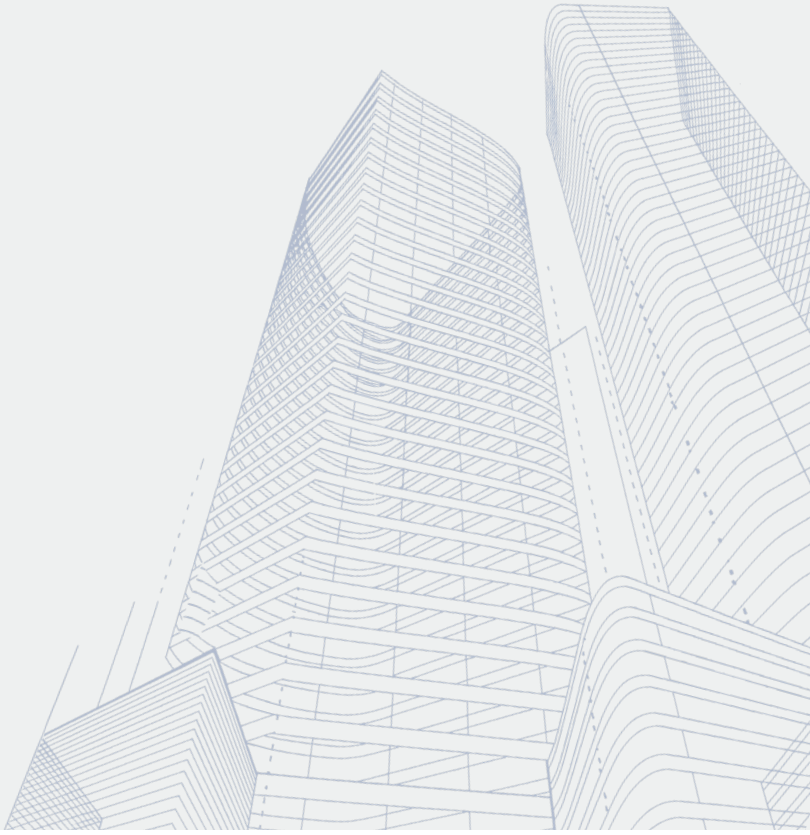
GLOBAL LONGEVITY GUIDE

Medicine Intervention & Commercial Implementation

2026

Co-compiled by

TimePie and Frost & Sullivan



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Introduction

The rapid advancement of modern medicine has significantly extended human life expectancy, but it has also created a pressing challenge: the lengthening of time spent living with illness at the end of life. As life expectancy is no longer the sole measure of health and well-being, extending healthy life expectancy has become a central issue in the global healthcare sector.

In 2025, TimePie and VCBeat jointly released a white paper on longevity medicine, exploring its scope, boundaries, and development roadmap, and providing an initial systematic overview of the industry's disparate perspectives.

In 2026, TimePie partnered with the global growth consulting firm Frost & Sullivan (hereinafter referred to as "Sullivan") to examine the global market development of longevity medicine and longevity technology, and explore the pathways for "technology implementation and service delivery" by longevity clinics.

As research in longevity science continues to deepen, our understanding of aging is gradually shifting from a single-organ, single-indicator perspective toward a holistic, multi-system, and multidimensional view. The "sandcastle effect" model in systems biology emphasizes that human aging is often not driven solely by a single obvious weakness, but rather by the continuous deterioration and mutual influence of multiple physiological systems, ultimately manifesting as a decline in overall function and bodily resilience.

This understanding has also driven a shift in the logic of aging interventions. **Scientifically grounded aging interventions should be based on long-term, systematic, and dynamic health maintenance underpinned by precise assessment.** This also means that future providers of longevity medical services must not only master a diverse range of intervention methods but also possess the ability to provide clients with full-lifecycle health management services. Specifically, this shift is primarily reflected in advancements across the following three dimensions:

I. Systematization of the intervention logic. Moving beyond single-target approaches, we achieve holistic, multidimensional maintenance of bodily functions by combining nutritional supplementation, physical conditioning, and medical technology;

II. Quantitative approach to efficacy assessment. By utilizing biomarkers and biological aging clocks, we provide objective baseline references and dynamic tracking data for intervention plans, ensuring that results are quantifiable and comparable;

III. Long-Term Management Model. Establish a closed-loop process of "assessment—intervention—re-evaluation—iteration" to transform short-term programs into long-term health management services, thereby enhancing client trust and loyalty.

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Study Scope & Key Highlights

I. Study Scope

Building on previous macro-level industry insights, this guide further explores the “Intervention Technology Landscape and Practical Implementation in Clinics.” The content will focus on the current matrix of aging intervention technologies that comply with global and Chinese regulations (including specific scenarios such as pilot medical zones), and will examine the ecosystem mechanisms involving core biological raw materials (upstream), digital assessment platforms (midstream), and physical longevity clinics (downstream).

The term “longevity clinic” as used in this guide refers to specialized institutions whose core business is aging assessment and intervention, providing long-term health management services to healthy and sub-healthy populations. These institutions take various forms, including extensions of hospital systems, independent outpatient clinics, and wellness destinations.

This guide aims to provide a reference that combines academic rigor with commercial practicality for traditional medical aesthetics and high-end health screening institutions seeking business upgrades, investment firms looking for high-quality targets in the longevity industry, and professionals in related sectors. It also seeks to offer an objective and rational scientific guide for the general public interested in cutting-edge anti-aging technologies and quality of life.

This guide will be published globally in both Chinese and English via Frost & Sullivan’s official website and distribution channels, with the aim of enhancing the global influence of Chinese longevity technology companies.

II. Key Highlights

A Systematic Shift in Aging Research: This section traces the evolution of aging theories—from macro-level explanations and mechanism identification to systemic interventions—and, drawing on research advances in geroscience and the characteristics of aging biology, illustrates the field's shift from a focus on individual diseases and isolated mechanisms toward multisystem coordination and healthy life expectancy management.

Longevity Medicine Assessment System: This section delineates the boundaries between traditional clinical testing and longevity medicine assessments, systematically outlines core concepts such as biological age and organ age, and explains the shift in assessment logic—from single-point testing to multidimensional information integration, and from one-time results to long-term dynamic tracking—to provide a basis for risk identification and intervention decisions.

Longevity Medicine Intervention Technology Atlas: Establishes a unified technical evaluation framework to classify and grade current major longevity intervention methods, with a focus on presenting the evidence base, application boundaries, and degree of clinical translation for different technologies.

Global Longevity Industry Landscape: Starting from shifts in demand, this section maps out the industrial development paths of major markets, as well as changes in policy, capital, and supply-side factors, observing the industry trend of longevity medicine moving from cutting-edge exploration toward large-scale application.

Implementation Framework for Longevity Clinics: This section focuses on the transformation strategies of various institutional types entering the longevity medicine sector, outlines key stages from capacity building to service delivery, and summarizes representative clinic implementation models.

Typical Case Studies: Through real-world examples involving diagnostic testing and evaluation, core raw materials, and physical clinics, this section demonstrates the practical performance of cutting-edge technologies during implementation.

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Chapter 1

Overview of Aging

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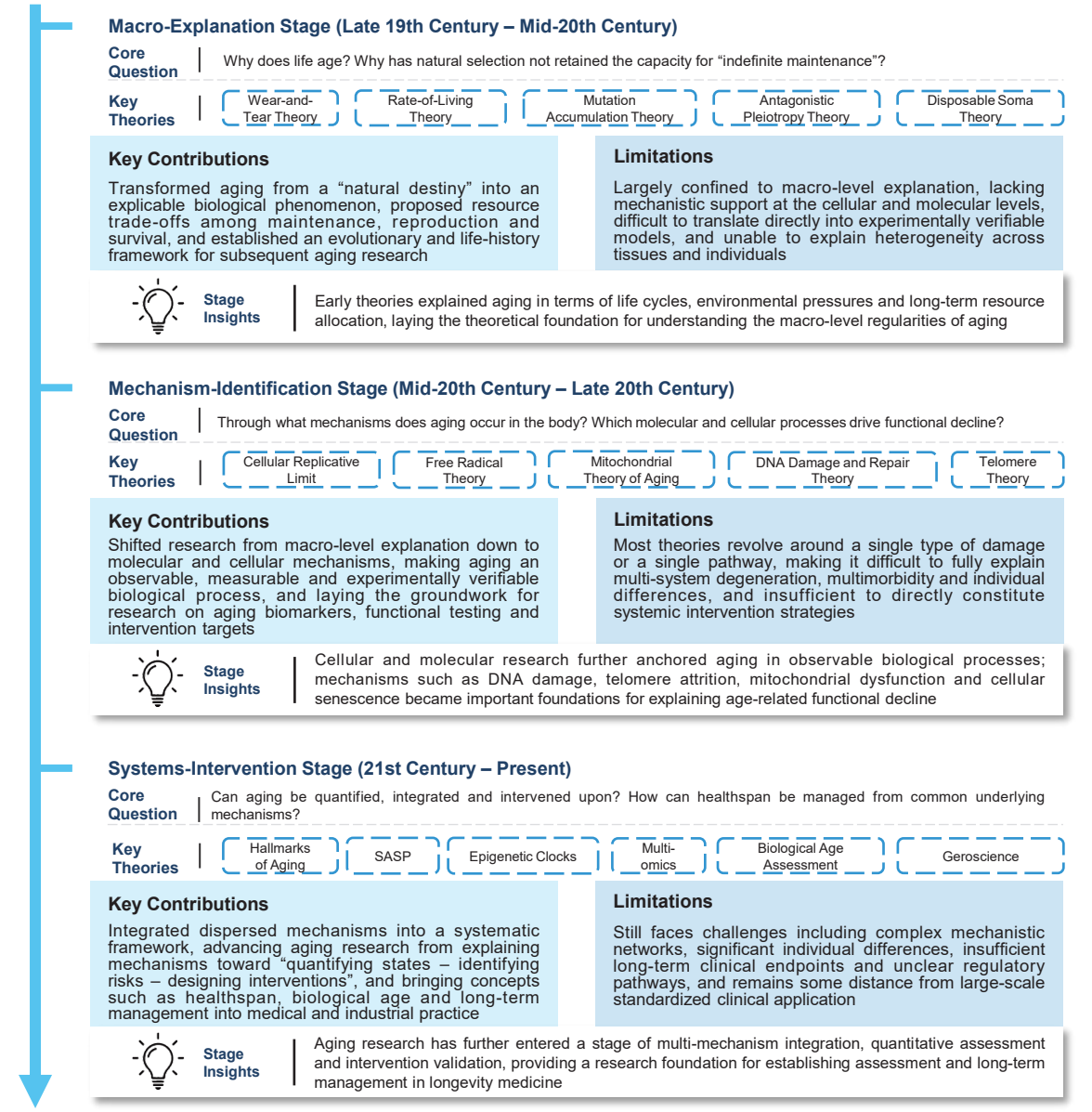
1.1 The Cognitive Foundations of Aging Science

Scientific explanations of aging have evolved continuously, from macro-level theories to cellular and molecular mechanisms and, more recently, to integrated systems research. Different theories explain the aging process from the perspectives of evolution, life history, cellular damage and systemic regulation, gradually converging on three core research questions: why aging occurs, how it occurs, and how it can be quantified, integrated and intervened upon.

1.1.1. The Evolution of Aging Hypotheses

Based on shifts in research questions and research scale, this guide divides the evolution of aging theories into three stages: **the macro-explanation stage, the mechanism-identification stage, and the systems-intervention stage**.

Fig.1 Overview of the Three Stages in the Evolution of Aging Theories



Source: Public information, literature review, TIMEPIE Research Institute analysis

1.1 The Cognitive Foundations of Aging Science

Over the past two decades, aging research has gradually acquired a more actionable research foundation: the hallmarks-of-aging framework has integrated dispersed mechanisms; epigenetic clocks and biological-age metrics have improved quantification; multi-omics, single-cell and spatial omics, and AI computational biology have strengthened the integrated analysis of cellular states, tissue microenvironments and molecular networks; and mammalian intervention studies and early human studies have begun accumulating evidence that aging-related phenotypes are modifiable. Aging has thus gradually become a medical subject that is measurable, researchable and evaluable for intervention effects.

1.1.2. The Reshaping of Aging Research over the Past Two Decades

Table 1 Key Enabling Conditions for Aging Research Entering the Stage of Medical Translation

Translational Foundation	Representative Advances	Core Judgment
Systemic Mechanistic Framework	• Geroscience (focusing on the common mechanisms underlying aging and multiple age-related diseases) • 2013 Hallmarks of Aging framework • 2023 expansion to 12 hallmarks • 2025 addition of extracellular matrix changes and psychosocial isolation	Aging research has shifted from single diseases and single mechanisms toward the common mechanisms of multiple age-related diseases and their interactions, gradually forming a systematic framework for aging biology
Quantification Tools	• Epigenetic clocks and pace-of-aging measures represented by PhenoAge, GrimAge and DunedinPACE	Aging states have begun to acquire a quantitative scale distinct from chronological age, extending research from population-level regularities to individual state comparison, longitudinal tracking and change assessment
Analytical Technologies	• Multi-omics • Single-cell omics • Spatial omics • Proteomics • Metabolomics • AI computational biology	Aging research has expanded from single molecules or pathways to cells, tissue microenvironments and molecular networks, with multi-level data further revealing aging heterogeneity across individuals, tissues and organs
Intervention Evidence	• Caloric restriction • mTOR-related interventions • Senolytics and other animal studies and early human studies	Certain aging-related mechanisms and phenotypes have shown modifiability, shifting the research focus from mechanism identification toward intervention validation and providing a direct basis for aging science to enter the stage of medical translation

As research logic and tool systems have matured, medical objectives have adjusted accordingly: **gradually extending from post-diagnosis treatment and management of disease to pre-disease risk identification, functional maintenance and healthspan management**.

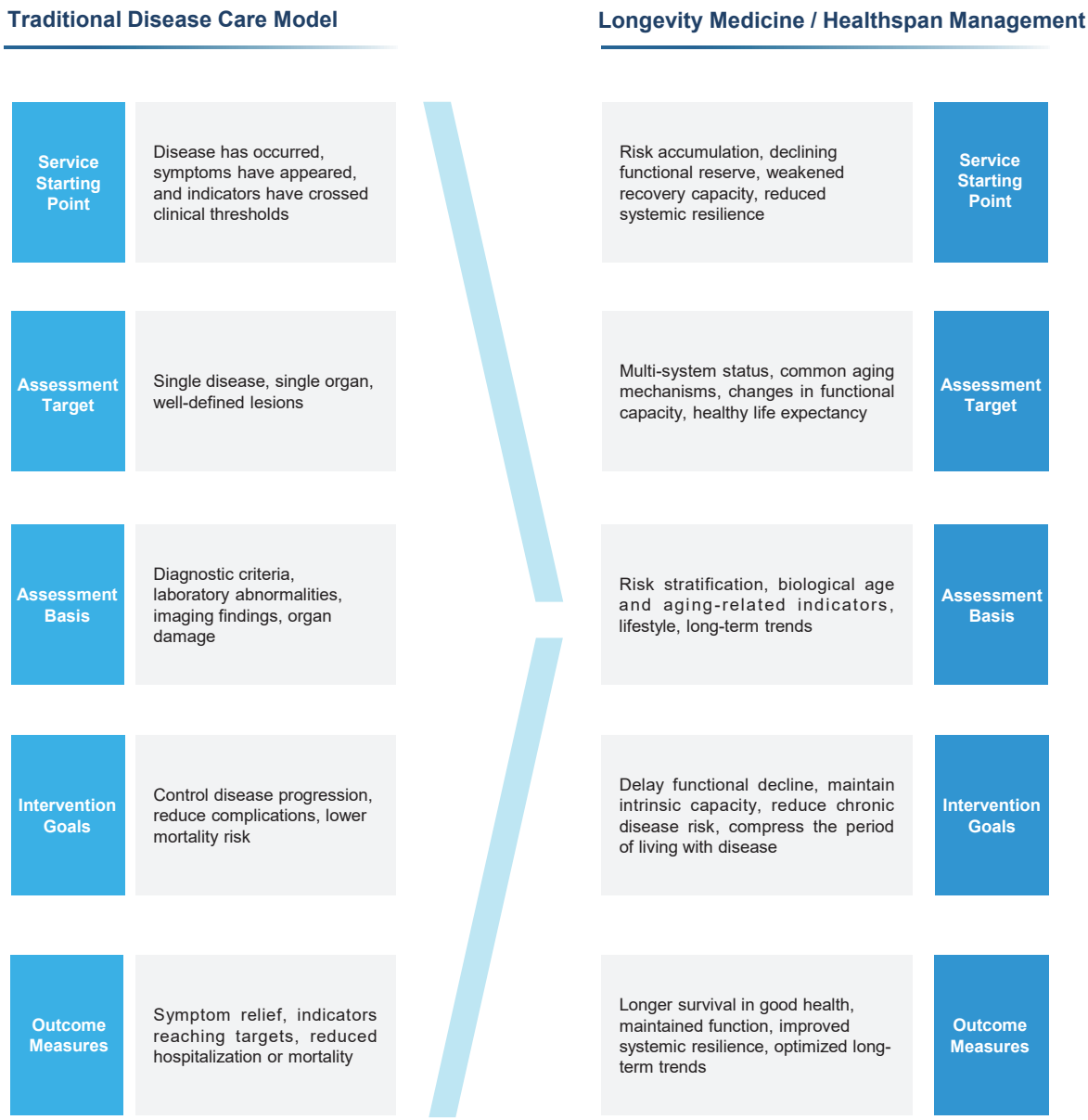
Source: Public information, literature review, TIMEPIE Research Institute analysis

1.1 The Cognitive Foundations of Aging Science

As research logic and tool systems have matured, medical objectives have adjusted accordingly: gradually extending from post-diagnosis treatment and management of disease to pre-disease risk identification, functional maintenance and healthspan management.

1.1.2. The Reshaping of Aging Research over the Past Two Decades (2/2)

Fig.2 Comparison of Focus Areas Between Traditional Disease Care and Longevity Medicine



Source: Public information, literature review, TIMEPIE Research Institute analysis

1.2 Overview of the Biological Hallmarks of Aging

Aging involves multiple interrelated changes at the molecular, cellular and tissue levels. The proposal of the Hallmarks of Aging established a unified organizational framework for these dispersed mechanisms and has become one of the most influential conceptual systems in aging biology over the past decade-plus.

1.2.1. From Scattered Mechanisms to a Systematic Framework

In 2013, researchers borrowed the conceptual framework of the “hallmarks of cancer” from oncology and systematically proposed the concept of “Hallmarks of Aging” for the first time, bringing previously dispersed aging mechanisms into a unified framework. In 2023, a Cell review expanded the hallmarks to twelve: genomic instability, telomere attrition, epigenetic alterations, loss of proteostasis, disabled macroautophagy, deregulated nutrient sensing, mitochondrial dysfunction, cellular senescence, stem cell exhaustion, altered intercellular communication, chronic inflammation and dysbiosis.

A 2025 Cell review further discussed aging mechanisms within the framework of “Precision Geromedicine”, emphasizing the connections among hallmarks of aging, risk factors, biomarkers, individual stratification and intervention pathways, and brought extracellular matrix changes and psychosocial isolation into the discussion. The former highlights the role of tissue architecture and the extracellular microenvironment in aging, while the latter suggests that social connection, psychological stress, loneliness, sleep rhythms and behavioral patterns also influence healthy aging trajectories.

