and PRISMA-ScR guidelines. Studies involving adults ≥50 years old that addressed vitality in IC were included. We extracted data on conceptual frameworks, measurement tools, and construct validity.

Results: Eighty-one studies met the inclusion criteria. Initial frameworks of vitality focused on nutritional indicators, while recent concepts include neuromuscular function, metabolism, and immune-stress responses. However, operationalization of these concepts remains inconsistent, with most studies relying on anthropometry, appetite, weight loss, and handgrip strength, while immune and stress response-related biomarkers were rarely assessed. Only 10.5 % of studies evaluated construct validity of vitality, and limited studies validated the potential roles of vitality underpinning the other expressed capacities.

Conclusions: Currently, vitality within IC varies in definitions and measurement approaches, with a predominant focus on nutrition and muscle strength. Empirical validation of vitality's role as a foundational IC domain remains limited. Expanding the scope of vitality to include metabolic and immune markers, and deeper examination of the interactions between vitality with other IC domains may enhance understanding and improve assessment frameworks for healthy aging.

1. Background

Intrinsic capacity (IC), a concept introduced by the World Health Organization (WHO), has emerged as a crucial framework for understanding and promoting healthy aging [1]. Defined as the composite of all physical and mental capacities an individual can draw upon, IC encompasses five domains i.e., cognition, psychological, sensory, vitality, and locomotion capacities. These domains collectively contribute to an individual's ability to maintain function and well-being in later life, and predict negative health outcomes, including frailty, mortality and care dependency [2–4].

Among these five domains of IC, vitality has received considerable attention due to its potential impact on overall health and quality of life in older adults. However, a clear and consistent definition of vitality remains to be established. The conceptual underpinnings of vitality have evolved over time, which have led to variations in how it is defined, measured, and applied in research and clinical settings. In 2022, a revised conceptual framework for vitality was developed, which emphasizes the centrality of the vitality domain as representing the underlying physiological determinant of IC [5]. Three inter-related physiological systems, namely, neuromuscular function, energy and metabolism, and immune and stress response functions were identified as core constructs of vitality, with potential biomarkers proposed for each construct of vitality. Despite this revised definition of vitality, it remains to be clarified how these proposed vitality constructs have been operationalized across research and clinical settings. Moreover, it is unknown whether the con-

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struct validity of the current definition of vitality has been established through empirical validation of the identified domains.

To address the above gaps in our understanding of vitality, the primary aim of this scoping review was to map out the conceptual underpinnings of vitality as a domain of intrinsic capacity. The secondary aim was to identify and analyze existing approaches in the measurement of vitality. By synthesizing current knowledge and highlighting areas of consensus and divergence, this review seeks to establish the current state of evidence that supports the need for systematic measurement and monitoring of vitality. The findings are intended to inform future research and clinical applications, supporting more consistent and comprehensive approaches in assessing vitality as a component of healthy aging.

2. Methods

We utilized Arksey and O'Malley's 5 stage framework to conduct the scoping review [6], which are "Identifying the research question," "Identifying relevant studies," "Study selection," "Charting the data," and "Collating, summarizing and reporting results." A scoping review approach was chosen to address the aims of this study as it allows for a comprehensive mapping of heterogeneous literature, facilitating the identification of key concepts and gaps in an emerging field where evidence is diverse and evolving. We report this review in accordance with the guidance provided by PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) [7].

2.1. Identifying the research question

Our aim was to map out the relevant critical research domains and to describe the limitations in the current literature. After an iterative process amongst the research team, we outlined the following two research questions:

1. What are the conceptual definitions and frameworks that underlie the measurement of vitality?
2. What are the measures currently used to assess vitality within the context of the intrinsic capacity framework?

In this context, "conceptual definitions" refer to explicit descriptions clarifying what is meant by vitality capacity, while "frameworks" refer to the organizing structure for the selection and interpretation of measures assessing vitality. "Measures" used to assess vitality may include tools, scales, indicators, or markers used to assess vitality.