Fig.2 14 Aging-Related Biological Hallmarks

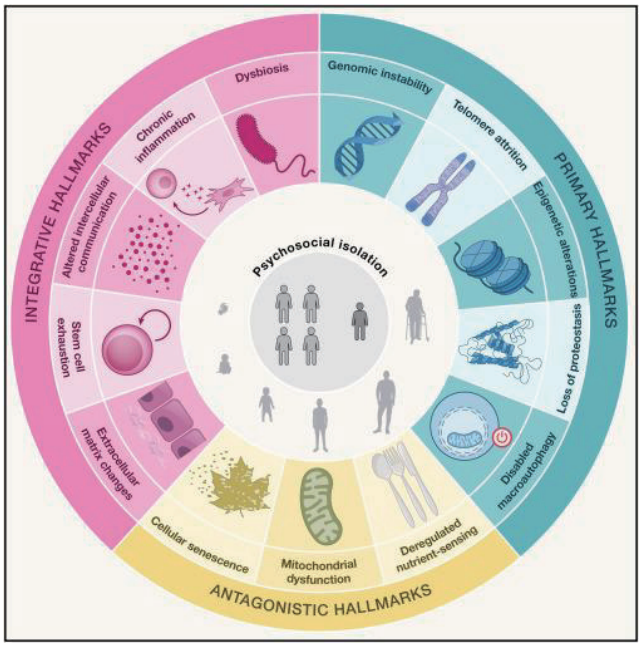


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Under this system, a biological process generally must meet three conditions to qualify as a hallmark of aging:

- **It appears or worsens with age**
- **Experimentally enhancing the process accelerates aging**
- **Intervening in or alleviating the change offers the opportunity to delay, halt or even partially reverse aging-related phenotypes**

Source: Public information, literature review, TIMEPIE Research Institute analysis

1.2 Overview of the Biological Hallmarks of Aging

The 14 aging-related biological hallmarks can be grouped into four categories: primary hallmarks, antagonistic hallmarks, integrative hallmarks, and psychosocial-level hallmarks, corresponding to biological changes at different stages and levels of the aging process.

The hallmarks of aging are not isolated from one another; extensive cross-talk and mutual influence exist among them, ultimately manifesting as the characteristics of complex system degradation: diminished coordination, weakened homeostasis maintenance, and slower recovery after stress.

1.2.2. Classification of the 14 Aging-Related Biological Hallmarks (1/3)

- **Primary Hallmarks**

Mainly include **genomic instability, telomere attrition, epigenetic alterations, loss of proteostasis and disabled macroautophagy**. These changes first occur in fundamental processes such as genetic information maintenance, epigenetic regulation and cellular quality control, and can accumulate continuously, further affecting cellular homeostasis and subsequent tissue function.

- **Antagonistic Hallmarks**

Mainly include deregulated nutrient sensing, mitochondrial dysfunction and cellular senescence, involving metabolic regulation, energy homeostasis and damage response. These hallmarks are stage- and context-dependent. In youth or under stress, the related responses may contribute to development, energy adaptation, damage repair and tumor suppression; but when prolonged, overactivated or dysregulated, they may drive the aging process.

- **Integrative Hallmarks**

These hallmarks include stem cell exhaustion, altered intercellular communication, chronic inflammation, dysbiosis and extracellular matrix changes. They mostly reflect long-term imbalances at the tissue, organ and system levels, involving tissue repair, immune homeostasis, microecological balance and structural integrity, and their changes are more readily associated with functional decline, weakened recovery capacity and age-related health risks.

- **Psychosocial-Level Hallmarks**

Psychosocial isolation further extends the observational scope of aging research to the long-term interaction between individuals and their social environment. Reduced social connection and sustained psychological stress can affect sleep, inflammation and overall functional status through neuroendocrine and immune modulation, and their long-term effects have therefore entered the assessment scope of aging biology and healthspan research.

Source: Public information, literature review, TIMEPIE Research Institute analysis

1.2 Overview of the Biological Hallmarks of Aging

1.2.2. Classification of the 14 Aging-Related Biological Hallmarks (2/3)

Table 2 Classification of the 14 Aging-Related Biological Hallmarks (1/2)

Category	Hallmark of Aging	Related Mechanisms	Representative Assessment Metrics	Core Meaning
Primary Hallmarks	Genomic instability	• DNA double-strand breaks • Base damage • Chromosomal abnormalities • Declining efficiency of DNA repair pathways	• DNA damage markers • Mutation load	Persistent accumulation of DNA damage reduces the stability of genetic information
	Telomere attrition	• Telomere shortening • Damage to telomere protective structures • Cell cycle arrest • Declining stem cell renewal capacity	• Telomere length • Telomerase activity	Telomeres gradually shorten or lose their protective function with cell replication, affecting sustained cell proliferation and tissue renewal
	Epigenetic alterations	• DNA methylation drift • Changes in chromatin accessibility • Abnormal histone modifications • Increased gene expression noise	• DNA methylation • Epigenetic clocks	Age-related drift occurs in regulatory mechanisms such as DNA methylation, histone modifications and chromatin structure, affecting the stability of gene expression
	Loss of proteostasis	• Protein misfolding • Abnormal protein aggregation • Decline of the ubiquitin–proteasome system • Weakened chaperone function	• Abnormal protein aggregation burden • Proteomics • Autophagy / proteasome-related metrics	The functions of protein folding, repair, degradation and clearance systems decline, and abnormal proteins gradually accumulate
	Disabled autophagy	• Reduced autophagic flux • Impaired mitophagy • Declining lysosomal function • Accumulation of cellular waste	• LC3 • P62 • Autophagic flux-related assays	The cell's ability to clear damaged proteins, abnormal organelles and metabolic waste declines, affecting cellular renewal and energy homeostasis
Antagonistic Hallmarks	Deregulated nutrient sensing	• Chronic mTOR activation • Insulin resistance • Reduced AMPK activity	• Fasting blood glucose • Insulin • HbA1c	Nutrient-sensing pathways such as mTOR, AMPK, IGF-1 and insulin become imbalanced with age and metabolic status
	Mitochondrial dysfunction	• mtDNA damage • Abnormal mitochondrial dynamics • Impaired mitophagy	• Lactate / pyruvate ratio • Energy metabolism-related metabolites • Mitochondrial function-related metrics	Mitochondrial energy production, quality control and stress-regulation capacity decline, affecting cellular energy homeostasis
	Cellular senescence	• Cell cycle arrest • DNA damage response • SASP secretion	• p16/p21 • γ-H2AX • SA-β-gal • SASP-related factors	Cells enter a long-term and usually irreversible cell cycle arrest and continuously influence surrounding cells and the tissue environment through the SASP

Source: Public information, literature review, TIMEPIE Research Institute analysis

1.2 Overview of the Biological Hallmarks of Aging

1.2.2. Classification of the 14 Aging-Related Biological Hallmarks (3/3)

Table 2 Classification of the 14 Aging-Related Biological Hallmarks (2/2)

Category	Hallmark of Aging	Related Mechanisms	Representative Assessment Metrics	Core Meaning
Integrative Hallmarks	Stem cell exhaustion	• Hematopoietic stem cell decline • Declining muscle satellite cell function • Weakened tissue renewal capacity	• Tissue repair / regeneration capacity • Studies on tissue-specific stem / progenitor cells	The number and regenerative potential of tissue stem cells decline, and tissue renewal and damage-repair capacity weaken accordingly
	Altered intercellular communication	• Abnormal endocrine regulation • Imbalanced immune communication • Altered cross-tissue signaling	• Hormone levels • Cytokine profiles • Neuroendocrine-related metrics	Signaling coordination among cells, tissues and whole-body regulatory systems declines, and cross-system information transmission becomes disordered
	Chronic inflammation	• Altered immune cell function • Persistently elevated inflammatory factors • Pro-inflammatory tissue microenvironment	• hs-CRP • IL-6 • TNF-α • Immune phenotyping	The body remains in a low-grade, chronic, systemic inflammatory state, driving tissue damage and elevating the risk of multiple chronic diseases
	Dysbiosis	• Reduced microbial diversity • Changes in short-chain fatty acids • Impaired gut barrier function	• Gut microbiome testing • Short-chain fatty acids • Gut barrier-related metrics	The composition, diversity and ecological balance of the host microbiota change, affecting overall homeostasis
	Extracellular matrix changes	• Collagen cross-linking • Fibrosis • Reduced vascular elasticity • Altered extracellular microenvironment	• Skin and vascular elasticity • Tissue stiffness • Fibrosis-related metrics	Age-related changes occur in collagen, elastin, matrix structure and the extracellular microenvironment, affecting tissue mechanics and cell behavior
Psychosocial-Level Hallmarks	Psychosocial isolation	• Reduced social connection and participation • Chronic neuroendocrine stress responses • Disrupted sleep rhythms	• Loneliness / social isolation scales • Sleep quality • Social engagement • Psychological status	Long-term social isolation, loneliness, chronic psychological stress and disrupted behavioral rhythms can affect neuro–endocrine–immune homeostasis

Source: Public information, literature review, TIMEPIE Research Institute analysis

1.3 The Systems Biology of Aging

Human life activities span molecules, cells, tissues, organs and whole-body regulatory systems, and are influenced by behavior and the external environment.

1.3.1. From System Emergence to Resilience Decline

Complex systems are composed of multi-level elements joined by networks, feedback loops and nonlinear relationships. All levels jointly maintain overall functional stability through information exchange, compensatory regulation and dynamic adaptation. A 2022 review published in Nature Aging proposed that, after identifying extensive genetic, molecular and pathway-level evidence, aging research is shifting its focus toward interactions across biological levels. **Complex-systems concepts such as emergence, networks and resilience are becoming important tools for understanding aging.**

Fig.3 Shift to complex systems approaches in ecology and aging biology

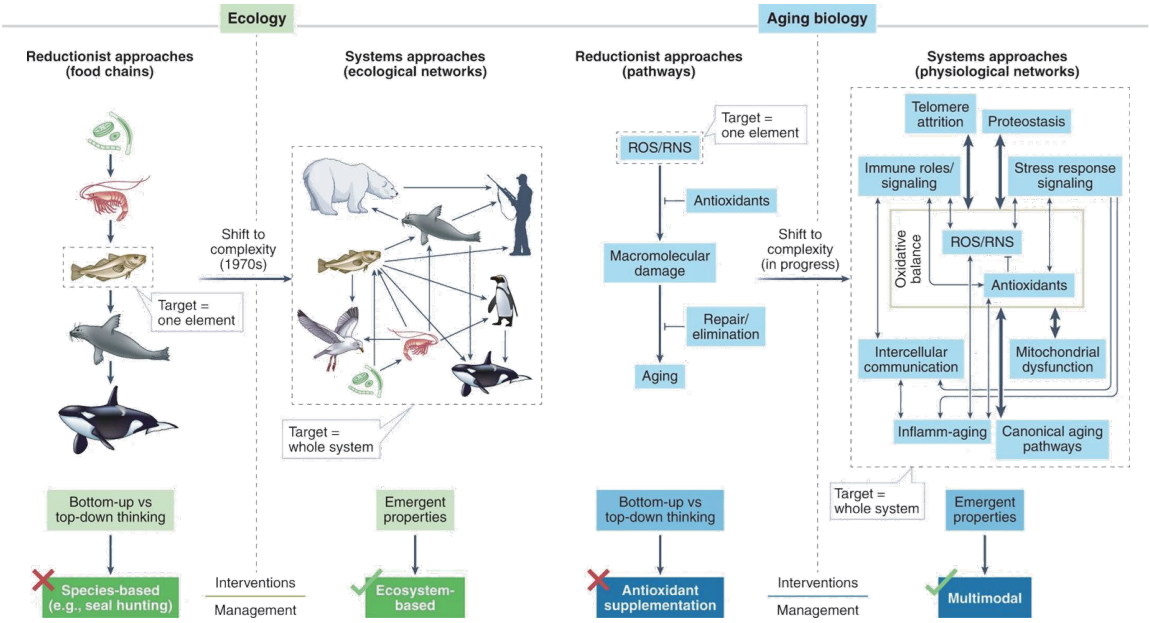


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- **Emergence refers to new properties that arise once a system reaches a certain level of complexity and cannot be obtained by simply summing its individual components.** In human aging, molecular damage, changes in cellular states and declining organ function influence one another, accumulating and amplifying across levels over time, ultimately manifesting as declining functional reserve, weakened recovery capacity and rising disease risk.
- **The decline of systemic resilience (the ability of a system to return to a stable state after perturbation) is the concentrated expression of these accumulated multi-level changes.** When resilience is high, the body can quickly return to baseline after infection, sleep deprivation, exercise load or psychological stress; as age increases and physiological reserve declines, the same perturbations may cause more pronounced and persistent functional deviations, manifested as prolonged recovery time and diminished metabolic, immune and physical regulatory capacity.

Source: Public information, literature review, TIMEPIE Research Institute analysis

1.3 The Systems Biology of Aging

Modern medicine has significantly extended average human lifespan, and time spent in good health has become an important dimension for measuring the quality of aging.

1.3.2. The Formation Mechanism of the Healthy Life Expectancy Gap

Healthy life expectancy (HALE) is an important indicator of healthy aging. As defined by the WHO, healthy life expectancy refers to the average number of years a person can expect to live in a state equivalent to "full health", given current mortality rates and disease burden. Beyond fatal outcomes, HALE also incorporates non-fatal disease, disability and health loss into its calculation, and therefore better reflects the impact of disease burden and functional impairment over the course of lifespan extension.

The gap between life expectancy and healthy life expectancy can be understood as time spent "alive but in impaired health". This gap is usually accompanied by disease, functional limitation or disability, and gradually emerges and widens through **the accumulation of chronic disease burden, declining functional capacity, rising frailty and disability risk, and increasing care dependence**.

Fig4. Main Contributing Factors to the Healthy Life Expectancy Gap

Accumulating chronic disease burden	➢ Advancing age leads to the stacking of risks for multiple chronic diseases (cardiovascular disease, diabetes, chronic kidney disease, chronic respiratory disease, neurodegenerative disease and cancer), whose impact affects physical strength, cognition, metabolic status and independence in daily living, gradually compressing survival time in good health. ➢ Assessment can focus on metabolic risk, cardiovascular risk, chronic inflammation, kidney function, cognitive risk and multimorbidity.
Declining functional capacity	➢ Healthy aging is not merely "the absence of diagnosed disease". Before reaching diagnostic thresholds for serious disease, some individuals already show reduced muscle mass, decreased bone density, poorer balance, deteriorating vision and hearing, and slower cognition — changes that directly affect mobility, daily activities and social participation. ➢ Assessment can focus on muscle strength, gait speed, balance, cardiopulmonary endurance, bone health, cognitive performance and sensory function.
Rising frailty and disability risk	➢ reduces the body's ability to withstand and recover from external perturbations. After events such as infection, falls or hospitalization, individuals are more likely to experience prolonged recovery, incomplete functional restoration or continued decline, and disability risk increases accordingly. ➢ Assessment can focus on frailty level, functional reserve and recovery capacity, judged in combination with functional changes after falls and hospitalization.
Increasing care dependence	➢ When mobility, cognition and self-care ability continue to decline, some individuals gradually lose autonomy in daily life and begin to require support from family or medical care. ➢ Assessment can focus on activities of daily living, instrumental activities of daily living, social participation, quality of life and care needs.

HALE combines lifespan length with health status, providing a more meaningful indicator for measuring healthy aging. Its focus is on extending the time individuals maintain good function and independence in daily life, and reducing life stages accompanied by disease, disability and care dependence.

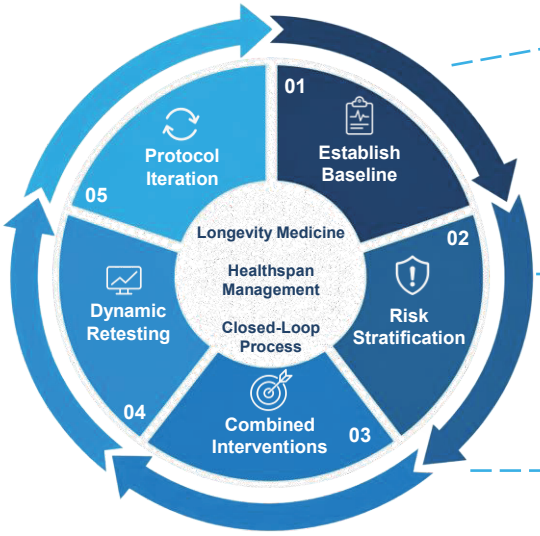
Source: Public information, literature review, TIMEPIE Research Institute analysis

1.3 The Systems Biology of Aging

Based on the systems-biology principles above, longevity medicine must shift from one-off testing or single interventions to a long-term maintenance closed loop that continuously tracks changes in individual status, major risks and intervention responses. The complete loop comprises five consecutive stages: baseline establishment, risk stratification, combined interventions, dynamic retesting and protocol iteration.

1.3.3. The Maintenance Logic of Longevity Medicine Based on Systems Properties

Fig.5 Long-Term Health Management Cycle in Longevity Medicine



Establish Baseline

01 Integrate clinical indicators, body composition and functional status with sleep, cognition and lifestyle information, and incorporate multi-omics testing of inflammation, metabolism and immunity as needed. Establish a reference for the individual's current health status and long-term changes, forming a continuously updatable individual baseline profile.

Risk Stratification

02 Use baseline results to identify existing abnormalities, early functional changes and potential risks, and determine the relative influence of different systems in the individual's aging process. Clarify the risk sources and risk levels that currently require priority management.

Combined Interventions

03 Centered on foundational measures such as nutrition, exercise, sleep and stress management, configure medications, supplements and related medical technologies according to major risks, clinical needs and evidence-based support, and form individualized intervention protocols in line with indications, safety and compliance requirements.

Dynamic Retesting

04 Set retest metrics around major risks and intervention goals, and use continuous data comparison to determine whether health status and key risks have changed. Retest frequency can be adjusted according to risk level, intervention intensity and individual status.

Protocol Iteration

05 Continuously adjust intervention priorities and implementation intensity based on retest results and changes in age, disease events and life circumstances. Replace or adjust measures that show limited effect, declining necessity or increasing risk, and update the protocol for newly emerging major risks.

Continuous Cycling, Dynamic Optimization

Through this closed loop, longevity medicine brings testing, functional assessment and intervention into a continuous management system. Through long-term tracking and dynamic adjustment, it delays the accumulation of health risks and functional decline, with the long-term goals of maintaining functional status and extending healthy life expectancy.

Source: Public information, literature review, TIMEPIE Research Institute analysis

Summary

Understanding of aging has expanded from single hypotheses to systemic comprehension

The observational scale of aging research has continued to expand, progressing from evolutionary and life-history explanations to cellular and molecular mechanisms and multi-system interactions. Research advances such as Geroscience, the hallmarks of aging, biological age and multi-omics have further strengthened the ability to analyze aging mechanisms, individual differences and dynamic changes, providing a foundation for medical assessment and intervention research.

Medical attention is shifting from age labels to changes in function and intrinsic capacity

Modern medicine should not simply pathologize aging itself. The WHO healthy aging framework places greater emphasis on maintaining intrinsic capacity and functional ability, and extends the assessment of health status from age or disease diagnosis alone to function and overall condition. This provides a clearer medical positioning for longevity medicine: focusing on functional maintenance, risk management and healthspan improvement, and avoiding equating normal aging directly with disease.

Longevity medicine needs to establish a long-term maintenance closed loop

The 14 aging-related biological hallmarks reveal extensive interconnections among aging mechanisms, and complex-systems research further emphasizes the accumulation of multi-level changes and the decline of systemic resilience. Accordingly, longevity medicine has formed a long-term management closed loop centered on **baseline establishment, risk stratification, combined interventions, dynamic retesting and protocol iteration**, with continuous attention to functional status and healthy life expectancy.

Source: Public information, literature review, TIMEPIE Research Institute analysis

Chapter 2
Assessment in Longevity Medicine



02

2.1 Assessment Framework in Longevity Medicine

Longevity medicine assessment focuses on current health status, accumulating risks, and changes following intervention. Conventional clinical testing, biological age assessment, functional assessment, and continuous monitoring provide complementary information to identify disease risks, assess functional status, and track long-term trends.

2.1.1. Scope of Conventional Clinical Testing

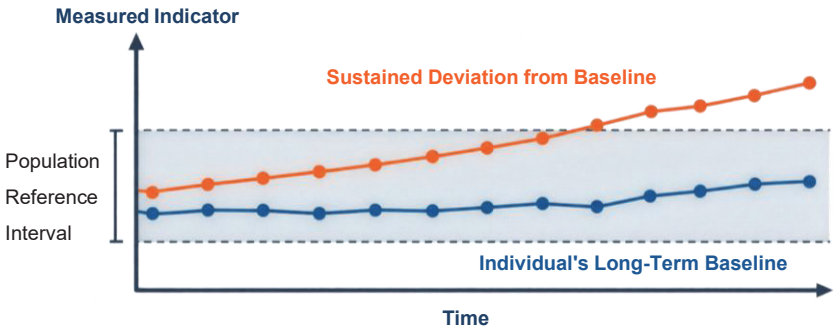
Conventional clinical testing supports disease screening, diagnosis, and treatment monitoring. Using reference intervals, diagnostic criteria, and clinical decision thresholds, it helps identify established diseases, major health risks, and contraindications to interventions, and determine whether further testing or clinical management is needed.

Healthspan management extends assessment to the period before disease diagnosis. Changes in metabolic health, muscle function, cognition, and recovery capacity may accumulate before diagnostic thresholds are reached. Longevity medicine assessment therefore also considers individual baselines, functional status, and longitudinal trends to identify sustained deviations from an individual's usual health status, even before disease-related diagnostic thresholds are met.

Table 1 Scope of Conventional Clinical Testing and Longevity Medicine Assessment

Conventional Clinical Testing	Assessment Basis	Additional Focus in Longevity Medicine
Established diseases or major health risks	Signs and symptoms, laboratory tests, imaging, and disease screening	Risk accumulation before disease onset
Whether indicators reach clinical decision thresholds	Reference intervals, diagnostic criteria, and clinical decision thresholds	Early functional changes
Contraindications and safety risks	Liver and kidney function, cardiovascular status, medical history, and medication use	Declining functional reserve and systemic resilience
Need for further testing, referral, or treatment	Screening results, severity of abnormalities, and clinical guidelines	Long-term deviations from individual baselines
Conventional clinical testing helps determine the need for clinical management, while longevity medicine assessment also examines deviations from an individual's healthy-aging trajectory.		

Fig. 1 Sustained Deviations Within Reference Intervals May Signal Health Risks



Sustained deviations from an individual's baseline may warrant further assessment, even when results remain within the reference interval.

Source: Public information, literature review, TIMEPIE Research Institute analysis

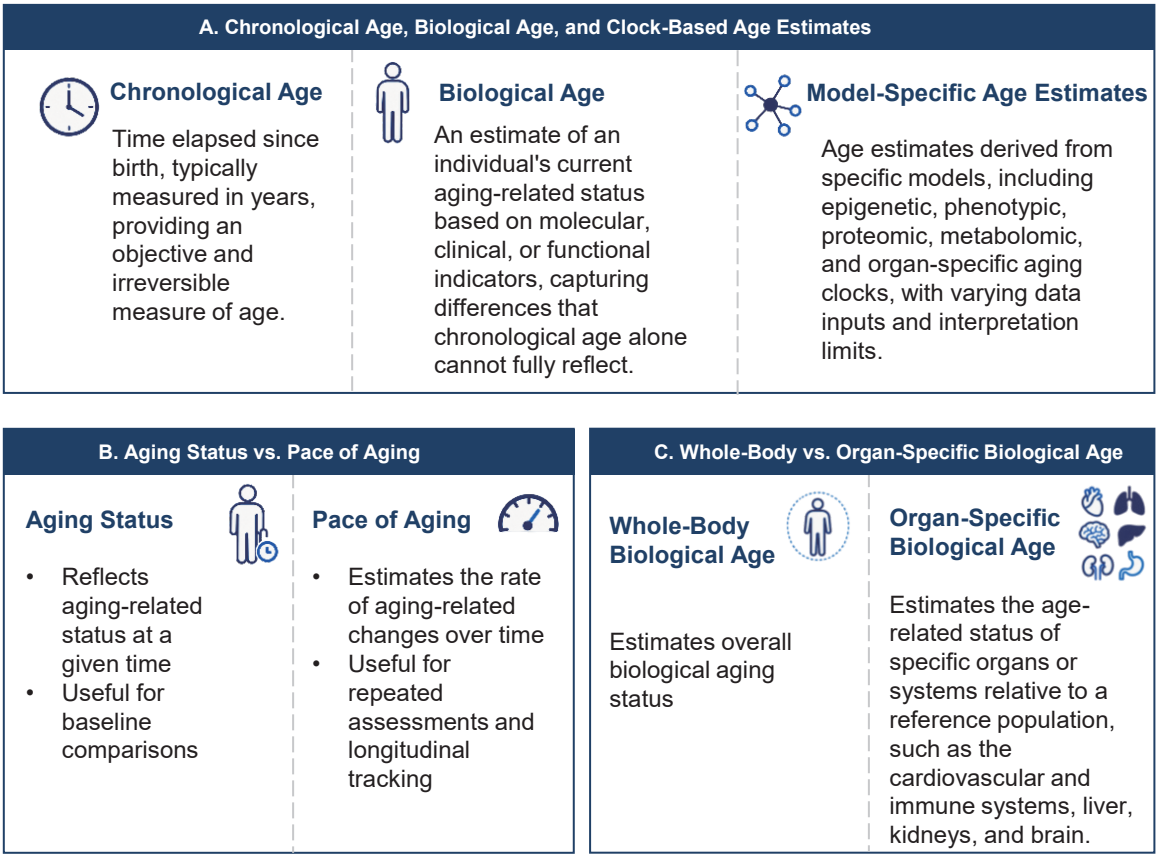
2.1 Assessment Framework in Longevity Medicine

Chronological age reflects the time an individual has lived but does not fully capture differences in physiological function, disease risk, and recovery capacity among people of the same age. Biological age can help quantify these differences for risk stratification and long-term monitoring.

2.1.2. Defining Biological Age

Biological age is a model-based estimate of an individual's physiological status, health risks, or pace of aging, derived from aging-related molecular, clinical, or functional markers. It provides a means of quantifying individual differences in aging that chronological age alone cannot fully capture.

Fig. 2 Biological Age: Key Conceptual Distinctions



Different models may yield different biological age estimates for the same individual due to differences in data inputs, training targets, and assessment domains. Results should be interpreted alongside clinical indicators, functional status, and longitudinal trends, taking each model's characteristics into account. Consistent models, testing platforms, and sampling conditions help improve comparability across repeated assessments.

Source: Public information, literature review, TIMEPIE Research Institute analysis

2.1 Assessment Framework in Longevity Medicine

Longevity medicine assessment is evolving from single-point evaluations to longitudinal monitoring.

2.1.3. From Single-Point Testing to Integrated Assessment (1/2)

Initial assessments establish individual baselines, while periodic reassessments track changes in clinical indicators and functional status, extending the focus beyond isolated abnormalities to long-term trends.

Assessment is moving from individual measures toward the integration of data sources. Clinical indicators, biological age estimates, functional tests, multi-omics, and continuous monitoring data can be interpreted alongside individual characteristics and longitudinal trends to support comprehensive risk assessment and result interpretation.

Multidimensional assessment should inform clinical management decisions. In designing assessment frameworks, priority should be given to findings that are interpretable and actionable, particularly those that can inform risk stratification, follow-up scheduling, intervention priorities and adjustments, or further testing. Such findings are best suited for inclusion in core assessment workflows.

Fig.3 Evolution of Assessment Framework in Longevity Medicine (1/2)



- Conventional health checkups provide a snapshot of health at a single point in time.
- Longevity medicine combines baseline assessments, periodic reassessments, and trend analysis to track the direction and rate of change.

Assessment findings should inform clear management decisions. Depending on the level of risk and nature of the findings, management actions may include continued monitoring, adjustment of intervention priorities, follow-up testing, further investigation, and specialist referral.

Conventional clinical measures and certain functional tests have established reference standards and interpretation frameworks. Biological age estimates, multi-omics, and continuous-monitoring measures are more often used to supplement risk assessment, monitor trends, or support targeted evaluations in longevity medicine. Their findings should be interpreted alongside clinical measures and longitudinal data.

Source: Public information, literature review, TIMEPIE Research Institute analysis

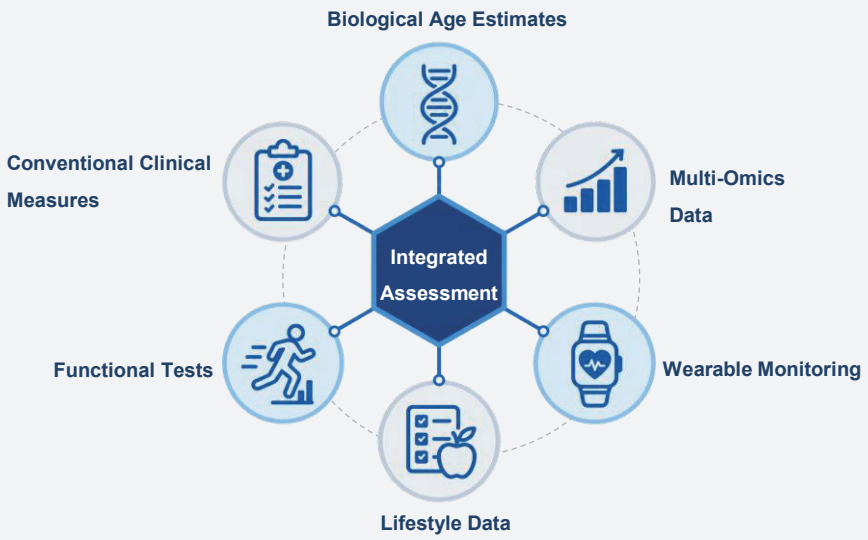
2.1 Assessment Framework in Longevity Medicine

Longitudinal monitoring and multidimensional assessment change how test results are interpreted. The former places individual measurements in the context of personal baselines and long-term trends, while the latter integrates data from multiple sources to provide a more comprehensive picture of health status and changes in risk.

2.1.3. From Single-Point Testing to Integrated Assessment（2/2）

Fig.3 Evolution of Assessment Framework in Longevity Medicine (2/2)

From Single Measures to Integrated Assessment



- No single measure fully captures an individual's aging status.
- Longevity medicine integrates clinical measures, biological age estimates, functional tests, multi-omics, and continuous monitoring into a unified assessment framework to examine whether molecular changes align with functional status and long-term trends.

2.2.1. Biological Aging Clocks (1/2)

Biological aging clocks use molecular, clinical, or multi-omics data to estimate physiological aging, health risks, or the pace of aging. Among these approaches, DNA methylation clocks have a substantial body of research and validation evidence and are among the more widely commercialized assessment tools.

DNA methylation clocks are based on age-related changes in methylation patterns at selected CpG sites. Researchers use statistical and machine-learning methods to integrate information from these sites and develop models for estimating chronological age, health risks, and the pace of aging. As training targets have expanded from chronological age to health outcomes and the pace of aging, different generations of DNA methylation clocks have emerged.

Source: Public information, literature review, TIMEPIE Research Institute analysis

2.2 Core Assessment Technology Matrix

Longevity medicine draws on four complementary assessment technologies: biological aging clocks, multi-omics testing, phenotypic and functional assessments, and digital monitoring with data integration.

2.2.1. Biological Aging Clocks (2/2)

In longevity medicine, DNA methylation clocks provide molecular estimates of aging-related status, supporting baseline assessments, comparisons and longitudinal monitoring. Their findings support risk assessment and communication but should be interpreted alongside clinical indicators, functional status, and other relevant health information. Current evidence does not support their use as stand-alone tools for disease diagnosis or individual lifespan prediction.

Table 2. Evolution of DNA Methylation Clocks

Generation	Representative Models	Model Basis	Primary Task	Applications	Limitation
First	Horvath Clock; Hannum Clock	DNA methylation data	Chronological age prediction	Molecular age estimation; research comparisons; baseline reference	Limited disease-risk prediction
Second	PhenoAge; GrimAge/GrimAge 2	DNA methylation data; clinical and protein-related biomarkers	Health and mortality risk prediction	Risk stratification; health assessment; clinical research	Population- and outcome-dependent; limited standalone clinical utility
Third	DunedinPoAm; DunedinPACE	DNA methylation data; longitudinal physiological data used for training	Pace of aging estimation	Longitudinal monitoring; intervention studies	Longitudinal responsiveness and interpretation require further validation
Fourth	AdaptAge; CpGPT; SITH	Large-scale methylation data; advanced modeling methods	High-dimensional pattern recognition and model optimization	Methodological research; model development; exploratory applications	Limited interpretability, reproducibility and clinical readiness

DNA methylation clock estimates may vary with testing platforms, algorithm versions, blood cell composition, smoking, inflammation, sample processing and batch effects. These clocks are currently better suited as supplementary tools for advanced assessment and longitudinal monitoring, alongside clinical and functional measures, rather than routine first-line screening.

Source: Public information, literature review, TIMEPIE Research Institute analysis

2.2 Core Assessment Technology Matrix

Multi-omics testing provides molecular and systems-level insights beyond conventional clinical measures. In longevity medicine, proteomic, metabolomic, immune, and microbiome data can help identify organ systems, biological pathways, and physiological states associated with abnormal signals.

2.2.2. Multi-Omics Assessment Matrix (1/2)

Proteomics

- Plasma proteomics, including the analysis of organ-enriched proteins, can reveal aging-related changes across organs and systems. Large cohort studies, including UK Biobank, have linked proteomic organ age estimates to all-cause mortality and organ-specific disease risks, though clinical validation remains at an early stage.
- In longevity medicine, proteomics is better suited to advanced risk stratification, organ-focused follow-up, and risk assessment in complex populations. Results may be affected by acute inflammation, medications, liver and kidney function, and assay platforms. Organ age deviations cannot replace imaging, pathology, or specialist diagnosis.

Metabolomics

- Metabolomics profiles small-molecule metabolites, lipids, and amino acids to assess metabolic status and responses to diet, exercise, and disease. Research has explored its use in disease risk prediction and metabolic assessment, bringing it relatively close to clinical application among omics technologies.
- In longevity medicine, metabolomics may supplement conventional metabolic measures in assessing obesity, metabolic syndrome, and fatty liver disease, as well as guiding nutrition and exercise management. Results are sensitive to fasting status, diet, exercise, alcohol, medications, and blood sampling time, and require clinical context for interpretation.

Immunomics

- Immunomics assesses immune function, inflammatory status, and immunosenescence using immune cell subsets, cytokine profiles, inflammatory markers, and composite immune age measures. Research models such as IMM-AGE and iAge have linked immune profiles to immune status, cardiovascular aging, and mortality risk, although clinical validation remains at an early stage.
- In longevity medicine, immunomics may support advanced assessment in selected groups, including those with recurrent infections, elevated inflammatory burden, autoimmune tendencies, or those who have undergone cancer treatment. Results may be significantly affected by vaccination, recent infections, medications, circadian rhythms, and testing conditions.

Source: Public information, literature review, TIMEPIE Research Institute analysis

2.2 Core Assessment Technology Matrix

In longevity clinics, multi-omics is better suited to advanced or targeted assessments. Its value lies in providing additional information for risk stratification, intervention priorities, follow-up planning, or further testing.

2.2.2. Multi-Omics Assessment Matrix (2/2)

Microbiomics

- Microbiomics examines gut microbiota composition, function, and ecosystem stability, including their associations with diet, medications, inflammation, and health status. Certain microbial signatures have been linked to healthy aging and survival, but substantial individual variability limits clinical interpretation.
- In longevity medicine, gut microbiome testing is better suited to supplementary assessment in individuals with gastrointestinal symptoms, a history of antibiotic use, dietary management needs, or specific inflammatory symptoms. Single stool samples may be affected by geography, diet, and medications, and may not capture long-term microbiome stability.

Genomics

- Genomics provides relatively stable genetic information to assess disease susceptibility, drug-response differences, and long-term inherited risks. Certain monogenic and pharmacogenomic applications are clinically established, but genomic data offer limited insight into current aging status or short-term intervention responses.
- In longevity medicine, genomics is best used for targeted screening and long-term risk assessment and as a source of long-term background information, while dynamic changes require monitoring with other assessment tools. Polygenic risk scores also vary across populations and cannot determine whether an individual will develop a disease.

Multi-Omics Integration

- Multi-omics integration combines proteomic, metabolomic, microbiome, and clinical data to provide systems-level insights beyond individual omics and assess whether multiple signals converge on specific organs, pathways, or aging subtypes.
- Current applications focus primarily on research, model development, and mechanistic studies of complex cases. Clinical translation remains limited by testing costs, sample requirements, cross-platform consistency, model interpretability, and uncertain value for individual clinical decisions.

Commercialization pathways differ across omics technologies. Gut microbiome tests and some integrated testing panels are available as consumer-facing products with at-home samplingdigital reports, and repeat testing options. High-throughput proteomics, metabolomics, and immunomics platforms primarily serve research, drug development, and clinical trials.

Source: Public information, literature review, TIMEPIE Research Institute analysis

2.2 Core Assessment Technology Matrix

Phenotypic and functional assessments reflect an individual's functional status and capacity, linking aging-related risks to healthspan. Measures of cardiorespiratory fitness, muscle strength, mobility, cognition, and sleep help identify functional changes and guide priorities for exercise, nutrition, and rehabilitation, as well as follow-up assessments.

2.2.3. Phenotypic and Functional Assessment

Functional measures vary in the functional capacities they assess, their evidence base and clinical applications. Cardiorespiratory fitness, grip strength, muscle strength, and gait speed have well-established associations with mortality risk and functional decline, making them useful baseline measures. Muscle mass should be interpreted alongside strength and mobility, while balance, cognitive, and sleep assessments should be selected based on age, symptoms, and risk history.

Table 3. Functional Assessment Measures and Applications

Assessment Domain	Key Measures	Applications	Limitations
Cardiorespiratory Fitness	Pulmonary function; VO_2max; exercise tolerance; resting heart rate	Intervention follow-up; fitness stratification; exercise prescription	Affected by testing protocols, equipment, and procedures; some tests require professional supervision
Muscle Function & Body Composition	Grip strength; gait speed; waist circumference; muscle mass; visceral fat	Resistance training; Nutritional interventions; Sarcopenia risk assessment	Muscle mass requires functional context; body composition varies with equipment and measurement conditions
Balance & Motor Control	Gait; flexibility; reaction time; balance tests	Rehabilitation; fall risk management; functional screening in middle-aged and older adults	Affected by test familiarity, environment, and short-term physical condition
Sleep & Recovery	Sleep duration; sleep quality; subjective fatigue; recovery status	Sleep management; stress management; training load adjustment	Subjective and objective findings may differ; longitudinal trends aid interpretation
Cognitive & Neurological Function	Memory; attention; reaction time; executive function	Cognitive risk screening; cognitive function management; intervention monitoring	Influenced by education, emotional state, test selection, and practice effects

Phenotypic and functional assessments track changes in cardiorespiratory fitness, muscle strength, mobility, and cognition. Repeated assessments help identify functional improvement or decline, guide exercise, nutrition, and rehabilitation goals, and evaluate responses to interventions. Marked abnormalities or rapid functional decline warrant review of medical history and clinical findings, with specialist assessment when needed to clarify underlying causes and ensure intervention safety.

Source: Public information, literature review, TIMEPIE Research Institute analysis

2.2 Core Assessment Technology Matrix

Digital monitoring extends longevity medicine assessment beyond one-time clinic-based testing into daily life. Wearables, continuous glucose monitoring, home monitoring, and electronic health records enable the collection and integration of longitudinal data on sleep, activity, heart rate, glucose, and blood pressure.

2.2.4. Integration of Continuous Monitoring Data (1/2)

Functional and clinical assessments provide snapshots of health at specific time points, while sleep, activity, heart rate, glucose, blood pressure, and adherence to health behaviors change throughout daily life. Wearables, continuous glucose monitoring (CGM), home monitoring tools, and other digital tools can capture these changes over time and integrate the data into long-term health management.

Digital tools extend single-point measurements into longitudinal monitoring. Established applications include high-frequency data collection and trend monitoring for sleep, activity, heart rate, glucose, and blood pressure. Algorithm-derived measures, cross-device data integration, and some digital biomarkers still face challenges in measurement consistency, clinical validation, and data standardization.