2.2. Identifying relevant studies

In line with the comprehensive nature of scoping reviews, we employed a broad search strategy to include a wide range of relevant papers. Our search terms included words used interchangeably to describe "intrinsic capacity," "ICOPE," "vitality," "biomarker," "nutrition," "healthy aging," and "healthy longevity" in Medical Subject Headings, text, and keywords. A certified medical librarian developed the primary search strategy using Ovid MEDLINE and adapted it for other databases as needed. On December 21, 2023, we conducted searches in MEDLINE, PubMed, Embase, Web of Science, and the World Health Organization (WHO) database. Our search covered publications from January 1, 2003, to September 30, 2023. Additionally, we examined the reference lists of identified reports and articles to capture any relevant studies not retrieved through the database searches. All identified citations were imported into the Covidence management software for further processing and screening.

2.3. Study selection

Three reviewers (J.C., J.L. and H.H.C.) independently screened the identified articles for eligibility. The articles were screened based on the inclusion and exclusion criteria using a two-stage approach. The first stage reviewed the titles and abstracts of shortlist articles, and second stage reviewed the shortlisted articles in full text. Any conflict was resolved by discussion with adjudication by a fourth reviewer if required. The study selection process is reported in Fig. 1 using the PRISMA flow diagram. The included studies were limited to full-text articles in English language only, published in or after 2003 until the end of 2023. We considered studies which included older adults 50 years and older, including meta-analyses, systematic reviews, randomized controlled trials (RCTs), cohort studies policies, guidelines, commentaries, editorials, opinion pieces, and letters to the editor that discussed or measured the vitality domain of intrinsic capacity. We excluded book chapters, conference abstracts and case reports. Studies which had no full text available, and those that discussed vitality outside the framework of intrinsic capacity were deemed irrelevant and were thus excluded.

2.4. Charting the data

Data were extracted using a standardized data extraction form that was pre-defined. The data was extracted by one reviewer (J.C.) and verified for accuracy and completeness by a second reviewer (L.W.S.). Disagreements were resolved by discussion between the reviewers when necessary.

For research question 1, we extracted and chronologically listed publications that explicated conceptual frameworks and definitions for vitality, along with their suggested measures when present. This chronological arrangement allowed us to trace the evolution of definitions over time. For research question 2, we classified vitality measures according to the WHO working definition of vitality capacity for healthy longevity monitoring [5]. This classification comprised three broad categories: energy and metabolism, neuromuscular function, and immune and stress response functions. Furthermore, we conducted an additional analysis of the publications to identify those which assessed the construct validity of the measures used, as well as the specific methods employed for this validity analysis.

2.5. Collating, summarizing and reporting results

The selected articles were synthesized in both tabular and narrative formats. Table 1 presents an overview of the conceptual frameworks and definitions, along with publication type and suggested measures. Table 2 illustrates the number and proportion of studies that assessed each of the three vitality domains, while Table 3 provides the number and percentage of specific measures used within each domain. Supplementary Table 1 details the measures used to assess vitality, and includes data extracted from each article such as: primary author and publication year, study country, mean age and gender of the study population, inclusion and exclusion criteria and study design. Data management was conducted using Microsoft Excel.

3. Results

From the initial 3988 records identified, 1973 abstracts remained after duplicates were removed. These abstracts were screened for relevance, and 1849 abstracts were excluded. Of the 125 articles selected for full-text review, 45 were excluded, due to the absence of full-text in 20 articles, lack of new data on vitality measures or conceptual frameworks in 17 articles, and the lack of contextual relevance in 8 articles that did not address vitality within the IC framework. Additionally, two reports from the WHO were included in this review due to their significant relevance to the topic. In total, 81 studies were included in the review. The PRISMA flow diagram summarizing this process is shown in Fig. 1.

Table 1
Conceptual frameworks or definitions of vitality capacity.