Table 3. Digital Monitoring Technologies and Applications

Technology	Measures	Applications	Limitations
Wearable Sensors	Activity, step count, heart rate, sleep, and other physiological and behavioral data	Long-term trend monitoring; behavioral feedback; exercise and sleep management	Consumer-grade measurement accuracy and algorithm standards vary; device or software updates may affect longitudinal comparability
Continuous Glucose Monitoring	Interstitial glucose trends, postprandial responses, and daily fluctuations	Established diabetes management; short-term targeted monitoring and behavioral feedback in healthy individuals	Targets, abnormal thresholds, and long-term outcome associations remain unclear in healthy populations; isolated fluctuations do not establish disease risk
Home Monitoring & Remote Sample Collection	Blood pressure, body weight, blood oxygen saturation, and home-collected samples	Chronic disease follow-up; risk monitoring; remote health management	Device calibration, user technique, and sample quality affect data reliability
Longitudinal Clinical Data	Laboratory results, prescriptions, diagnoses, imaging, and medical history	Long-term health trajectories and historical risk assessment	Missing data, inconsistent coding, and limited interoperability hinder data integration and cross-institutional comparisons
AI-Assisted Medical Imaging	Structural features and risk information extracted from CT, MRI, fundus images, and other existing imaging modalities	Opportunistic screening; targeted risk assessment; secondary use of imaging data	Performance may vary across devices, scanning protocols, and populations; AI findings require clinical interpretation alongside original images and clinical findings
Digital Biomarkers	Algorithm-derived measures from gait, speech, sleep, and cognitive data	Research, clinical trials, and exploratory monitoring of functional status	Limited standardization of definitions and clinical thresholds; insufficient cross-device consistency and real-world validation

Source: Public information, literature review, TIMEPIE Research Institute analysis

2.2 Core Assessment Technology Matrix

As biological aging clocks, multi-omics, functional assessments, and digital monitoring enter healthcare and health management settings, a diversified supply ecosystem for longevity medicine assessment is emerging.

2.2.4. Integration of Continuous Monitoring Data (2/2)

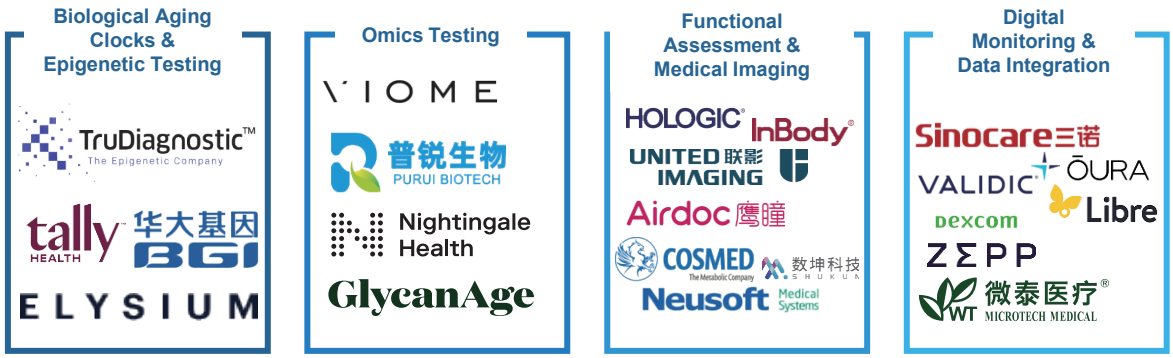
Digital tools are currently most useful for supplementing daily health data, tracking long-term trends, and providing behavioral feedback. Findings from consumer wearables, CGM in healthy individuals, and digital biomarkers should be interpreted in light of device performance, measurement conditions, and individual longitudinal data. Measurement errors, algorithm differences, and short-term physiological fluctuations may affect results; isolated abnormalities or short-term changes should not be treated as definitive evidence of health risk.

2.2.5. Commercialization Pathways for Longevity Medicine Assessment (1/2)

➢ **A Multi-Stakeholder Supply Ecosystem**

Longevity medicine assessment does not yet have a standalone industry supply chain. Instead, it draws on established sectors such as clinical diagnostics, life science tools, functional assessment equipment, and digital health. Sequencing platforms, methylation arrays, mass spectrometers, reagents, and sensors provide the underlying testing capabilities. Independent laboratories, biological age algorithms, and multi-omics platforms support sample analysis, modeling, and reporting, while healthcare providers, health screening centers, and longevity clinics deliver assessment services to end users.

Fig.4 Longevity Medicine Assessment Industry Landscape



Application Case | Cellcare healthcare centers

Cellcare healthcare centers uses functional medicine assessments as an entry point for health management. Through cellular metabolic health screening, physiological testing, and multidimensional assessments covering metabolism, immunity, sleep and stress, and cardiovascular health, it evaluates individual health status and follows a service pathway of precision assessment, stratified intervention, and longitudinal monitoring. Assessment findings inform multidisciplinary consultations and personalized care plans, supported by proprietary AI models for ongoing health management and follow-up adjustments.

Source: Public information, literature review, TIMEPIE Research Institute analysis

2.2 Core Assessment Technology Matrix

Some emerging assessment technologies are already commercially available, but limitations in result interpretation, repeat-test comparability, and clinical utility continue to hinder their adoption in routine clinical practice.

2.2.5. Commercialization Pathways for Longevity Medicine Assessment (2/2)

- **Four Technologies, Distinct Commercialization Pathways**

Biological aging clocks have established recognizable commercial product models. DNA methylation testing typically combines sample collection, laboratory analysis, algorithm-based estimates, and digital reports, with additional offerings such as periodic retesting, subscriptions, and partnerships with healthcare providers. Commercial value is shifting beyond a single age estimate toward result interpretation, repeat-test comparability, and long-term trend monitoring.

Multi-omics technologies show varying levels of commercialization. Microbiome tests and some comprehensive health panels have entered the consumer health market through at-home sampling, digital reports, and follow-up services. High-throughput proteomics, metabolomics, and immunomics remain primarily focused on research, drug development, clinical trials, and specialized assessments. Broader adoption in routine health management requires reliable reference frameworks, standardized interpretation, and consistent retesting protocols.

Phenotypic and functional assessments enter longevity medicine through established medical device, sports medicine, and rehabilitation channels. Cardiorespiratory fitness, body composition, muscle strength, gait, and balance assessments can be delivered through equipment purchases, in-house testing, and integrated assessment services. These tests generally follow established protocols, allow relatively affordable repeat assessments, and can be linked to exercise, nutrition, and rehabilitation goals. Digital monitoring further extends this model through ongoing data collection.

Wearables, CGM, and home monitoring devices provide hardware-based entry points for longitudinal health management. Data platforms extend these services through subscriptions, SaaS, APIs, and enterprise systems, generating value beyond hardware sales through recurring data services, customer retention, and ongoing care delivery. Established applications primarily involve continuous data collection and trend monitoring, while clinical interpretation standards for sleep, recovery, and certain algorithm-derived biomarkers remain inconsistent.

Source: Public information, literature review, TIMEPIE Research Institute analysis

■ Summary

□ From Abnormality Detection to Individual Health Trends

Conventional clinical testing focuses on whether results exceed diagnostic or clinical decision thresholds. Longevity medicine also considers risk accumulation and trends before disease onset. Even within population reference intervals, sustained deviations from an individual's baseline may signal changes in health status. Isolated abnormal findings should be interpreted alongside repeat measurements and other clinical information. Individual baselines and longitudinal trends therefore provide important context beyond conventional clinical thresholds.

□ An Integrated Assessment Framework for Molecular, Functional, and Continuous Monitoring Data

Biological aging clocks and multi-omics provide molecular insights into aging, while tests of cardiorespiratory fitness, muscle strength, gait, and balance assess specific aspects of physical function. Wearables and continuous glucose monitoring (CGM) add daily data on sleep, activity, heart rate, and glucose.Combined with individual baselines and repeated assessments, these data allow molecular markers, functional performance, and long-term trends to be considered together, reducing reliance on any single test result.

□ Competition Shifts from Testing Capabilities to Reliable Service Delivery

Competition in longevity medicine assessment increasingly depends on the coordinated delivery of testing, algorithms, data, and services. As testing equipment, third-party laboratories, and digital health tools become more accessible, individual technologies alone offer less durable competitive advantages. Biological aging clocks and multi-omics require suitable reference populations, quality control, stable algorithms, and longitudinal data. Functional assessments depend on standardized measurements and comparable repeat testing, while wearables and digital platforms rely on reliable connectivity, long-term management, and ongoing services.

Source: Public information, literature review, TIMEPIE Research Institute analysis

Chapter 3

Atlas of Medical Interventions for Longevity



03

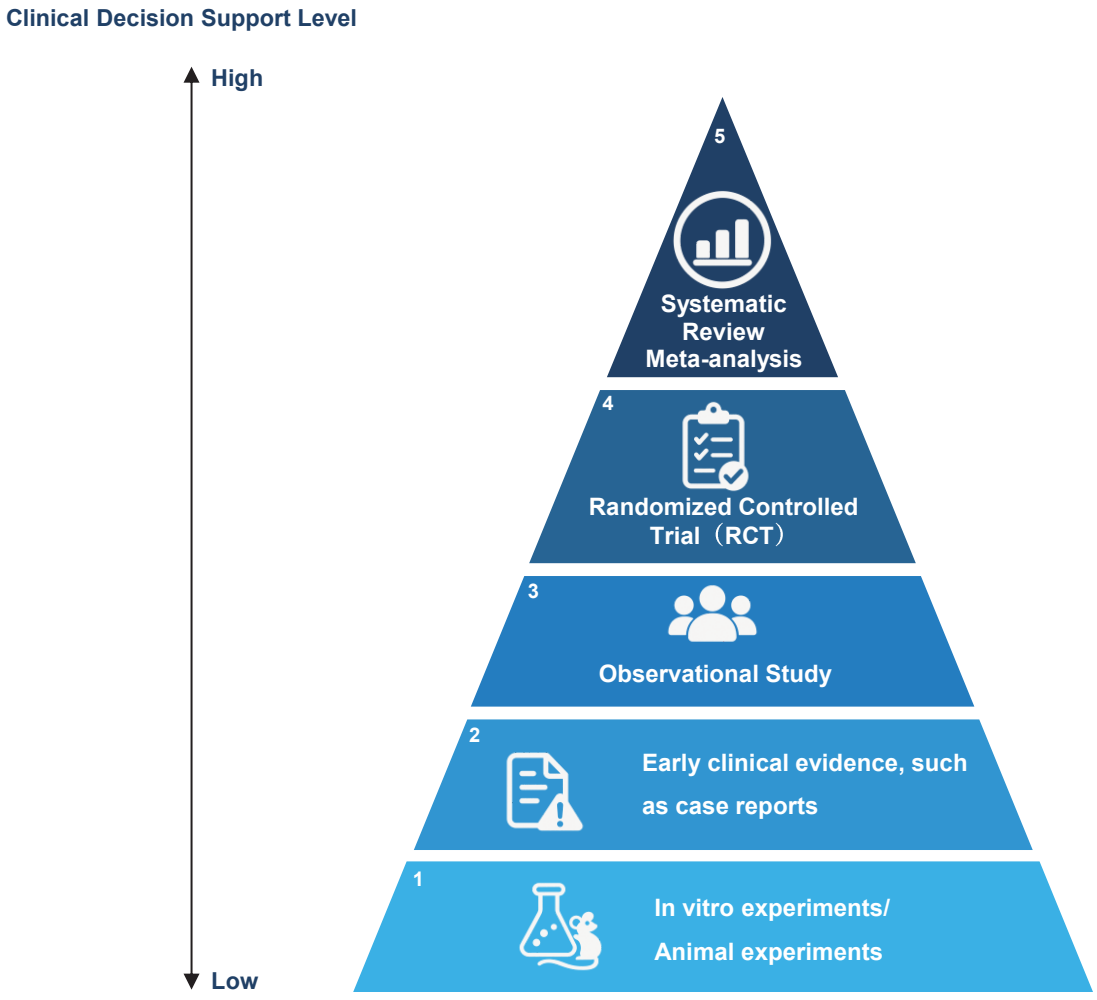
3.1 Intervention Technology Evaluation Framework

From nutritional supplements and medical devices to prescription drugs, cell therapy, and genetic technologies, the range of interventions available to the field of longevity medicine is rapidly expanding. However, these technologies are not all at the same stage in terms of scientific basis, human evidence, safety risks, and clinical maturity.

3.1.1. Levels of Evidence for Longevity Intervention Technologies (1/2)

While the supply of technologies in the field of longevity medicine is expanding rapidly, the evidence base for different interventions varies widely. Some technologies remain at the stage of mechanistic research or animal experiments, while others have progressed to human trials and randomized controlled studies; a small number have established a relatively mature foundation for application in specific diseases or clinical settings. When evaluating these technologies, it is important to distinguish between the discovery of mechanisms, short-term biological changes, and actual health benefits, and to avoid equating market hype directly with medical maturity.

Fig.1 Main Types of Research Evidence on Longevity Interventions



Source: Public information, literature review, TIMEPIE Research Institute analysis

3.1 Intervention Technology Evaluation Framework

Establishing a unified framework for technology assessment is a prerequisite for determining whether an intervention can progress from scientific research to practical application.

3.1.1. Levels of Evidence for Longevity Intervention Technologies (2/3)

Table 1 Main Types of Research Evidence on Longevity Interventions

	Key Features	Supported Conclusions	Major Limitations
Systematic Review & Meta-analysis	Synthesizes multiple studies on the same clinical question, assessing consistency and overall effects	Estimates overall effect direction, size, and consistency With high-quality studies, supports strong evidence for clinical decision-making	Depends on study quality, heterogeneity, search completeness, statistical methods, and publication bias; pooling low-quality studies yields low-quality evidence
Randomized Controlled Trial	Tests intervention effectiveness under prespecified population, control, and endpoints	Supports causal inference that the intervention caused outcome changes — a key basis for confirming human efficacy	Limited by sample size, follow-up duration, study design, loss to follow-up, endpoint choice, and bias control
Observational Study	Observes exposures, interventions, and outcomes in real-world settings to identify long-term trends	Assesses associations with disease risk, functional changes, and adverse events; complements long-term real-world evidence	Prone to confounding and selection bias; cannot establish causation alone
Early clinical evidence	Identifies new phenomena, adverse reactions, rare events, and early clinical clues	Suggests an intervention "may be effective or may pose risks," informing hypotheses and directions for further validation	Prone to chance, selection, and interpretation bias; unsuitable for definitive efficacy conclusions
In vitro experiments/ Animal experiments	Investigates mechanisms of action, screens targets, and assesses preliminary biological effects and safety	Supports biological plausibility, preclinical value, and provides a basis for human studies	Does not directly prove human efficacy; animal lifespan or cellular/ molecular biomarker improvements may not translate into human healthspan benefits

Different types of research designs focus on answering different questions. In vitro and animal studies are primarily used to identify mechanisms and potential avenues of research; case reports and observational studies can be used to identify early signals, long-term associations, and real-world risks; randomized controlled trials are used to test the efficacy of specific interventions under defined population, dosage, and endpoint conditions; systematic reviews and meta-analyses provide a comprehensive evaluation of existing research. While a study's design determines what questions it can answer, it does not, on its own, determine the reliability of its conclusions.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.1 Intervention Technology Evaluation Framework

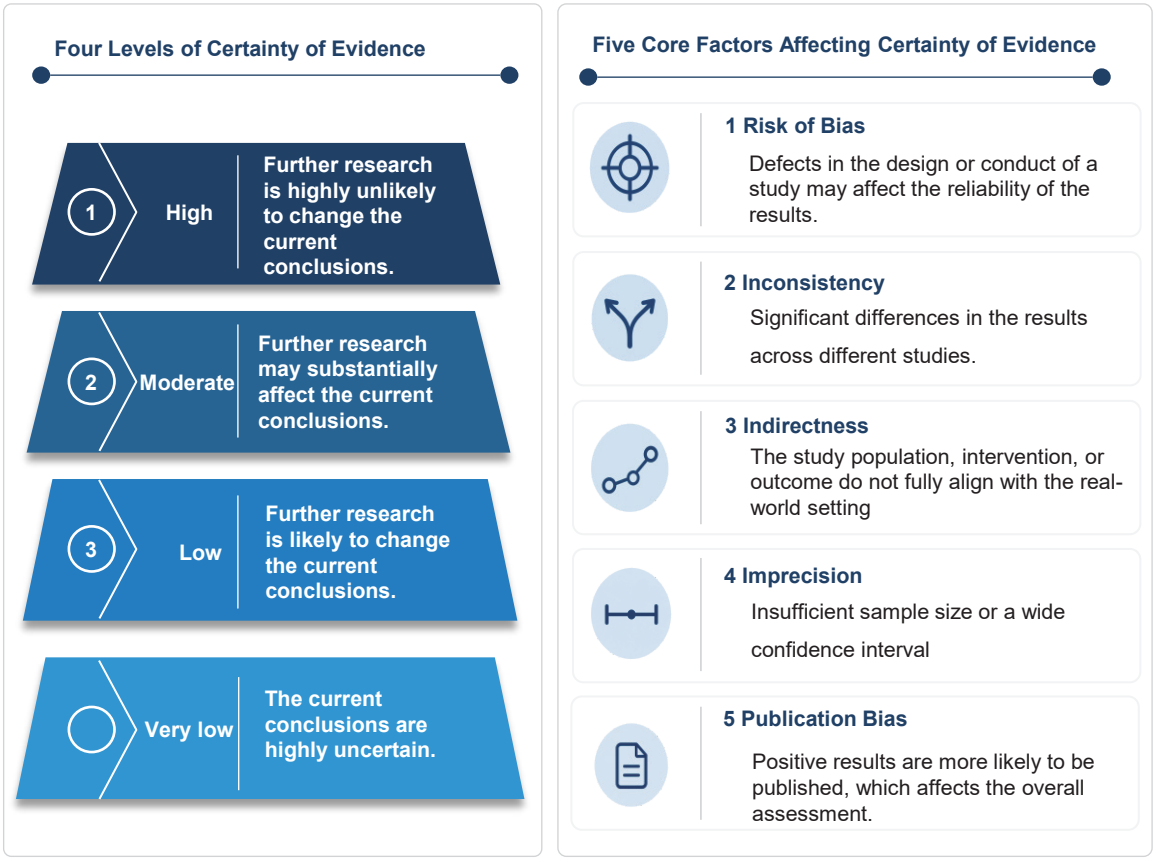
Beyond study design, the certainty of evidence should also be graded in light of study quality. Factors such as sample size, risk of bias, consistency of results, directness of evidence, and statistical precision can all influence the final judgment.

3.1.1. Levels of Evidence for Longevity Intervention Technologies (3/3)

The credibility of evidence also depends on the quality of the study itself. Even in randomized controlled trials (RCTs), a small sample size, insufficient follow-up duration, an inappropriate control group, or significant inconsistencies in results can all undermine the credibility of the conclusions. Evidence-based evaluation frameworks such as GRADE further assess the certainty of evidence by comprehensively evaluating dimensions such as risk of bias, inconsistency, indirectness, imprecision, and publication bias.

Outcomes such as survival, disability, and age-related diseases often require long-term observation; therefore, existing studies frequently use biomarkers—such as inflammatory markers, metabolic markers, telomere length, and biological age— as surrogate endpoints. While these changes may indicate that an intervention has produced biological effects, the aforementioned indicators only hold more direct clinical significance when they reliably reflect or predict functional improvement, reduced disease risk, delayed onset of disability, or survival benefits. Improvements in short-term indicators cannot be directly equated with “delaying aging” or “extending healthy life expectancy.”

Fig.2 GRADE Framework for Assessing the Certainty of Evidence



Source: Public information, literature review, TIMEPIE Research Institute analysis

3.1 Intervention Technology Evaluation Framework

The field of longevity medicine remains in a stage where scientific discovery.

3.1.2. Application Boundaries of Cutting-Edge Interventions

Clinical translation, and commercial application are developing in parallel; off-label use of approved drugs, exploratory medical technologies, and interventions without established clinical standards may coexist for the long term. It is important to clarify that off-label use of drugs is not the same as the use of unapproved products or technologies: the former is based on existing quality and safety data for approved drugs, while the latter may still involve greater uncertainty regarding product sourcing, quality control, human safety, and regulatory pathways.

Longevity medicine primarily serves healthy individuals, those in suboptimal health, and people at high risk of chronic diseases. As the need for immediate treatment is generally lower than in severe disease settings, higher standards of safety and evidence are required. The more uncertain the expected benefits, or the more invasive, long-lasting, and irreversible an intervention is, the lower the acceptable risk and the stricter its conditions of use should be. In vitro experiments and animal studies can support further translation, but are insufficient alone to support routine application in healthy populations.

Fig.3 Safety Governance Chain for Cutting-Edge Interventions



Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

Nutritional intervention is one of the most commercialized and widely applied foundational intervention approaches in the field of longevity medicine. With advances in the biology of aging, metabolic medicine, and precision nutrition, its application has gradually expanded from meeting basic nutritional needs to functional maintenance, metabolic health support, and personalized health management, driving the nutrition industry's shift from single-ingredient supplements toward comprehensive solutions tailored to specific health goals.

3.2.1. Nutritional Intervention (1/7)

In recent years, the focus of longevity nutrition has gradually shifted from basic nutritional supplementation to specific health benefits. Early nutritional products were primarily centered on basic nutritional needs such as vitamins, minerals, and proteins, and were mainly designed to address dietary deficiencies and nutritional gaps. As research into the mechanisms of aging and metabolic regulation has deepened, certain functional ingredients have begun to be used to explore areas such as energy metabolism, mitochondrial function, inflammation regulation, muscle maintenance, and the gut microbiome.

Table 2 Key Technical Areas for Nutritional Interventions to Promote Longevity (1/2)

Technical Focus	Representative Ingredients/Formulation	Main Application Scenarios	Trend Analysis
Basic Nutrition and Functional Reserve	Protein, essential amino acids, active folic acid, HMB, creatine, vitamin D, vitamin K2, omega-3, minerals, etc.	• Daily Nutritional Supplements • Correcting Nutritional Deficiencies • Basic Health Maintenance • Nutritional Support for Special Populations	Widely applied in humans and closely linked to disease management and healthy aging; a foundational area in longevity nutrition
Cellular Energy and Mitochondrial Function	Urolithin A, CoQ10, NR, NMN, PQQ, α-lipoic acid, acetyl-L-carnitine, etc.	• Energy Metabolism Support • Fatigue Management and Recovery • Product Development for Healthy Aging	Mechanistic and human research is growing, but long-term evidence for healthy lifespan is still needed
Redox Reactions and Cellular Defense	Ergothioneine, (acetyl)glutathione, SPM-related lipid metabolic mediators, NAC, vitamin C, vitamin E, polyphenols, etc.	• Antioxidant Support • Inflammation-Related Health Management • Celluar Protection	Raw materials are highly commercialized, but translating mechanism evidence into clinical value remains challenging for some components

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

Throughout this process, the competitive focus of nutritional interventions has also gradually shifted. In the past, promoting a single “trendy” ingredient could drive market growth; however, as consumer awareness has increased and the number of similar products has grown, companies have begun to place greater emphasis on raw material quality control, clinical research support, formulation design, and the long-term user experience. Developing comprehensive solutions tailored to specific health goals has gradually become a key trend in the longevity nutrition industry.

3.2.1. Nutritional Intervention (2/7)

Table 2 Key Technical Areas for Nutritional Interventions to Promote Longevity (2/2)

Technical Focus	Representative Ingredients/Formulation	Main Application Scenarios	Trend Analysis
Cell Homeostasis and Autophagy	Spermidine, resveratrol, quercetin, etc.	• Exploring Healthy Aging • Development of Functional Nutritional Products	A cutting-edge field with growing academic interest, but long-term human studies remain limited
Metabolism and Cardiovascular Health Management	Omega-3 (pure EPA), active folate, dietary fiber, prebiotics, inositol, chromium, plant-derived active ingredients, etc.	• Cardiovascular Health Support • Blood Sugar and Lipid Metabolism Management • Weight Management • Metabolic Health Maintenance	With chronic disease prevention and lifestyle management, commercial applications continue to expand
Cognition, Sleep and Stress Management	Theanine, magnesium, phosphatidylserine, plant-derived active ingredients, etc.	• Sleep Support • Cognitive Function Maintenance • Stress Management	Consumer demand has grown significantly, but human evidence varies across functional categories
Gut Microbiome	Probiotics (including yeast), prebiotics, postbiotics, synbiotics, HMOs, etc.	• Gut Health Management • Immune System Support • Metabolic Regulation	Shifting from strain screening toward precise microbiome regulation and personalized applications
Precision Nutrition Plans	Combination Nutritional Formulas, Tiered Nutrition Programs, Long-Term Management Programs	• Health Management Organization • Membership-Based Long-Term Nutrition Services	Evolving from standardized products toward assessment-driven, continuous management models

Source: Public information, literature review, TIMEPIE Research Institute analysis

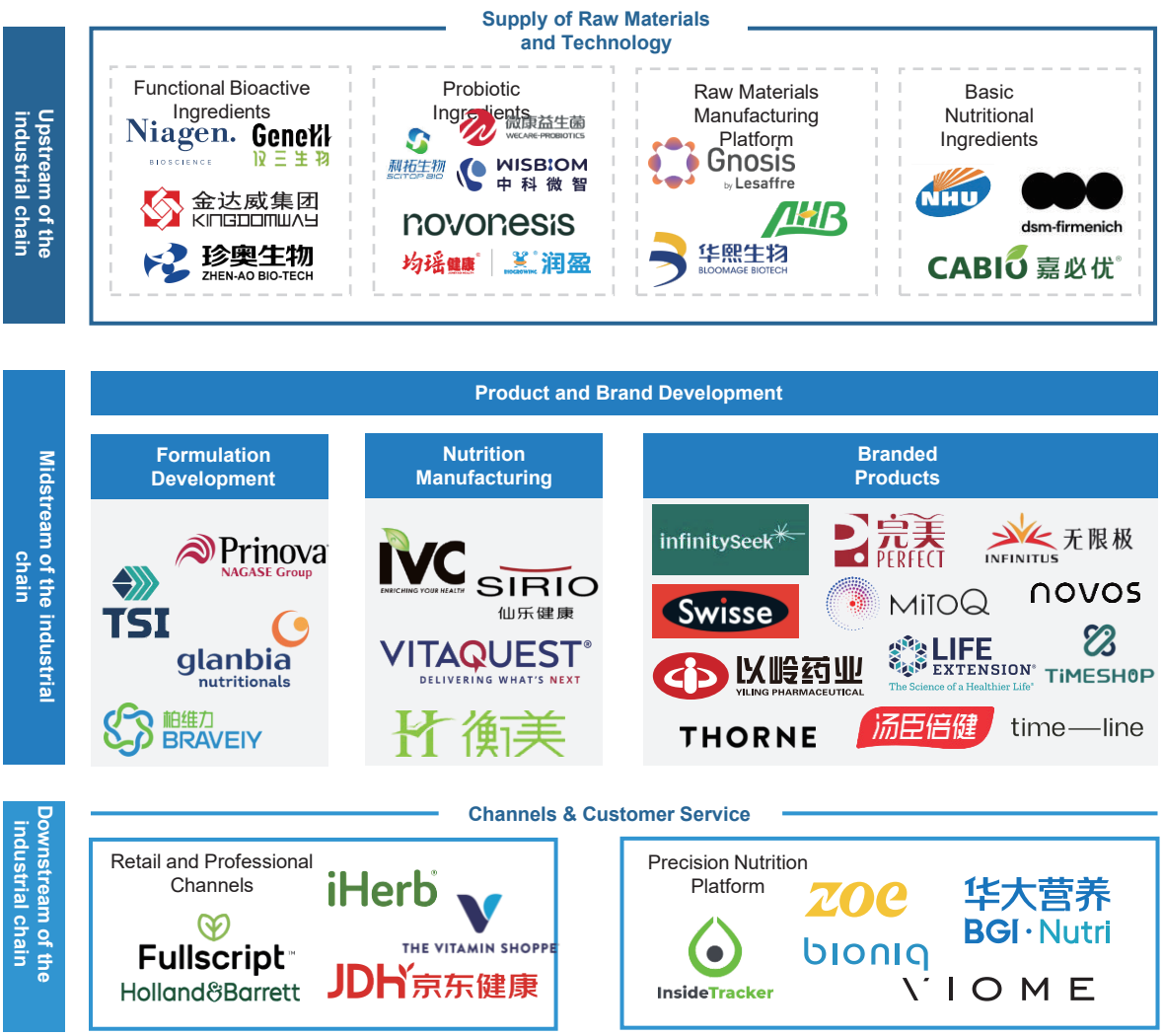
3.2 Long-Term Health Management Interventions

Based on different health goals, mechanisms of action, and roles across the industry chain, current nutritional interventions for longevity have formed an industrial ecosystem that encompasses functional ingredients, product development, brand management, and personalized health management services.

3.2.1. Nutritional Intervention (3/7)

The longevity nutrition industry is gradually shifting from competition based on individual products toward synergy across the entire industrial chain. Upstream raw material companies lay the foundation for products through technological development, quality control, and the accumulation of evidence; midstream companies transform functional ingredients into nutritional products tailored to specific health goals; and downstream companies connect with consumers through retail and specialized channels, while further leveraging testing and data analysis to provide personalized nutrition management.

Fig.4 The Longevity Nutrition Intervention Industry Chain



Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

As nutritional products are gradually integrated into long-term health management systems, the formats in which they are delivered are also expanding; companies need to consider ingredient formulations, product forms, service models, and long-term usage scenarios in tandem.

3.2.1. Nutritional Intervention (4/7)

From the perspective of industrial structure, nutritional interventions for longevity have formed a relatively complete supply chain. Upstream companies produce raw materials and enhance their recognition through patents, quality documentation, and human clinical studies. Natural extraction remains significant, while microbial fermentation and enzyme catalysis improve the production efficiency of certain active ingredients, and synthetic biology enables the large-scale production of otherwise high-cost or limited-supply molecules.

As raw materials become abundant, upstream competition has shifted from production capacity to evidence accumulation and regulatory approval. Companies with branded raw materials, safety data, and clinical research hold advantages in downstream partnerships and market expansion.

Gnosis by Lesaffre, for example, has built a portfolio centered on Quatrefolic® active folate (the 4th-generation folate), MenaQ7® vitamin K2, Emothion® S-acetyl-glutathione, MyCondro™ fermented chondroitin sulfate, LANDKIND® Pure Salidroside, and Lynside® S. boulardii CNCM I-3799. Leveraging its microbial fermentation and biotransformation platforms, the company has achieved large-scale integration of active ingredients with specialty yeast strains.

Available clinical studies and evidence provide support in the following areas: supporting homocysteine metabolism across different MTHFR genotypes, markers associated with the progression of vascular calcification and bone health, cellular-level antioxidant defense, and gut microbiome balance. It has made the purity of the active (6S)-5-MTHF isomer and the 99.8% all-trans content of MK-7 its key quality-control parameters. For vitamin K2, its patented MenaQ7® Matrix protective technology, which is free of coatings and additives, helps preserve stability even under the harshest supplement and food processing conditions. On this basis, the company conducts stability testing and compliance assessments covering resistance to formulation degradation, bioavailability of finished products, and adaptability to clinical use — demonstrating end-to-end capability in transforming raw materials into evidence-based nutritional interventions.

Since its founding in 1996, Zhen-Ao has focused on nucleotides and was the first company in China to conduct human clinical trials on these compounds. In 2025, a joint randomized controlled trial (RCT) by Zhen-Ao and Peking University, titled “Targeting Aging and Longevity with Exogenous Nucleotides (TALENTs),” was published in *Advanced Science*. The study demonstrated for the first time in humans that 19 weeks of exogenous 5′-nucleotide intervention reduced median DNA methylation age by 3.08 years compared with the control group in older adults.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

Midstream companies transform functional ingredients into end products—enhancing stability through formulation and packaging and designing around specific health goals.

3.2.1. Nutritional Intervention (5/7)

Zhen-Ao has established China's largest nucleic acid industrialization base. It uses food-grade yeast fermentation to extract food-grade RNA, which is then enzymatically hydrolyzed to produce food-grade 5′-nucleotides that meet U.S. Food Chemicals Codex (FCC) standards. This makes Zhen-Ao one of the few companies worldwide to integrate the entire nucleic acid industrial chain, from upstream production to downstream processing.

As ingredients grow increasingly homogeneous, simple combination no longer differentiates products; establishing an evidence-based formulation system spanning ingredient screening, mechanism research, and finished product validation has become a key development direction.

PERFECT, for example, developed the Perfectus CMH™-8 formulation for vascular health, combining pumpkin seed protein peptides, Panax notoginseng stem and leaf extract, wampee fruit powder, saffron extract, Dendrobium officinale extract, and osmanthus extract. Cellular and animal studies have shown positive results in improving vascular endothelial function, maintaining blood vessel wall structure and elasticity, and regulating microcirculation. The company also incorporated peptides, rare saponins, and total flavonoids into quality control metrics and conducted stability tests and raw material compliance assessments covering formulation stability, finished product quality, and regulatory compliance.

Another category of brand companies focuses on product definition and formulation design around specific health goals. Infinityseek, a pioneering anti-aging brand, draws on cutting-edge gerontology research through its in-house longevity laboratory and collaborations with international institutions such as Germany's Lipidomix and SGS, transforming evidence-based life sciences into precise nutrition solutions.

Its flagship Ocean Youth™ redefines third-generation Omega-3: 100% of its EPA is derived from microalgae, it directly supplements SPMs (specialized pro-resolving mediators), balancing lipid regulation with anti-inflammatory repair, and its unique polar lipid structure offers four times the bioavailability of high-purity fish oil. Its women's health product, Ovary Youth™ (Urolithin A and ubiquinol), uses a hormone-free formula combining Urolithin A with patented ubiquinol and active folic acid to gently support ovarian reproductive rhythms.

Within the longevity clinic intervention system, traditional Chinese medicine is evolving from empirical to evidence-based medicine. Bazi Bushen Capsules, developed by Yiling Pharmaceutical based on the "Qi-Luo Theory of Jing, Qi, and Shen," have been proved by multiple basic studies to target ten major aging mechanisms, enabling systematic intervention against multi-system aging.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

As the range of nutritional products and services for longevity continues to expand, competition in the industry is shifting from a focus on ingredient concepts and first-mover advantages to a comprehensive evaluation of overall product quality, clinical evidence, and long-term delivery capabilities.

3.2.1. Nutritional intervention (6/7)

Building on studies involving 1,200 animals, multiple human trials were conducted: an RCT of 530 cases led by Xiyuan Hospital and published in Phytomedicine reported improvements in premature aging symptoms and showed a favorable safety profile. The product acts on seven major systems—skin, bones, nerves, muscles, cardiovascular, metabolic, and reproductive—improving both external signs of aging and internal organ decline.

Downstream operations focus on product distribution, demand matching, and continuous delivery. Beyond retail channels such as e-commerce, pharmacies, and supermarkets, brand-direct sales, membership subscriptions, precision nutrition platforms, and comprehensive health management institutions are on the rise.

Some platforms integrate blood, genetic, or microbiome testing to generate personalized nutritional recommendations, extending one-time product sales into long-term management.

Fig.5 Trends and Challenges in the Longevity Nutrition Industry



➢ **Comprehensive product evidence has become a key competitive factor**

As supply of popular raw materials grows and similar products proliferate, first-mover advantages for single-ingredient formulations are diminishing. Full-product validation of stability, safety, and clinical efficacy is thus increasingly key to differentiation.



➢ **Health benefits require further verification**

For some nutritional products, effects are still inferred from mechanistic studies, animal experiments, or biomarker changes. While suggestive, evaluating their longevity value requires confirming tangible health outcomes—such as physical function, disease risk reduction, or quality of life.



➢ **Shifting the Focus from Raw Material Quality to the Quality of the Final Product**

As compound products and new dosage forms emerge, quality control must reach the finished product. Active content, batch consistency, stability, storage, and ingredient dosage ratios all affect performance; Probiotics additionally require strain identity, viable count, and shelf-life verification.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

Interventions can also be delivered beyond oral products: some health institutions have begun exploring IV nutrition, administering NAD^+, glutathione, and vitamin C intravenously.

3.2.1. Nutritional intervention (7/7)

Table 3 The Boundaries Between Oral Nutrition and Intravenous (IV) Nutrition

	Oral Nutrition	Intravenous (IV) Nutrition
Product Attributes	• These products enter the market as general food, dietary supplements, or special dietary foods (including foods for special medical purposes (FSMP), with their specific classification depending on the product's intended use and registration or filing status	• This is a medical service involving injectable medications, prescriptions or medical orders, and intravenous procedures
Use Cases	• Designed to address nutritional deficiencies, suitable for long-term use, and adjusted based on reassessment results	• This should be based on a clear medical necessity and should generally be implemented on a per-service or per-treatment-phase basis
Deliverables	• Available through retail channels, specialized nutrition brands, or health management organizations	• This must be performed by medical institutions and healthcare professionals with the appropriate qualifications, who also possess the necessary capabilities in pharmaceutical affairs and emergency management
Risk Management	• Source of raw materials, actual content, stability, rationality of formulation, and long-term safety; for formulated products, dosage relationships must also be considered	• Source of the preparation, basis for prescription, infusion guidelines, infection risks, and management of adverse reactions such as allergic reactions
Regulatory Status	• Different product categories have different promotional requirements; therapeutic claims must not exceed the scope of approval or filing	• Exploratory projects should not be marketed as proven "anti-aging" or "life-extending" treatments

Primary Legal and Regulatory Basis: Oral nutrition is governed by the ***Food Safety Law***, ***Administrative Measures on the Registration and Filing of Health Foods***, and ***Administrative Measures for the Registration of Formula Foods for Special Medical Purposes***;
IV nutrition falls under the ***Drug Administration Law***, ***Regulations on the Administration of Medical Institutions***, ***Measures for the Administration of Prescriptions***, and institutional pharmaceutical and IV administration rules.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

Behavioral interventions are gradually evolving from general advice on healthy living into long-term management approaches with clear objectives, implementation plans, and evidence-based boundaries.

3.2.2. Behavioral Interventions

Behavioral interventions primarily include **exercise, meal timing and energy management, sleep and circadian rhythm management, and stress and recovery management**. They aim to produce long-term effects on physiological functions and the metabolic environment through continuous adjustments to physical activity, energy intake, meal timing, sleep rhythms, and stress levels. These approaches have broad applicability and are highly sustainable, making them the most common long-term management strategies in the field of longevity medicine.

Table 4 Main Directions and Theoretical Foundations of Behavioral Interventions

Type	Representative Methods	Main Functions	Assessment of Current Evidence
Exercise Intervention	Aerobic Exercise, Resistance, Interval, and Combined Training	Muscle contraction and cardiopulmonary exercise promote **mitochondrial adaptation and glucose utilization**, enhancing insulin sensitivity; myokines and other signals mediate cross-organ regulation among muscle, fat, liver, and the nervous system	Systematic reviews, RCTs, and long-term cohort studies
Meal Timing and Energy Management	Calorie Restriction, Intermittent Fasting (IF), Time-Restricted Eating (TRE), etc.	Modulates **energy balance, insulin, and fat oxidation** while interacting with circadian rhythms; nutrient-sensing pathways (AMPK, mTOR, autophagy, insulin/IGF-1) are central to these mechanisms	RCTs and systematic reviews; limited long-term outcomes
Sleep and Circadian Rhythm Management	Regular Routines, Sleep Behavior Intervention, and Circadian Adjustment	Regulates glucose and appetite through **sleep homeostasis and circadian rhythms**, and modulates the autonomic nervous system and HPA axis	Systematic reviews, RCTs; limited evidence for precision circadian interventions
Stress and Recovery Management	Mindfulness-Based Stress Reduction, Cognitive Behavioral Stress Management, Breathing Exercises, etc.	Chronic stress engages the **HPA axis and autonomic nervous system**; structured stress management and breathing exercises modulate threat assessment, vagal activity, and autonomic regulation	RCTs and systematic reviews; limited long-term outcomes

Behavioral interventions typically require a combination of approaches and should be tailored to age, disease status, nutritional baseline, and living conditions. In particular, approaches such as intermittent fasting should be used with greater caution among older adults, individuals at nutritional risk, and those taking medication for certain chronic conditions.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

There is a clear divergence in the evidence supporting physical and environmental interventions in longevity medicine. While some techniques have been established as mature applications in specific disease treatment and rehabilitation settings, others are still primarily based on short-term improvements in physiological indicators or subjective experiences.