Authors, year	Title	Publication type	Conceptual frameworks or definitions	Suggested measures
Cesari M, et al. 2018 [8]	Evidence for the Domains Supporting the Construct of Intrinsic Capacity	Review	Vitality defined as energy metabolism for homeostasis: Vitality encompasses the body's functions that are dedicated to metabolizing dietary intake, crucial for generating the necessary energy to sustain an optimal level of homeostasis. Maintaining vitality through energy balance: Aging is associated with changes in metabolism, including a decrease in both resting metabolic rate and activity energy expenditure, which are integral components of vitality. Maintaining vitality through energy balance: The maintenance of vitality in aging requires a delicate balance between energy intake and expenditure, ensuring the organism functions properly. Nutrition as intervention targets for vitality: Indicators of malnutrition, such as weight loss, low body mass index, and overweight/obesity, are critical targets for interventions designed to support vitality and prevent the disabling effects of aging.	Markers of malnutrition (e.g., weight loss, low body mass index, overweight/obesity) are targets of intervention for preventing the disabling cascade.
World Health Organization; 2020 [1]	Decade of healthy ageing: baseline report.	Global report	Vitality conceptualised as physiological status reflecting energy and equilibrium (balance): Vitality is described as the biophysiological status of an individual, encompassing the capacity to maintain homeostasis amidst daily exposures and more severe challenges such as injuries or infections. Vitality as resilience, vigor and stamina: Vitality represents the amount of intrinsic capacity retained by an individual, underpinning a person's resilience, vigor, and stamina.	Nutritional influence on vitality: Nutrition is crucial for maintaining vitality, especially in older age, where factors like sensory impairments, poor oral health, and social isolation can heighten the risk of malnutrition. Handgrip strength as an indicator of vitality: Hand grip strength is recognized as a key indicator of vitality and a specific domain of intrinsic capacity in older adults, reflecting skeletal muscle function's pivotal role.
World Health Organization; 2021 [9]	WHO Vitality Capacity Working Group report on initial steps towards measurements of vitality capacity in older people: virtual meeting, 8–9 December 2021.	Global report	Attributes of vitality capacity defined at higher-level physiological systems. A draft conceptual working definition was agreed: Vitality capacity is a physiological state (due to normal or accelerated biological ageing processes) resulting from the interaction between multiple physiological systems, reflected in (the level of) energy and metabolism, and the neuromuscular and immune and stress response functions of the body.	Not stated
Cesari M, et al. 202,2 [10]	What Is Intrinsic Capacity and Why Should Nutrition Be Included in the Vitality Domain?	Commentary	Relationship between nutrition and aging: Nutrition profoundly impacts the biological processes of aging, influencing energy metabolism and the maintenance of homeostasis in aging organisms. Nutritional status as a phenotype: Assessing nutritional status is a vital phenotypic marker for evaluating an organism's ability to manage energy inputs and outputs effectively. Nutrition influences other domains of intrinsic capacity: While nutrition is critical to the vitality domain, it also plays a crucial role in supporting and developing the other four domains of intrinsic capacity: locomotion, cognition, psychological, and sensory. Clinical and preventive significance of nutrition: Nutritional assessment helps describe the clinical manifestation of an individual's underlying metabolic reserves and aids healthcare professionals in identifying and intervening with individuals at risk of adverse outcomes due to physiological depletion.	Integrated Care for Older People (ICOPE): Guidance for Person-Centred Assessment and Pathways in Primary Care: 2 questions oriented explicitly on the evaluation of nutritional status. (1) Have you unintentionally lost more than 3 kg over the last three months?"; and (2) "Have you experienced a loss of appetite?"), followed by the Mini Nutritional Assessment for further in-depth assessment for undernutrition.
Bautmans I, et al. 2022 [5]	WHO working definition of vitality capacity for healthy longevity monitoring	Commentary/ Personal View	Vitality capacity is considered a fundamental physiological determinant of intrinsic capacity, influencing and interacting with other domains of intrinsic capacity. Measures of vitality encompass both direct indicators of biological aging and proxy measures, all reflecting the biological aging process that can be influenced by behavioral and environmental factors. Assessing vitality capacity can predict an individual's vulnerability to adverse health outcomes based on their functional reserves and overall functioning, rather than solely on chronological age. A conceptual working definition of vitality that comprises of multiple interacting physiological systems.	Proposed physiological systems and measures: 1. Energy and metabolism: self-perceived fatigue; muscle fatiguability; malnutrition or nutritional status; body composition; circulating biomarkers of metabolism (e.g. HbA1c). 2. Neuromuscular function: knee extensor strength; handgrip strength; respiratory muscle strength. 3. Immune and stress responses: circulating biomarkers of inflammation; immune symptoms; oxygen saturation; autonomic function.