3.2.3. Physical and Environmental Interventions (1/3)

Physical and environmental interventions primarily rely on devices to apply controlled stimuli to human tissues and physiological systems through external physical and environmental conditions such as sound, light, electricity, magnetism, temperature, pressure, and oxygen levels. Most of these technologies originated in the fields of medicine, rehabilitation, or sports recovery. Such interventions are highly device-dependent; their operational parameters, exposure duration, and treatment courses are relatively controllable, and they hold significant potential for standardization.

Table 5 Key Technical Directions and Industrial Landscape of Physical and Environmental Interventions (1/2)

	Representative Technologies	Main Applications	Industry Trends	Representative Companies
Sound	• Focused Ultrasound • Low-Intensity Pulsed Ultrasound • Extracorporeal Shock Wave Therapy • Mechanical/Whole-Body Vibration	• Skin/Tissue Regeneration • Bone/Soft Tissue Repair • Pain Management • Relaxation/Sleep	Leveraging medical rehabilitation foundations, low-frequency acoustic and vibration devices are expanding into health management	Sunnyou 翔宇 科技照护人生 STORZ MEDICAL The Shock Wave Company
Light	• Photobiomodulation • Low-Level Laser Therapy (LLLT)Red/Near-Infrared Light Therapy • Intense Pulsed Light • Fractional Laser	• Skin Care • Localized Repair • Pain Management • Exercise Recovery	With medical and consumer products coexisting, parameter standardization and clinical evidence are key differentiators	THOR® THE FUTURE OF MEDICINE Lifotronic 普门科技 celluma
Electricity	• Neuromuscular Electrical Stimulation • Microcurrent • Transcranial Electrical Stimulation • Radiofrequency (RF) and RF Microneedling	• Muscle Activation • Neural Modulation • Pain Management • Tissue Remodeling	Technology diverges across rehabilitation, medical aesthetics, and consumer health	Longest 龙之杰 NE neuroelectrics® beoka 倍益康

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

Upon their integration into the field of longevity medicine, their application objectives have been further expanded to include the long-term management of cognitive function, physical function, pain, sleep, and recovery status.

3.2.3. Physical and Environmental Interventions (2/3)

Table 5 Key Technical Directions and Industrial Landscape of Physical and Environmental Interventions (2/2)

	Representative Technologies	Main Applications	Industry Trends	Representative Companies
Temperature	• Far-Infrared Therapy Chamber • Hot Bath • Localized Heat Therapy • Cryotherapy	• Heat/Cold Adaptation • Circulation/Recovery • Local Pain Intervention	Actively applied in health management and sports recovery	sunlighten, KLAFS, MECCTEC
Liquid	• Aquatic Rehabilitation • Alternating Hot/Cold Hydrotherapy • Hot Spring Therapy	• Exercise Stress Reduction • Functional Rehabilitation • Fatigue/Post-Exercise Recovery	Highly venue-dependent; integrated with rehabilitation and athletic recovery	HYDROWORX, SWIMEX
Magnetism	• Transcranial Magnetic Stimulation • Pulsed Electromagnetic Fields • High-Intensity Focused Electromagnetic Stimulation • Static Magnetic Fields	• Neural Modulation • Tissue Repair • Muscle Strengthening • Pain Relief	Technological approaches and medical characteristics vary significantly	BEMER GROUP, VISHEE
Oxygen	• Hyperbaric Oxygen Therapy (HBOT) • Intermittent Hypoxic-Hyperoxic Training (IHHT)	• Tissue Oxygenation • Cardiopulmonary/Metabolic Adaptation • Wound/Recovery Management	HBOT is established in healthcare; IHHT is expanding; ozone anti-aging remains controversial	PERRY BAROMEDICAL, 豪特氧业 HOTO OXYGEN INDUSTRIAL, Rlab

Physical and environmental interventions have not yet formed a unified equipment market; relevant companies primarily come from established industries such as medical devices, rehabilitation, aesthetic medicine, and consumer health. Some expand along existing healthcare systems, while others simultaneously enter sports recovery, health management, and consumer scenarios. The market is characterized by multiple parallel commercialization pathways and a relatively fragmented participant base.

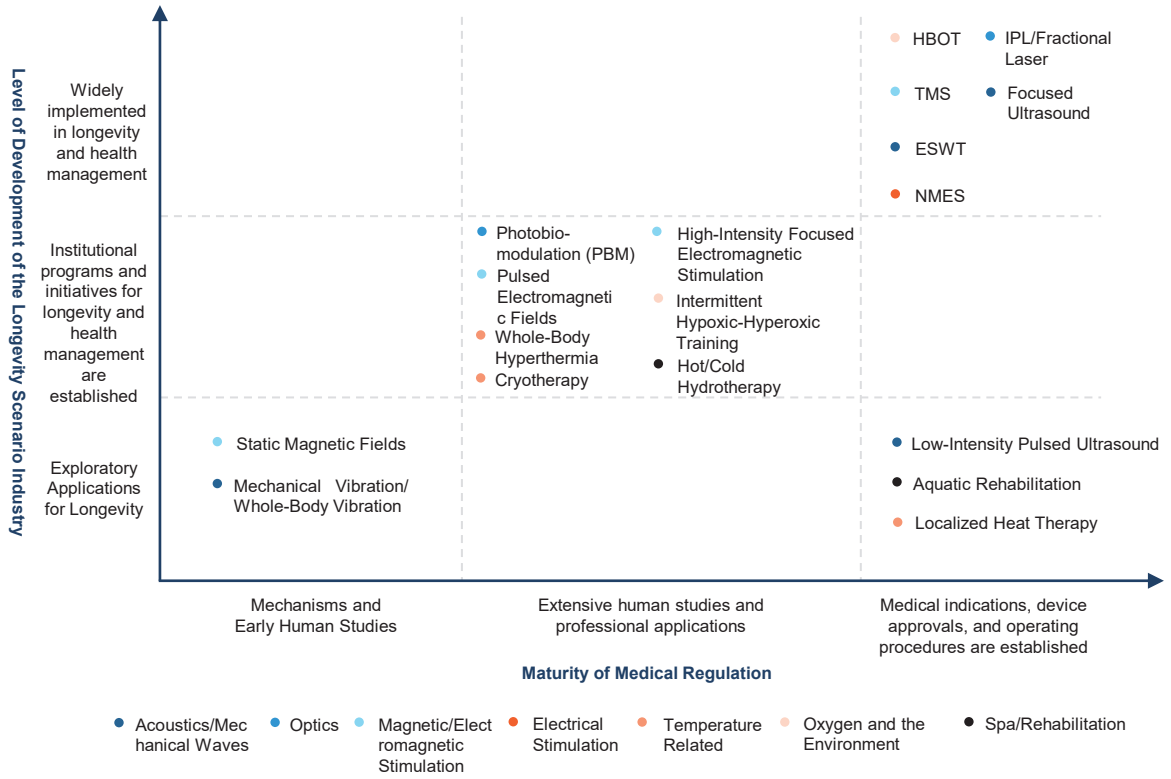
Source: Public information, literature review, TIMEPIE Research Institute analysis

3.2 Long-Term Health Management Interventions

Commercial progress in physical and environmental interventions does not fully correspond to the level of medical maturity; some technologies build on existing medical foundations to extend into longevity applications, while others have entered the health management and consumer markets first.

3.2.3. Physical and Environmental Interventions (3/3)

Fig.6 Maturity Matrix for Key Physical and Environmental Intervention Technologies



Note: The points in the figure indicate the maturity levels of each technology; their relative positions within the same range are for visual presentation purposes only and do not represent precise scores or a ranking of the technologies' relative merits.

Overall, TMS, HBOT, and select laser/electrical stimulation technologies have established clinical foundations and are expanding into longevity medicine; low-intensity pulsed ultrasound and aquatic rehabilitation remain limited in longevity despite mature medical and rehabilitation bases; PBM, HIFEM, and IHHT have generated human evidence and standardized protocols and are expanding significantly; static magnetic fields, mechanical vibration, and certain consumer-grade acoustic, light, and electrical devices remain exploratory.

Evidence for these interventions is device- and parameter-specific. Variations in intensity, frequency, site, duration, and protocol alter actual conditions, so findings should not be extrapolated across products or protocols. Detailed device models, core parameters, and protocols improve cross-study comparability and reproducibility.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Pharmacological interventions are part of clinical medicine, involving prescribing, assessment of indications, risk evaluation, and ongoing monitoring under established regulatory and professional standards. In longevity medicine, pharmacological interventions may include both the treatment of diseases and high-risk conditions that affect healthspan and interventions targeting mechanisms such as nutrient sensing, chronic inflammation, and cellular senescence.

3.3.1. Pharmacological Interventions (1/3)

As of 2026, no systemic prescription drug has been approved in China, the United States, the European Union, Japan, or South Korea specifically to slow general biological aging, treat aging itself, or extend healthspan. Pharmacological approaches relevant to longevity medicine fall into three categories: guideline-based management of obesity, metabolic disorders, and cardiovascular or kidney risks; repurposing approved drugs such as metformin and rapamycin for aging-related applications; and developing new therapeutics targeting cellular senescence, NLRP3, mTOR, autophagy, and mitochondrial function.

Established disease therapies have well-defined development, regulatory, and commercialization pathways. Drug repurposing can build on existing safety and pharmacological data, potentially reducing early development barriers, but new indications still require evidence of clinical benefit. Therapeutics directly targeting aging mechanisms remain largely in preclinical or early clinical development.Many innovative companies are pursuing defined indications, including obesity, neurodegenerative diseases, fibrosis, and dermatological conditions, to establish clearer target populations, clinical endpoints, and regulatory pathways.

Table 6 Pharmacological Interventions in Longevity Medicine: Pathways and Maturity (1/2)

Pathway	Application Area	Representative Drugs / Research Focus	Maturity	Role in Longevity Medicine
 Guideline-Based Disease and Risk Management	Obesity & Metabolic Risk Management	Semaglutide (GLP-1 RA); tirzepatide (dual GIP/GLP-1 RA)	High	Evidence-based management of diseases and high-risk conditions affecting healthspan, within approved indications.
	Cardiorenal & Chronic Disease Management	Dapagliflozin, empagliflozin (SGLT2i); ACE inhibitors/ARBs; ARNIs; finerenone		
	Lipid & Vascular Risk Management	Statins; ezetimibe; PCSK9 inhibitors		
	Blood Pressure Management	ACE inhibitors/ARBs; CCBs; thiazide diuretics		
	Bone Health & Fracture Risk Management	Bisphosphonates; denosumab; PTH analogs		
	Organ-Specific Disease Management	Tafamidis; anti-VEGF agents; pirfenidone; nintedanib		

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Therapeutics targeting aging-related mechanisms have entered clinical development, with most clinical-stage programs in Phase 1 or 2 and focused on defined disease indications.

3.3.1. Pharmacological Interventions (2/3)

Table 6 Pharmacological Interventions in Longevity Medicine: Pathways and Maturity (2/2)

Pathway	Application Area	Representative Drugs / Research Focus	Maturity	Role in Longevity Medicine
Drug Repurposing for Aging Research	Metformin	Diabetes treatment; AMPK, nutrient sensing & healthspan research	Moderate	Repurposing existing drugs may reduce early development barriers by leveraging established safety and pharmacological data. However, evidence from approved indications cannot be directly extrapolated to longevity-related uses.
	Sirolimus (Rapamycin)	Transplant immunosuppression; mTOR, immune aging & functional decline		
	Acarbose	Glucose control; postprandial glucose peaks, insulin exposure & nutrient sensing		
	Repurposed Senolytic Regimens	Investigational use of existing agents for selective senescent-cell clearance		
Novel Aging-Targeted Therapeutics	Selective mTORC1 Modulation	AV078; TOR-101	Investigational	Novel therapeutics targeting aging-related mechanisms, with selected programs in Phase 1 or 2. Clinical endpoints, regulatory pathways, and commercialization models remain under development.
	Inflammaging / NLRP3 Inhibition	BGE-102; ruvonoflast (NT-0796); dapansutrile		
	Senescence-Targeted Therapies	RLS-1496; Deciduous' immune-mediated senescent cell clearance		
	AMPK & Metabolic Regulation	ATX-304; other direct AMPK activators		
	Autophagy & Proteostasis	RTR242; CSM-101; fosigotifator		
	Mitochondrial Quality Control	MTX325; MTX652 (USP30 inhibitors)		
	Other Aging-Related Mechanisms	9MW3811 (anti-IL-11); immune surveillance programs		

Unlike drug repurposing, novel therapeutics targeting aging mechanisms typically pursue defined indications, such as osteoarthritis, ophthalmic or metabolic diseases, rather than aging itself. Development first requires evidence of safety and efficacy in specific diseases before broader aging-related applications can be explored. Examples include BGE-102 in Phase 2 trials targeting cardiovascular risk, RLS-1496 in Phase 1b/2a dermatology studies, and AV078 in development for refractory epilepsy associated with tuberous sclerosis complex (TSC).

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Prescription drug use in longevity medicine must distinguish between approved indications, off-label use, and clinical research.

3.3.1. Pharmacological Interventions (3/3)

As more candidates enter clinical trials, efficacy and safety concerns are influencing pipeline decisions. Unity Biotechnology ceased clinical development following Phase 2 studies and dissolved in 2025, while BioAge discontinued azelaprag development after elevated liver transaminases emerged in its Phase 2 trial.

Meanwhile, next-generation senescence-targeted therapies are increasingly focused on cell and tissue selectivity, while mTOR-targeted drugs pursue more selective pathway modulation. Safety, demonstrated clinical benefit, and measurable clinical endpoints remain critical to further development and commercialization.

Under Article 29 of China's Physicians Law, off-label prescribing may be permitted in exceptional circumstances, such as when no effective or better treatment is available, provided it is supported by evidence-based medicine and the patient gives explicit informed consent.

Healthcare institutions must establish procedures to review the appropriateness of prescriptions and medication orders. Off-label prescribing remains a regulated clinical practice; drug development, registration, and commercial promotion are subject to separate regulatory requirements.

Table 7 Key Players in the Longevity Prescription Drug Industry

Industry Segment	Representative Companies	Primary Focus	Current Position
Established Pharma Companies	恒瑞, SCIWIND 先为达生物, Innovent 信达生物制药, BrightGene, Lilly, novo nordisk	Obesity, metabolic, cardiorenal, lipid & bone disorders	Established R&D, regulatory and commercialization capabilities
Geroscience Biotechs	BIOAGE, DECIDUOUS THERAPEUTICS, Aeovian PHARMACEUTICALS, Rubedo	Cellular senescence, inflammation, nutrient sensing, autophagy & mitochondria	Mostly preclinical or early clinical; pursuing defined indications and approvable clinical endpoints
Integrated Longevity R&D Platforms	Insilico Medicine, Calico, ALTOS, Cambrian, Retro BIOSCIENCES	Aging biology, cellular reprogramming & multi-mechanism drug discovery	Translate basic research into drug candidates through long-term, multi-pathway R&D
Prescription & Care Delivery Platforms	agelessrx, hims & hers	Assessment, prescribing & longitudinal care	Connect drug access with patient assessment, prescribing and ongoing management

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

"Bioidentical hormones" have the same or highly similar molecular structure as endogenous human hormones.

3.3.2. Bioidentical Hormones

Hormones regulate reproductive, metabolic, skeletal, muscular, and neurological functions through endocrine feedback systems. Hormone replacement therapy primarily treats established hormone deficiencies or related dysfunctions to relieve symptoms, protect target organs, and restore physiological function.

The market comprises approved, standardized hormone products and custom-compounded preparations. Approved products have defined formulations, quality standards, and pharmacovigilance requirements, while compounded preparations primarily address specific dosing, formulation, or excipient needs.

Salivary and dried urine hormone testing, along with multi-hormone combinations, are also used in some personalized services, but sufficient comparative evidence of improved efficacy and safety is lacking.

Table 8 Pathways Overview of Prescription Hormone Therapies

Intervention	Evidence Base	Target Population	Risks / Limitations
Menopausal Hormone Therapy (MHT)	Mature human evidence and guideline support; Established benefits for vasomotor symptoms, menopausal symptoms, and bone health	Women with menopause-related symptoms, premature menopause, and other indications	Thrombotic, stroke, breast, and endometrial risks vary by patient population, formulation, and duration of use
Testosterone Replacement Therapy (TRT)	Clinical trial and guideline support for confirmed hypogonadism	Symptomatic individuals with repeatedly low testosterone and completed diagnostic evaluation	Erythrocytosis, blood pressure changes, fertility suppression, and prostate monitoring
Thyroid Hormone Replacement	Established for hypothyroidism; limited. proven benefit in euthyroid individuals	Patients with confirmed hypothyroidism	Overtreatment may cause atrial fibrillation, bone loss and muscle wasting
DHEA / Pregnenolone	Mainly small studies, body composition, and subjective outcomes	Exploratory use in healthy aging individuals and those seeking to improve vitality	Acne, hirsutism, lipid changes, and hormone-sensitive tissue effects
Growth Hormone (GH)	Established for treating GH deficiency; aging studies mainly focus on changes in body composition	Patients with confirmed GH deficiency; exploratory use in healthy older adults	Edema, arthralgia, carpal tunnel syndrome, and glucose dysregulation
GH Secretagogue Peptides	Limited long-term human outcome data	Vitality, body composition, and rejuvenation-oriented use	Uncertain long-term safety; potential glucose and fluid-retention risks
Compounded Bioidentical Hormones	Limited comparative clinical evidence	Patients with unmet dose, formulation, or excipient needs	Dose variability, uncertain effects of combinations, and limited ability to adjust implanted pellets

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Regenerative medicine uses cells, cell-derived products, and tissue engineering to repair or replace damaged tissues or modulate their function.

3.3.3. Regenerative Medicine (1/4)

Clinical translation in regenerative medicine has largely been driven by disease-specific treatments. Hematopoietic stem cell transplantation (HSCT) is an established therapy, while CAR-T and tumor-infiltrating lymphocyte (TIL) therapies have developed relatively mature development, manufacturing and clinical delivery systems in oncology. Selected mesenchymal stromal cell (MSC) and tissue-engineered cell products have also received approval in specific countries and for specific indications.

Meanwhile, MSCs, induced pluripotent stem cell (iPSC)-derived cells, NK/DC immune cells, and extracellular vesicles (EVs) remain under clinical investigation for tissue repair, neurodegenerative diseases, and immune modulation.

Table 9 Clinical Translation of Regenerative Medicine Technologies

Category	Modality	Product Forms	Applications	Clinical Development Status
Stem Cells	Hematopoietic Stem Cells (HSCs)	Bone marrow, peripheral blood, or cord blood grafts; autologous or allogeneic	Hematologic diseases; hematopoietic and immune reconstitution	Established therapy with standardized transplant protocols
	Mesenchymal Stromal Cells (MSCs)	Cell suspensions; local injectables; cell sheets; cell–scaffold constructs	Graft-versus-host disease (GVHD); tissue repair; joint disorders	Selected products approved for specific indications in some countries; numerous clinical trials ongoing
	iPSC-Derived Cells	Neural, retinal, and cardiac cell preparations or implants	Neurological, ophthalmic, and tissue replacement therapies	Human clinical studies are underway across multiple specialties; overall still in clinical translation

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Applications relevant to longevity medicine include stem cells, immune cell therapies, and extracellular vesicles/exosomes, ranging from established treatments and products approved for specific indications to early-stage clinical research.