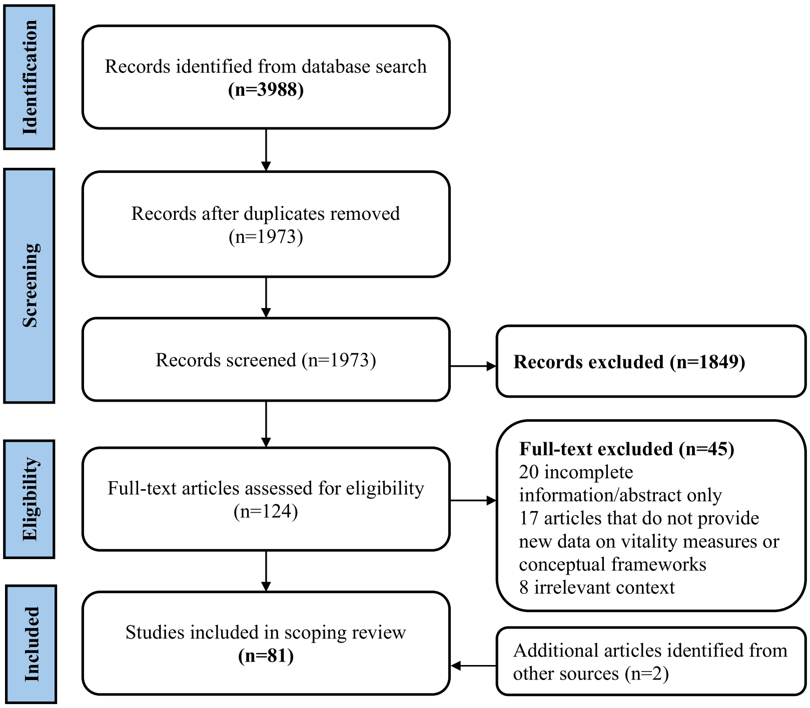

Fig. 1. PRISMA flow chart.

Table 2
Number of measures for each vitality domains.

Domain	Frequency	Percent
Energy and Metabolism	45	52.3 %
Neuromuscular Function	40	46.5 %
Immune and Stress Response	1	1.2 %
Total*	86	

* Number exceeds the total count of extracted studies as some studies use measures that span across other vitality domains.

3.1. Definitions and conceptual frameworks

The evolution of the conceptual frameworks and definitions of vitality is summarized in Table 1. Of the 81 included studies, five publications, comprising reviews, commentaries, or WHO reports, addressed the conceptualization of vitality within the IC framework.

Initially, vitality was assessed primarily through nutritional status, using indicators like unintentional weight loss and appetite changes. This approach was based on the understanding that proper nutrition is crucial for energy production and maintaining homeostasis in older adults. For instance, the WHO's Integrated Care for Older People (ICOPE) guidelines[11] included questions about weight loss and appetite as proxies for evaluating vitality.

More recent literature has broadened the definition of vitality to encompass multiple interrelated physiological systems. A WHO meeting in 2021 discussed whether vitality functions as an equivalent IC domain or as an underlying biological process influencing other domains [12]. Subsequently, a WHO expert meeting in 2022 proposed a revised framework that positions vitality as a fundamental physiological determinant of IC that interacts with other domains [5]. This framework extends beyond nutritional measures alone, recognizing vitality as influenced by genetic factors, biomolecular changes linked to aging (such as cellular senescence and inflammation), and higher-level physiological systems. It identifies potential biomarkers for three core domains of vitality: neuromuscular function, energy and metabolism, and immune and stress response functions.

In response, experts have provided a pragmatic perspective and reemphasized the significant impact of nutrition on aging, advocating for its integration within the broader context of vitality [10]. They highlighted that nutrition not only influences energy metabolism and homeostasis but also supports other IC domains. This underscores nutrition's clinical and preventive significance as a vital phenotypic marker for evaluating metabolic reserves and identifying individuals at risk of adverse outcomes.

3.2. Measures used to assess vitality

76 studies (Supplementary Table 1) focused on the measures used to assess vitality originated from various countries, predominantly in East Asia and Europe. China contributed the largest number of studies with

Table 3
Specific measures used for each vitality domain.

Vitality Domain	Measures	N (%)
Energy and Metabolism	Nutritional assessment scales, anthropometry, appetite, weight loss	24 (53.3)
	Body composition (Adiposity-to-muscle ratio, appendicular skeletal muscle mass)	8 (17.8)
	Self-reported fatigue, self-reported degree of exhaustion, cardiorespiratory endurance (two-minute step-in-place test), low physical activity levels	10 (22.2)
	Blood biomarkers (IGF-1, DHEA, Hemoglobin)	3 (6.7)
Neuromuscular Function	Handgrip strength	32 (80.0)
	Lung function (FEV1, FVC, PEFR)	6 (15.0)
	Fatigue resistance (FR) Test; Grip work (GW)	1 (2.5)
	30-second chair stand test	1 (2.5)
Immune and Stress Response	C-reactive protein (CRP), interleukin-6 (IL-6), tumour necrosis factor receptor-1 (TNFR-1), monocyte chemoattractant protein-1 (MCP-1)	1 (100)

Table 4
Other measures of vitality capacity.

Measures used
EAT-10 questionnaire (dysphagia) [13]
Self-rated health; Existing long-term illness; Existing limitations in activities because of health; Health problems limiting paid work; Existing diseases; Taking at least 5 different drugs a typical day; Bothered with frailty; fatigue; dizziness, faints or blackouts; fear of falling down [14]
FRAIL [15]
Self-reported chronic musculoskeletal pain; incontinence [16]
Mitochondrial markers: growth differentiation factor-15 (GDF-15), ATPase inhibitory factor 1 (IF1) [17]

19 (25.0 % of the total). France was the next most represented country with 13 studies (17.1 %). Other notable contributions came from Hong Kong with 9 studies (11.8 %), and both Taiwan and Singapore with 6 studies each (7.9 %). Japan and Belgium each provided 4 studies (5.3 %), while the United Kingdom contributed 3 studies (3.9 %). Single studies (1.3 % each) were conducted in Norway, India, Costa Rica, Colombia, the Baltic states (Latvia, Estonia, and Lithuania), and a multi-country study encompassing China, Ghana, India, Mexico, the Russian Federation, and South Africa.

The scoping review identified 86 occurrences of measures used across the three core domains of vitality: energy and metabolism, neuromuscular function, and immune and stress response. As shown in Tables 2 and 3, Energy and metabolism had the highest representation with 52.3 % of all the measures, where nutrition-related indicators (including anthropometry, appetite, and weight loss) comprised 53.3 %. Other metrics included body composition (17.8 %), fatigue and low activity indicators (22.2 %), and blood biomarkers (6.7 %), such as IGF-1, DHEA, and hemoglobin. Neuromuscular function was measured with 40 indicators, predominantly using handgrip strength (80 %), followed by lung function tests (15 %) and other fatigue and strength assessments. Lastly, only one study addressed the immune and stress response domain, utilizing biomarkers like CRP, IL-6, TNFR-1, and MCP-1 to evaluate inflammatory stress responses. This distribution highlights a predominant focus on nutritional and physical strength measures, with less emphasis on immune and stress-related biomarkers within the vitality framework.

The scoping review also identified a diverse range of measures beyond the primary domains of vitality (Table 4), capturing various health and functional aspects relevant to aging. These included general health assessments (e.g., self-rated health, chronic illness, activity limitations), specific conditions (e.g., dysphagia, chronic musculoskeletal pain, incontinence), and tools like the FRAIL scale. Additionally, mitochondrial markers such as growth differentiation factor-15 (GDF-15) and ATPase inhibitory factor 1 (IF1) were used to assess cellular function.

3.3. Assessment of construct validity

There was limited assessment of construct validity among the measures used for vitality. Of the 76 studies, only 8 (10.5 %) reported evaluating construct validity through techniques like principal component analysis (PCA), exploratory factor analysis (EFA), or confirmatory factor analysis (CFA). The vast majority (89.5 %) did not assess construct validity of the measures used.