3.3.3. Regenerative Medicine (2/4)

Table 9 Clinical Translation of Regenerative Medicine Technologies

Category	Modality	Product Forms	Applications	Clinical Development Status
Immune Cells	CAR-T / TIL Therapies	Autologous or allogeneic cell products; primarily single or short-course treatment	Hematologic malignancies; selected solid tumors	Relatively mature in disease treatment, with multiple approved therapies with specialized treatment-center networks
	NK / DC Cell Therapies	NK-cell preparations; dendritic-cell vaccines; combination approaches	Cancer; investigational applications in infections and immune modulation	Extensively studied in oncology and other diseases; overall still under ongoing clinical investigation
Exosomes / Extracellular Vesicles (EVs)	Exosomes / Extracellular Vesicles (EVs)	Injectables; nebulized formulations; gels; topical preparations	Wound repair; skin and respiratory disorders	Primarily early clinical research and product development; no established therapeutic pathway

MSC research has expanded from tissue repair to frailty, joint degeneration, cardiovascular disease, and neurological disorders. iPSC-derived therapies focus on dopaminergic cells, retinal cells, and other tissue replacement applications. Further clinical translation depends on demonstrating long-term functional benefits through human follow-up and ensuring product quality. Key challenges include cell sourcing, post-expansion viability and potency, genomic stability, and control of residual undifferentiated cells.

Exosome/extracellular vesicle research and development are expanding into tissue repair and engineered delivery systems. Modifying source cells, vesicle surfaces, or cargo may improve targeting and the delivery efficiency of bioactive substances. Product standardization remains a major challenge for clinical translation. Cell sources, culture conditions, isolation and purification methods, and storage conditions can all affect product quality, requiring consistent characterization, potency assays, and quality control.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Established applications of immune cell therapies are concentrated in disease treatment, while their longevity-related applications are still investigational.

3.3.3. Regenerative Medicine (3/4)

CAR-T and tumor-infiltrating lymphocyte (TIL) therapies have developed mature product development, manufacturing, and clinical delivery systems in oncology, supported by defined therapeutic targets, indications, and clinical endpoints.

Natural killer (NK) cells and dendritic cells (DCs) are being explored for longevity-related applications, including immune surveillance, chronic inflammation, and maintenance of immune function. However, human evidence remains largely derived from studies in cancer and infectious diseases. High-quality clinical studies are still needed to establish functional benefits in healthy or relatively healthy populations.

Major markets have established distinct regulatory pathways for regenerative medicine. In the United States, relevant cell therapy products are primarily regulated as biologics. The European Union applies the Advanced Therapy Medicinal Products (ATMP) framework. Japan regulates approved regenerative medical products through its pharmaceutical approval system, while maintaining a separate framework for regenerative medicine provided by medical institutions.

In China, the Regulations on the Administration of Clinical Research and Clinical Translation of Biomedical New Technologies (State Council Decree No. 818) took effect on May 1, 2026, establishing requirements for clinical research filing and approval of clinical translation. Cell therapy drugs remain subject to pharmaceutical regulation. Investigational technologies cannot enter routine clinical practice without the required regulatory authorization.

At the clinic level, regenerative medicine places higher requirements on specialized cell processing and quality management. BiOSTYLE CLINIC, part of 5STAR MEDICAL GROUP, operates on-site Cell Processing Centers (CPCs) in Ginza and Osaka. These facilities have completed the required notification to Japan's Ministry of Health, Labour and Welfare as facilities for manufacturing specified processed cells.

A specialized team, including10 cell culture specialists, oversee cell status, culture processes, raw materials, storage and product release. Collaboration with medical facilities such as CLINIC 9ru connects cell processing and quality control with clinical delivery, reflecting the growing industrial emphasis on specialized processing and quality control beyond clinical implementation.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Regenerative medicine products require reliable manufacturing processes, clear regulatory pathways, and specialized clinical delivery. These requirements have shaped distinct industry roles in product development, specialized manufacturing, and clinical translation.

3.3.3. Regenerative Medicine (4/4)

Table 10 Key Players in the Regenerative Medicine Industry

Industry Segment	Representative Companies	Core Capabilities	Commercialization Features
Stem Cell Product Development	Help 艾尔普再生医学 HELP THERAPEUTICS; iRegene; 铂生卓越生物科技（北京）有限公司 PLATINUM LIFE EXCELLENCE BIOTECH; RACTHERA; Sumitomo Pharma; 士泽生物 XellSmart; CUORiPS; mesoblast	MSC- and iPSC-derived therapies; cell replacement products	Development through defined indications and clinical translation
Exosome/Extracellular Vesicle (EV) Platforms	恩泽康泰 ECHO BIOTECH; STEXO 思德克索; AEGLE THERAPEUTICS; evox; RION HEAL FROM WITHIN; DIRECT BIOLOGICS	Development of EV production, engineering, and delivery platforms	Standardized manufacturing and potency assessment remain key steps in clinical translation
Immune Cell Product Development	上海细胞治疗集团 SHANGHAI CELL THERAPY GROUP CO., LTD.; 药明巨诺 JW Therapeutics; IOVANCE BIOTHERAPEUTICS; FOSUN KAIROS 复星凯瑞; IASO BIOTHERAPEUTICS; CARSGEN THERAPEUTICS; artiva; LEGEND BIOTECH	Development and manufacturing of CAR-T, TIL, and other immune cell therapies	Established products and specialized treatment-center networks
Process Development & Manufacturing Platforms	OBiO 和元生物; CytoNiche 华龛生物; RESILIENCE; Minaris Advanced Therapies	Cell culture, process development, quality control, and scale-up manufacturing	Support from process development through scale-up manufacturing

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Medical biomaterials support tissue repair by providing structural support, filling defects, acting as protective barriers, or improving the local healing environment. Established applications include soft tissue augmentation, wound healing, tissue repair patches, and bone repair.

3.3.4. Medical Biomaterials (1/2)

Medical biomaterials have established several clinical product pathways, including standardized injectable products used in outpatient care, products for wound, tissue, and musculoskeletal repair, and functional delivery platforms under development.

Table 11 Product Pathways and Clinical Applications of Medical Biomaterials

	Materials / Technologies	Formats	Applications	Representative Companies
Soft Tissue Injectables	Hyaluronic acid; recombinant collagen; PLLA/PDLLA; PCL; CaHA	Injectable gels; lyophilized fibers; microsphere/particle suspensions	Soft tissue augmentation; wrinkle correction; local tissue remodeling	华熙生物 BLOOMAGE BIOTECH; 爱美客 IMEIK; 锦波 jinbo; 昊海生物科技 Haohai Biological Technology
Skin & Wound Repair Materials	Collagen; HA hydrogels; natural polymers; skin substitutes	Dressings; gels; membranes; skin substitutes	Superficial and chronic wounds; burns; postoperative repair	Trauer 创尔生物; Vcolga 敷尔佳; ORGANOGENESIS
Tissue Repair Patches	Acellular dermal matrix (ADM); extracellular matrix (ECM); collagen membranes	Patches; membranes; implants	Soft tissue repair; tissue reconstruction; meningeal and oral tissue repair	正海生物 ZH-BIO; 冠昊生物 GUANHAO BIOTECH; AROA
Musculoskeletal Repair Materials	Mineralized collagen; bioceramics; cartilage/tendon scaffolds	Bone substitutes; repair membranes; scaffolds and implants	Bone defect, cartilage, and tendon repair	VERICEL; Allgens; Smith+Nephew
Functional Biomaterial Platforms	Functional hydrogels; composite scaffolds; microneedles	Delivery hydrogels; microneedles; composite scaffolds	Local delivery of bioactive agents; tissue regeneration research	CollPlant Pioneering Regenerative Medicine; TRAUTEC 创健医疗

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

In longevity medicine, medical biomaterials are primarily used for tissue repair and functional maintenance, with applications in skin and soft tissue remodeling, wound repair, and musculoskeletal functional recovery

3.3.4. Medical Biomaterials (2/2)

Table 12 Medical Biomaterials: Clinical Maturity and Role in Longevity Medicine

Product Pathway	Clinical Maturity	Role in Longevity Medicine
Soft Tissue Injectables	Hyaluronic acid (HA) fillers have established regulatory , clinical and risk-management pathways. Selected recombinant collagen, PLLA, and CaHA products are approved; newer materials remain in development.	**Medical aesthetics and skin aging management**, including soft tissue augmentation, local remodeling and appearance enhancement; requires standardized injection procedures and complication management
Skin & Wound Repair Materials	Superficial wound dressings and hydrogels are well established. Skin substitutes and complex wound therapies are in clinical use but require specialized care.	**Outpatient care for superficial wounds and postoperative healing**; specialist care for complex wounds, burns, and skin substitutes
Tissue Repair Patches	Acellular dermal matrix (ADM)、extracellular matrix (ECM), and collagen membranes are available in various implant and repair products, established in selected reconstructive, oral, and surgical applications.	**Primarily specialist surgical reconstruction**, rather than routine longevity clinic services
Musculoskeletal Repair Materials	Bone substitutes and selected cartilage/tendon repair products include approved products and have established orthopedic and sports medicine applications.	Bone, cartilage, and tendon repair; **directly relevant to mobility recovery and long-term functional maintenance**

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Injectable and superficial wound care products have established outpatient applications, while complex tissue repair requires specialist or surgical care. Functional delivery materials remain largely in clinical research and early translation.

3.3.4. Medical Biomaterials (2/2)

Table 13 Medical Biomaterials: Clinical Maturity and Role in Longevity Medicine (2/2)

Functional Biomaterial Platforms	Active research in hydrogels and composite scaffolds; many drug-, cytokine-, and EV-loaded systems remain preclinical or early clinical.	Exploratory tissue engineering and local delivery applications; limited clinical standardization; better viewed as a pipeline for future translational development

Regulation of medical biomaterials depends on the final product and its intended use :

- **In China**, injectable HA products used for dermal and subcutaneous filling are generally regulated as Class III medical devices, with specific technical review requirements also applying to recombinant humanized collagen injectables. Such procedures must be performed by qualified healthcare professionals in licensed medical facilities.
- **In the United States**, soft tissue fillers are primarily regulated as medical devices under the FDA framework. Human tissue, amniotic membrane, and adipose-derived products may fall under the Human Cells, Tissues, and Cellular and Tissue-Based Products (HCT/P) framework. Products that do not meet the criteria for regulation solely under Section 361 of the Public Health Service Act are subject to more stringent regulatory requirements.
- **In the European Union**, the Medical Device Regulation (MDR), covers certain aesthetic fillers. Implantable devices with biological effects or substantial absorption may be classified as Class III under the applicable rules. Combining biomaterials with cells, tissue engineering, or delivery systems may change their regulatory classification.
- **Japan and South Korea** have also established dedicated frameworks for regenerative medical products.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Extracorporeal blood purification uses separation, filtration, adsorption, or exchange to remove or replace blood and plasma components for therapeutic purposes. Major modalities include therapeutic plasma exchange (TPE), double-filtration plasmapheresis (DFPP), immunoadsorption (IA), hemoperfusion (HP), and lipoprotein apheresis.

3.3.5. Other Medical Procedures (1/6)

Blood Purification Technologies (1/3)

Table 14 Major Blood Purification Modalities

Technology Pathway	Mechanism	Target Components	Established Clinical Uses
Plasma Exchange (PE/TPE)	Removes plasma and replaces it with albumin, plasma, or other replacement fluids	Autoantibodies; immune complexes; abnormal proteins; other circulating factors	Neuroimmunologic, hematologic, and renal disorders; transplantation; liver failure
Double-Filtration Plasmapheresis (DFPP)	Secondary filtration selectively retains components by molecular size after plasma separation	Immunoglobulins; immune complexes; lipoproteins	Immune-mediated and transplant-related disorders; severe lipid metabolic abnormalities
Immunoadsorption (IA)	Plasma passes through an adsorber column containing specific or semi-specific ligands that selectively bind target molecules	Autoantibodies; specific immunoglobulins; immune complexes	Transplant desensitization; autoimmune and neuroimmunologic disorders
Hemoperfusion (HP)	Whole blood passes through adsorbent materials to remove circulating substances	Toxins; drugs; inflammatory mediators; bilirubin; endotoxins	Acute poisoning; liver failure; selected critical care applications
LDL/Lp(a) Apheresis	Selective lipoprotein removal by adsorption, filtration, or precipitation	LDL-C; Lp(a)	Severe familial hypercholesterolemia; elevated Lp(a) with progressive atherosclerotic cardiovascular disease (ASCVD)
Other Selective Removal Techniques	Uses target-specific membranes, adsorbents, or ligands designed for the component to be removed	Bilirubin; DNA; selected antibodies	Artificial liver support; severe immune disorders; specialized supportive care

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Therapeutic plasma exchange (TPE) is one of the more actively researched and commercialized blood purification approaches in longevity medicine.

3.3.5. Other Medical Procedures (2/6)

Blood Purification Technologies (2/3)

In longevity medicine, blood purification research has expanded from removing disease-related substances to the long-term management of inflammatory mediators, lipoproteins, autoantibodies, and other circulating factors. Plasma exchange has entered research on age-related diseases and healthy aging, while LDL/Lp(a) apheresis has accumulated more long-term outcome evidence in high cardiovascular-risk populations.

With human TPE studies following two directions:: assessing cognitive and functional outcomes in diseases such as Alzheimer's disease, and tracking biological age and other aging-related biomarkers in healthy adults.

In disease-specific research, the AMBAR trial evaluated plasma exchange with albumin replacement in patients with mild-to-moderate Alzheimer's disease. Over 14 months, treatment significantly slowed decline in activities of daily living, while cognitive outcomes showed a favorable trend. In healthy adults, a 2025 study enrolling 42 healthy adults over age 50 reported reductions in multi-omics-based biological age measures, following monthly TPE, with more pronounced changes in the group receiving TPE combined with intravenous immunoglobulin (IVIG).

Another study involving repeated plasmapheresis reported improvements in metabolic markers, but found no consistent improvement across DNA methylation clocks. Human studies suggest that plasma interventions can influence aging-related biomarkers, but consistent evidence of health benefits remains insufficient in healthy populations.

Table 15 TPE Services and Delivery Models at Overseas Longevity Clinics (1/2)

Provider	Region	Service Offering	Service Delivery Model
EXTENSION HEALTH	New York, USA	$10,000/session; Catalyst membership: $50,000/year with $15,000 therapy credits applicable for TPE; Superhuman membership: $250,000/year, includes 4 TPE sessions	Single sessions + premium memberships
NEXT|HEALTH	Los Angeles, New York, and other US locations	$10,000/session, 3 sessions: $24,000, 6 sessions: $45,000; Platinum membership: $100,000/year with quarterly TPE	Single sessions + packages + membership
FOUNTAIN LIFE	Naples, Orlando, Dallas, New York, and Houston, USA	$10,000/session; offered under Restorative Therapeutics	Testing-led standalone treatment

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Therapeutic plasma exchange (TPE) is now offered by some overseas longevity clinics, with delivery models expanding from single-session pricing to treatment packages, membership services, and partnerships with specialized service providers.

3.3.5. Other Medical Procedures (3/6)

Blood Purification Technologies (2/3)

Table 15 TPE Services and Delivery Models at Overseas Longevity Clinics (2/2)

Provider	Region	Service Offering	Service Delivery Model
HUMANAUT HEALTH.	Austin, Dallas, and Palm Beach Gardens, USA	From $8,500/session for members; bundles available; TPE is not included in standard membership fees	Membership + separate payment
REBORNE+ LONGEVITY	London, UK	£5,300/session; package pricing on consultation	Assessment + single/multiple sessions
circulate By VIOME	Seattle, USA (headquarters)	No standardized public price; partner clinics charge patients directly, while Circulate provides nurses, equipment, protocols, and operational support	Platform-supported delivery

In China, TPE has established clinical operating standards and is primarily used for defined disease indications. The Blood Purification Standard Operating Procedures (2021 Edition) cover indications, procedural requirements, and complication management. TPE is not listed in the National Catalogue of Restricted Medical Technologies. Applications of TPE for anti-aging or biological age improvement in healthy individuals are not established clinical indications. Such uses in longevity medicine remain largely investigational, with some being explored through self-pay services overseas.

Commercial TPE services follow two main models: clinics offering TPE directly to clients, with single sessions typically ranging from US$8,500 to US$10,000, alongside treatment packages, and annual memberships; and specialized platforms, such as Circulate Health, providing partner clinics with clinical staff, equipment, protocols, and operational support. Regardless of the model, TPE remains an extracorporeal medical procedure requiring trained personnel, anticoagulation, plasma replacement, and monitoring. Risks include hypotension, citrate-induced hypocalcemia, allergic or transfusion reactions, loss of coagulation factors and immunoglobulins, and vascular access-related infections or thrombosis.

Unlike TPE for established disease indications, young-donor plasma and plasma-derived protein fractions remain investigational in aging-related applications, largely informed by preclinical heterochronic parabiosis studies. The FDA has warned that young-donor plasma is not approved for anti-aging or memory-related uses. A 2025 randomized trial involving 38 older patients undergoing major surgery observed changes in certain inflammatory and immune pathways following administration of a young-donor plasma protein fraction. However, the study assessed perioperative immune responses, not longevity or long-term health outcomes.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Fecal microbiota transplantation (FMT) transfers screened and processed fecal microbiota from healthy donors into a recipient's gastrointestinal tract to restore or modify the gut microbiota.

3.3.5. Other Medical Procedures (4/6)

Fecal Microbiota Transplantation (1/2)

FMT was initially performed primarily in hospital settings relying on donor screening, microbiota preparation, and clinical administration. Advances in preparation methods and quality control have enabled standardized suspensions, frozen preparations, and oral products, with increasingly structured processes for donor screening, batch control, storage, distribution, and clinical use.

Defined microbial consortia and live biotherapeutic products (LBPs) are advancing through pharmaceutical development. Control of strain composition, viability, purity, stability, and manufacturing processes supports more standardized development and regulatory pathways for microbiota-based therapeutics.

Table 16 Main Product Pathways in Microbiota Therapy

Product Pathway	Product Format	Key Features	Developments
Fecal Microbiota Transplantation (FMT)	Processed microbiota from healthy donors administered via colonoscopy, enema, or enteral tube	Complex donor microbiota; highly dependent on individual donors; requires donor screening, preparation, and standardized clinical procedures	Established hospital-based clinical practice for selected indications
Fecal Microbiota Products	Standardized donor-derived suspensions, frozen preparations, or oral spore formulations	Enhanced batch control, release testing, storage and distribution, and dosage-form standardization	FDA-approved REBYOTA (rectal microbiota suspension) and VOWST (oral microbiota spores)
Live Biotherapeutic Products (LBPs)	Defined microbial strains or consortia developed as therapeutics	Controlled strain composition, viability, dosage, stability, and manufacturing	VE303 in Phase 3; live microbial drug candidates in clinical development in China

Beyond recurrent Clostridioides difficile infection (rCDI). Research has expanded to obesity, metabolic syndrome, and Parkinson's disease.

Some studies report changes in abdominal adiposity, insulin sensitivity or microbiota composition without corresponding improvements in weight or motor outcomes. Evidence in healthy aging is more limited. A 2019 study in healthy volunteers found donor microbial engraftment lasting nearly one year after FMT, but did not establish benefits for frailty, physical function, disease risk, or lifespan. China's STEP-aging study (NCT05598112) is investigating oral FMT for frailty and related functional outcomes in older adults, with no conclusive efficacy results available.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

The clinical benefits of microbiota-based therapies in other diseases and healthy aging remain uncertain.

3.3.5. Other Medical Procedures (5/6)

Fecal Microbiota Transplantation (2/2)

FMT requires stringent safety and quality controls, as donor material may transmit pathogens or drug-resistant organisms. FDA issued multiple safety alerts concerning the potential transmission of multidrug-resistant organisms, pathogenic Escherichia coli, and emerging infectious diseases since 2019, which therefore have reinforced the importance of donor screening, pathogen testing, batch release, and traceability.

Regulatory approaches vary by region. The United States permits conventional FMT for recurrent C. difficile infection under limited enforcement discretion while regulating standardized microbiota products as biologics. European frameworks continue to evolve, while Japan and South Korea are refining quality and clinical development requirements for microbiota-based therapeutics.