4. Discussion

The findings of this scoping review reveal several limitations in the current research on vitality within the intrinsic capacity (IC) framework. First, while the concept of vitality has evolved to include multiple physiological systems, studies have primarily focused on nutrition and neuromuscular function, particularly handgrip strength, which may not fully align with the broader framework recommended by the WHO. Additionally, there is currently a lack of alignment with the WHO framework, which is evidenced by the wide variety of measures used, such as assessments for dysphagia, polypharmacy, and self-rated health. There is also a scarcity of research on immune and stress response markers, with only one study addressing this area. Furthermore, there is a lack of empirical construct validation through methods like EFA, CFA, or PCA [18], and this was typically done for IC as a whole rather than specifically for vitality. These findings underscore the need for standardized, validated tools and a more comprehensive approach that aligns with the WHO's multidimensional framework for assessing vitality.

Nutrition has long been regarded as an indicator for assessing vitality within the intrinsic capacity framework, and it is recommended in the 2025 version of the Integrated Care for Older People (ICOPE) guidance for primary care [19]. Initially, vitality was conceptualized as the body's capacity to metabolize dietary intake to generate the energy needed for maintaining homeostasis [8]. This view positioned nutrition as a direct reflection of vitality, highlighting its role in indicating an organism's metabolic reserves and physiological resilience. However, questions remain on the specific role of nutrition within the vitality domain. One view sees nutrition as a foundational component directly supporting the body's reserves and resilience to stressors. Alternatively, nutrition may be viewed as a consequence of underlying physiological declines rather than a primary determinant. Age-related changes, such as disruptions in metabolic processes [20], changes in the gastrointestinal tract [21], and altered food intake control that impact hunger and satiety can contribute to anorexia of aging [22] and poor nutritional status, suggesting that declining vitality drives poor nutritional status rather than the other way around.

This distinction is crucial for designing effective interventions. If nutrition is foundational, then addressing nutritional deficits should be central to strategies that aim to enhance vitality and IC, given that nutritional assessments and dietary modifications offer practical and direct benefits. Conversely, if malnutrition results from intrinsic physiological declines, interventions should focus on correcting these underlying issues, such as metabolic or hormonal dysregulation, indirectly improving nutritional status and impacting IC. To date, no pharmacological treatment addressing the underlying physiological determinants of anorexia of aging has been found to be effective. For instance, existing appetite stimulants offer limited benefits with significant risks [23]. Emerging therapies such as ghrelin mimetics [24] or monoclonal antibodies targeting GDF-15 to address the underlying biology of cachexia, show promise but require further research [25].

In this context, the effectiveness of nutritional indicators for measuring vitality, such as the Mini Nutritional Assessment (MNA) [26], may vary significantly depending on the population being studied [27]. In healthier aging populations, particularly in more developed or high-income countries where overt undernutrition is less common, tools like the MNA may fail to capture declines in vitality that are not associated by evident nutritional deficits. A previous study showing reduced sensitivity of the MNA-Short Form (MNA-SF) in detecting pre-frailty compared to frailty further suggests that it may not adequately identify early nutritional deficits that precede clinically evident decline [28]. This limitation highlights the importance of tailoring assessment methods to the specific characteristics of the population, as traditional tools may not adequately capture subtle nutritional changes or their impact on healthier, well-nourished individuals. Moreover, in these populations, the rising prevalence of obesity adds further complexity, as excess adiposity may also impact health outcomes, which are not captured by scales primarily designed to detect undernutrition [29]. For instance, the MNA assigns higher scores to BMI values above 23 kg/m^2, classifying them as indicative of good nutritional status, which may not accurately reflect the nutritional risks associated with obesity.

Beyond nutrition, other components of the vitality domain such as neuromuscular function, immune and stress response remain poorly defined in current assessments. Whilst chronic low-grade inflammation is a recognized feature of aging, blood biomarkers like IL-6 and TNF-α are non-specific, influenced by acute conditions and comorbidities, and are not routinely used in clinical practice. Questionnaires that assess perceived immune status [30,31] have been proposed as low-burden alternatives, but their validity in older adults is limited [32] and their correlation with objective immune markers remains unclear [33]. Neuromuscular indicators such as grip strength are commonly used because of their feasibility and predictive value, but they primarily reflect observable performance at a phenotypic level rather than a direct measure of physiological reserve. Measures of body composition, such as muscle mass and adiposity assessed by bioelectrical impedance or dual-energy X-ray absorptiometry (DXA), may provide a better indication of physiological status, but their role within the vitality construct remains uncertain. Variability in measurement methods and cut-off values across studies also limit comparability. These issues highlight the ongoing need for clearer definitions and conceptually aligned measurement approaches that reflect the intended scope of the vitality domain.

Another key concept of vitality is its hierarchical framework, positioning it as a foundational element for other IC domains [34,35]. Initially, vitality was regarded as an independent domain focused on the body's energy metabolism and neuromuscular function. However, evolving perspectives now position vitality as a fundamental reserve, influencing other capacities such as cognition, psychological, mobility, and sensory function [36]. Our scoping review highlights the narrow scope of existing vitality studies, which overlooks the broader concept of vitality as a multi-system reserve that may predict declines across other domains, suggesting the need for a more comprehensive framework.

This evolving understanding is bolstered by other studies showing how vitality and its domains through metabolic [37], immune function [38], and neuromuscular strength [39,40], interacts with other IC domains, may represent physiological reserve in the face of age-related stressors [41]. Our review findings reveal gaps in research on metabolic and immune aspects of vitality, as most studies are confined to nutritional and neuromuscular assessments. Aging involves reductions in physiological complexity and adaptability, which compromise stress response and lead to declines across functional domains [42,43]. These insights suggest that a view of vitality, focused primarily on nutrition and strength, may limit our understanding of how declines in vitality broadly impact other IC domains.

Further evidence supporting a more integrative view of vitality comes from studies on IC domain interactions in aging populations. These studies reveal that interventions targeting core physiological functions, such as exercise and nutritional support, have positive impacts across multiple domains, enhancing not only mobility but also cognitive and psychological health [44,45]. Systems modeling and network analyses in aging research indicate that these core functions interact in a non-linear manner, where interventions in one area may reinforce others due to system interdependencies [46]. Our scoping review highlights a critical need to test the construct validity of vitality within the IC framework, particularly to capture these complex, cross-domain interactions more accurately. Moving beyond the current focus on discrete measures, this approach would better reflect vitality's foundational role across domains. This aligns with the perspective that vitality, as a core physiological reserve, is essential for sustaining overall resilience in aging, necessitating a broader, multidimensional framework for its assessment [47].

A key strength of this scoping review is its comprehensive mapping of the existing research on vitality within the intrinsic capacity framework, which identifies critical gaps and areas for future study. However, several limitations should be noted. This review did not include targeted searches for gray literature, which may have excluded relevant non-published findings or data from reports and theses. Although this review covers literature up to the present, the rapid development in aging research and geroscience could mean that emerging trends may not be not fully captured here. Additionally, consistent with the more inclusive methodology employed in scoping reviews, we did not explicitly assess the quality of included studies, focusing instead on breadth of coverage. As a result, methodological limitations within the individual studies, such as variability in vitality measurement and study design, were noted but not systematically evaluated. Given the large number of studies included, providing detailed analysis on each thematic area was challenging, leading to broader categorizations that may not capture the full nuance of individual study findings. Future reviews should provide a more in-depth focus on specific aspects of vitality, such as its metabolic or immune components, within the broader intrinsic capacity framework to enhance specificity and depth of analysis.

In conclusion, this scoping review reveals a limited focus within current research on vitality, predominantly centered on nutrition and neuromuscular function, which precludes our understanding of vitality as a foundational measure of physiological reserve within the intrinsic capacity framework. Our findings suggest a need for further research that captures the broader, multidimensional nature of vitality, and explores its hierarchical relationships with other IC domains. Testing the construct validity of vitality as a core domain is essential to advancing the intrinsic capacity model of healthy aging and fostering more effective interventions for aging populations. Addressing these gaps will not only refine the theoretical framework of intrinsic capacity but also enhance practical approaches for promoting healthy aging, supporting WHO's broader goal of a more inclusive and functional model of aging.

Declaration of generative AI and AI-assisted technologies in the writing process

Generative AI and AI-assisted technologies have not been used in the writing process of this scoping review.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

J. Chew: Data curation, Conceptualization. **J. Lee:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **H.H.C. Hernandez:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Y.L. Munro:** Data curation. **C.L. Lim:** Data curation. **W.S. Lim:** Writing – review & editing, Conceptualization.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjfa.2025.100058.

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