China has developed parallel pathways for clinical FMT services and pharmaceutical development. Hospitals follow clinical management guidance for donor screening, microbiota preparation, and treatment, while biopharmaceutical companies pursue drug development and registration of defined microbial consortia and live microbial therapeutics. Industry capabilities are expanding beyond hospital-based FMT to donor screening, microbiota processing and preservation, microbiota banks, donor–recipient matching, and microbiome drug development.

Stellate Ganglion Block (1/2)

SGB has long been used for pain and certain sympathetically mediated conditions, with established techniques for image guidance, anesthetic administration, and risk management. Its investigational applications have expanded to PTSD, anxiety, sleep disorders, long COVID symptoms, and autonomic dysfunction. Some overseas longevity clinics now offer SGB as a self-pay service. Providers also combine SGB with vagus nerve hydrodissection —a procedure that uses ultrasound-guided fluid injection around the vagus nerve to separate it from surrounding tissues—or low-dose ketamine, marketing packages such as "Sympathetic Reset" and "Neuro Reset.“

Clinical evidence for SGB remains mixed. A 2020 randomized trial involving 113 participants reported short-term improvements in PTSD symptoms with two right-sided SGB, while a 2016 trial found no significant benefit over sham treatment. The 2023 VA/DoD guideline concluded that evidence remains insufficient to recommend for or against SGB for PTSD. Studies have reported short-term improvements in anxiety and sleep, but long-term efficacy and repeat-treatment protocols remain unestablished. Evidence for vagus nerve hydrodissection is more limited to case reports and small case series, while combined protocols such as “Neuro Reset” lack independent human trials.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.3 Medical Interventions

Stellate ganglion block (SGB) is an image-guided procedure in which a local anesthetic is injected near the cervical sympathetic chain to temporarily block sympathetic nerve activity.

3.3.5. Other Medical Procedures (6/6)

Stellate Ganglion Block (2/2)

Table 17 Overseas Autonomic Modulation Services

Service Name	Underlying Procedure	Applications	Published Price	Clinical Positioning
Sympathetic Reset / Dual Sympathetic Reset	SGB; some protocols use dual-level or staged bilateral blocks	PTSD, anxiety, stress, and autonomic symptoms	Self-pay; varies by protocol	Established SGB procedure; limited evidence for expanded indications
Vagus Nerve Hydrodissection Services	Perivagal hydrodissection	Autonomic dysfunction, fatigue, brain fog	Private, self-pay services; pricing varies	Mainly case reports and small technical studies
Neuro Reset	SGB + Vagus nerve hydrodissection	Chronic stress, trauma, insomnia, brain fog, autonomic symptoms	$ 1,500/session	Commercial combination; no independent trial evidence for the full protocol
Complete Neuro Reset	SGB + vagus nerve hydrodissection + low-dose ketamine	Similar to Neuro Reset	$ 2,000/session	Multimodal package without independent validation

These interventions are invasive medical procedures requiring qualified practitioners and appropriate risk management. In China, they should be performed in healthcare facilities with relevant clinical specialties, trained personnel, suitable equipment, and institutional authorization. Its use for expanded indications such as anxiety, PTSD, insomnia, and long COVID should also follow applicable medical technology management and informed consent procedures, with ethics review where required. Vagus nerve hydrodissection is less standardized and has not yet established a routine clinical pathway.

In longevity medicine, SGB and related interventions are primarily being explored for managing stress, sleep disturbances, and autonomic symptoms. Studies of SGB and vagus nerve hydrodissection have not established biological age, frailty, functional lifespan, or healthspan as primary clinical endpoints. No mature intervention pathway has been established for slowing aging or extending healthspan.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.4 Cutting-Edge Exploratory Technologies

Gene therapy is a class of technologies that treat diseases by introducing, replacing, regulating, or editing genetic information to alter specific genes and their expression. With advances in genome editing and delivery technologies, the scope of research has gradually expanded to include mechanisms related to aging, such as genomic stability, metabolic homeostasis, chronic inflammation, and the restoration of cellular function.

3.4.1. Gene Therapy（1/4）

Gene editing, also known as genome editing, is a class of genetic engineering techniques used to modify specific target genes in an organism's genome. New gene-editing tools, such as CRISPR-Cas9, have improved the accuracy and efficiency of genetic modification and enabled researchers to more directly explore the relationships between genetic and epigenetic changes and cellular aging, tissue degeneration, and age-related diseases. In addition to directly editing the genome, gene therapy can also intervene in aging-related pathways by using vectors to introduce functional genes, regulate gene expression, or silence specific genes.

Fig.7 Major Technical Approaches to Gene Therapy in Aging Intervention

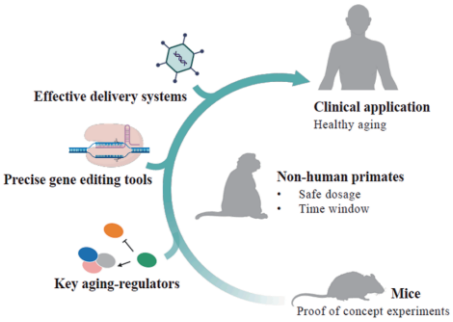
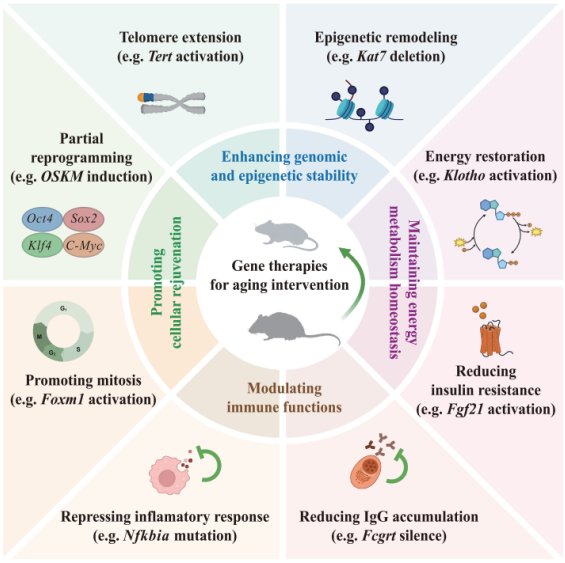


Figure source: Jing, Y., Ren, J., Qu, J., & Liu, G. H. (2025). Gene therapy strategies for aging intervention. Cell insight, 4(4), 100254. https://doi.org/10.1016/j.cellin.2025.100254

☐ Key Regulators of Aging (1/2)

At this stage, research on gene therapy in the field of aging is primarily focused on four areas: **genomic stability and epigenetic remodeling, maintenance of energy metabolism homeostasis, regulation of inflammatory pathways, and cellular rejuvenation**. Key genes and regulatory factors include *TERT*, *Klotho*, *FGF21*, *KAT7*, *FOXM1*, and *OSK/OSKM*.

Fig.8 Major Technical Approaches to Gene Therapy in Aging Intervention



In genomic stability and epigenetic remodeling, research has primarily focused on telomere maintenance, DNA damage repair, chromatin state, and epigenetic alterations. Targets such as telomerase reverse transcriptase (TERT), DNA damage repair-related genes like *YIPF2*, heterochromatin maintenance factors such as *BMAL1*, and epigenetic factors such as the histone acetyltransferase *KAT7* have demonstrated the potential to delay certain aging phenotypes in cellular and animal studies.

Figure source: Jing, Y., Ren, J., Qu, J., & Liu, G. H. (2025). Gene therapy strategies for aging intervention. Cell insight, 4(4), 100254. https://doi.org/10.1016/j.cellin.2025.100254

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.4 Cutting-Edge Exploratory Technologies

Currently, related studies have observed certain signs of tissue function improvement and lifespan extension in cellular and animal studies; however, clinical evidence supporting interventions for human aging remains in its early stages.

3.4.1. Gene Therapy（2/4）

□ Key Regulators of Aging (2/2)

Regarding the maintenance of energy metabolism homeostasis, the focus is primarily on regulatory factors such as fibroblast growth factor 21 (FGF21) and the single-pass transmembrane glycoprotein Klotho. By influencing energy metabolism, insulin sensitivity, and tissue function, researchers are exploring their roles in metabolic abnormalities and age-related functional decline.

In terms of regulating inflammatory pathways, gene therapy targets key nodes in the cGAS-STING pathway—such as *SIRT5* and *NFKBIA*—as well as genes associated with humoral immune responses, such as *IGKC*. This approach can improve chronic inflammation, glucose tolerance, and insulin sensitivity, effectively delaying aging in multiple organs.

In terms of cellular rejuvenation, gene therapy primarily targets *SIRT2*, *FOXM1*, and others, which can promote cell proliferation and regeneration, improve pathological aging phenotypes in various tissues—including skin, adipose tissue, the aorta, and bone—and extend the lifespan of experimental animals. The reprogramming factors *OSKM* (*OCT4*, *SOX2*, *KLF4*, and *c-MYC*), which gained widespread attention following the 2012 Nobel Prize in Physiology or Medicine, also fall within the realm of senescent cell regeneration. By reshaping the epigenome and promoting the regeneration of senescent cells, these reprogramming factors can alleviate cellular senescence and demonstrate the potential to delay organ degeneration, promote tissue regeneration, and extend lifespan.

□ Gene Therapy Strategies and Delivery Systems (1/2)

Gene therapy strategies can be broadly categorized into four types:

① **genome editing** (using technologies such as CRISPR-Cas9, base editing, and prime editing to precisely edit the genome or achieve specific regulation of gene expression)

② **Transcriptional regulation** (regulating gene expression by combining catalytically inactivated Cas9 with transcriptional repressors such as KRAB, activators such as VP64, or epigenetic modifiers such as P300)

③ **Gene replacement and overexpression** (delivering functional genes to compensate for defective or missing genes, or to upregulate gene expression)

④ **Gene silencing** (suppression of gene expression based on small interfering RNA, antisense oligonucleotides, and other RNA interference technologies)

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.4 Cutting-Edge Exploratory Technologies

Whether gene therapy can advance to clinical use depends crucially on whether the regulatory strategies align with the delivery systems. The former determine how the target gene or its expression is modified, while the latter determine whether the therapeutic tool can reach the target tissue and maintain the intended effect.

3.4.1. Gene Therapy（3/4）

□ Gene Therapy Strategies and Delivery Systems (2/2)

Fig.9 Gene Therapy Strategies

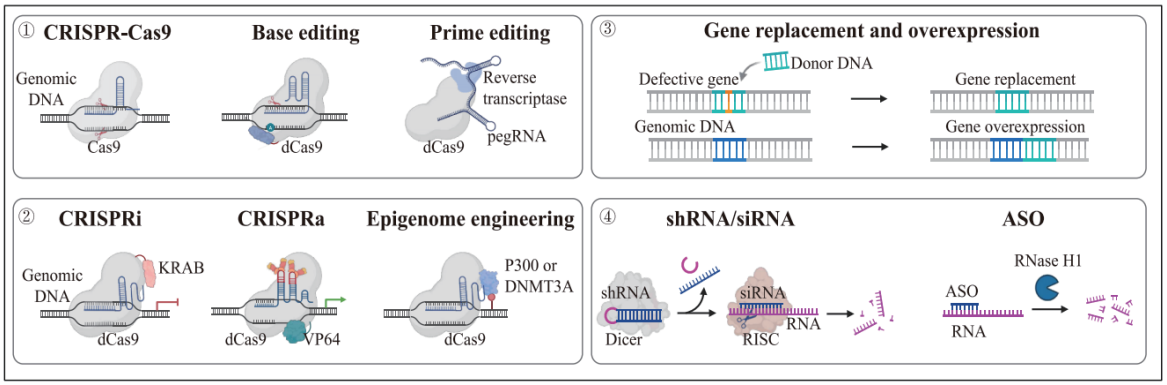


Figure source: Jing, Y., Ren, J., Qu, J., & Liu, G. H. (2025). Gene therapy strategies for aging intervention. Cell insight, 4(4), 100254. https://doi.org/10.1016/j.cellin.2025.100254

Delivery systems can be broadly categorized into physical delivery methods (electroporation, hydrodynamic injection, biolistic delivery/gene gun, laser-mediated transfection, etc.), chemical methods (cationic lipid reagents, polyethyleneimine (PEI), calcium phosphate, liposomes, and a range of other delivery reagents), and viral vectors (replication-defective viral genomes, such as lentivirus, adenovirus, and adeno-associated virus (AAV)).

Table 18 Comparison of Common Gene Delivery Vectors

Type	Main applications	Reach	Adaptive immune response	Genomic integration rate	Max cargo size	Cost
AAV	Systemic delivery and genetic diseases	Systemic	High	Low（0.1%–5%）	4.7kb	**High (systemic) and low (local)**
Lentivirus	Ex vivo cell therapy and CAR-T and stem cell engineering	Local	Low	High	10kb	**Medium**
Adenovirus	Anticancer therapies and vaccines	Local	High	Very low（<0.1%）	37kb	**Medium**
Liposome/ proteolipids	Local or liver-specific delivery	Local/liver	Varied	Very low（<0.1%）	100kb	**Low**

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.4 Cutting-Edge Exploratory Technologies

In recent years, human studies on aging-related gene therapy have begun to show progress, with partial reprogramming emerging as a key area of exploration.

3.4.1. Gene Therapy（4/4）

In June 2026, Life Biosciences launched the first human trial of ER-100, marking a clinical milestone for partial epigenetic reprogramming. This therapy uses adeno-associated virus (AAV) to deliver the three reprogramming factors—*OCT4*, *SOX2*, and *KLF4*—to retinal ganglion cells, and employs a drug-induced system to control their expression. It is currently being used to treat open-angle glaucoma and nonarteritic anterior ischemic optic neuropathy (NAION), with the primary focus on evaluating safety, tolerability, and changes in visual function.

In addition to Life Biosciences, companies such as Altos Labs, NewLimit, and Turn Biotechnologies are also advancing research and development focused on cellular reprogramming and the regulation of aging-related genes.

Table 19 Leading Companies in Gene Therapy for Anti-Aging and Their R&D Focus

Company	Technical Approach	Key Progress
ALTOS™	Partial Reprogramming (*OSKM*)	Study on AAV-OSK-Induced Lifespan Extension in Mice Published in 2024; Shinya Yamanaka Appointed Chair of the Scientific Advisory Board
NewLimit	Epigenetic Reprogramming (AI-Driven)	Liver-targeted mRNA-LNP therapy; $435 million in Series C funding in 2026; plans for human trials in 2028
life BIOSCIENCES	Partial Reprogramming (*OSK*, without *c-Myc*)	The world's first clinical trial of partial reprogramming in humans (ER-100, for the treatment of glaucoma/NAION) was approved by the FDA in 2025.
turn.bio	mRNA Partial Reprogramming	ERA Platform Targets Skin and Musculoskeletal Aging; Plans to Conduct Skin Rejuvenation Trials in 2026
REJUVENATE BIO	Gene Therapy (*FGF21/sTGFβR2*)	Clinical Progress in Gene Therapy for Canine Heart Disease; Research on Partial Reprogramming to Extend Human Lifespan

From a clinical translation perspective, some reprogramming approaches have moved beyond the purely preclinical stage, but they are still a long way from routine application in longevity medicine. Current human trials still focus on specific diseases such as glaucoma and optic neuropathy, primarily to verify safety, tolerability, and improvements in local function; they do not directly evaluate endpoints such as biological age, frailty, or healthy life expectancy. Whether these approaches can be further expanded in the future will largely depend on whether issues such as off-target effects, immune responses, potential carcinogenicity, tissue delivery, and long-term safety can be effectively controlled based on human data. **In the short term, these technologies are more likely to advance through well-defined disease indications rather than directly into anti-aging applications for healthy individuals.**

Source: Public information, literature review, company websites, TIMEPIE Research Institute analysis

3.4 Cutting-Edge Exploratory Technologies

Brain-Computer Interface (BCI) enables information exchange between the brain and external devices by acquiring and decoding signals from the central nervous system. Currently, they are primarily used in applications such as motor function compensation, communication assistance, and neurological rehabilitation.

3.4.2. Brain-Computer Interface (BCI)（1/2）

Based on signal acquisition methods, BCIs can be classified as invasive or non-invasive:

- **Invasive BCIs** require the surgical implantation of electrodes into the brain, including intracortical electrodes, and provide high-quality signals with high spatial and temporal resolution. As such, they are particularly suitable for research environments and applications requiring highly precise control; however, they carry greater surgical risks and complications.
- **Non-invasive BCIs** utilize electroencephalography (EEG), functional near-infrared spectroscopy (fNIRS), functional magnetic resonance imaging (fMRI), magnetoencephalography (MEG), and positron emission tomography (PET) to acquire neural signals non-invasively from outside the skull. These methods do not require invasive surgery and enable information exchange between the brain and external devices in a safe, non-invasive manner; however, they present significant technical challenges and are costly.

In terms of clinical applications, the most evident value of BCIs lies in functional compensation following disease or disability. For patients with spinal cord injuries, stroke, amyotrophic lateral sclerosis (ALS), and severe motor disorders, research focuses on using brain signals to control computers, robotic arms, or other assistive devices, and explores the restoration of grasping, communication, and motor abilities. Some stroke rehabilitation studies combine the decoding of motor intent with rehabilitation training, driving the transition of brain-computer interfaces from laboratory validation to clinical application. As the target population gradually expands, brain-computer interfaces are also beginning to extend beyond post-disease functional compensation to address age-related cognitive and motor decline.

Based on the target population and application objectives, their connection to longevity medicine can be further divided into three tiers:

- **The first tier involves functional compensation following disease or disability**, primarily achieved by decoding motor or communication intentions to help patients regain the ability to control devices, grasp objects, walk, or communicate. Its value lies primarily in extending functional healthy life expectancy and the duration of independent living.
- **The second tier extends further to age-related neurological decline and is primarily used for cognitive training and motor rehabilitation**; currently, this level is more closely aligned with research on functional maintenance and early rehabilitation.
- **The third tier focuses on cognitive enhancement for healthy individuals**, exploring improvements in attention, memory, and learning efficiency; its direct connection to longevity medicine is relatively weak.

Source: Public information, literature review, company websites, TIMEPIE Research Institute analysis

3.4 Cutting-Edge Exploratory Technologies

Brain-Computer Interface (BCI) is gradually expanding from providing functional compensation for conditions such as paralysis and stroke to supporting the maintenance of age-related cognitive and motor functions; cognitive enhancement in healthy individuals remains primarily in the experimental exploration phase.

3.4.2. Brain-Computer Interface (BCI)（2/3）

Table 20 Three-Level Application Framework for BCI and Longevity Medicine

	Target Population	BCI Effects	Current Evidence	
Level1: Functional Compensation Following Disease or Disability	ALS; spinal cord injury; Stroke; severe motor disorders; aphasia	Restoring communication; device control; Grasping; Walking; tactile feedback	There have been human feasibility studies, randomized trials on stroke rehabilitation, and a limited number of approved products	**The most established application with a clearer payment pathway**
Level2: Interventions for Age-Related Neurofunctional Decline	Mild cognitive impairment (MCI); early-onset Alzheimer's disease (AD); age-related decline in motor function; post-stroke rehabilitation in the elderly	EEG Neurofeedback; Closed-Loop Cognitive Training; Movement-Intent-Driven Rehabilitation	The studies are small in scale, lack randomized controlled trials and long-term follow-up, and evidence of disease modification has not yet been established.	**Suitable for clinical trials and real-world studies**
Level3: Cognitive Enhancement in Healthy Individuals	Healthy young and middle-aged adults & healthy older adults	Attention; Memory; Learning Efficiency; Fatigue; Brain Optimization	Mostly short-term surrogate markers, laboratory tests, or studies without a control group	**Should not be marketed as a longevity treatment**

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.4 Cutting-Edge Exploratory Technologies

From the perspective of longevity medicine, BCIs are currently better suited as complementary tools for neurological assessment, functional rehabilitation, and specialist referrals.

3.4.2. Brain-Computer Interface (BCI)（3/3）

Currently, BCIs are used or explored in the following applications:

- Motor/cognitive training;
- Controlling home appliances;
- Communicating with others during daily activities;
- Controlling an exoskeleton to assist joint movement and augment physical strength.

On the industrial side, multiple technological approaches—including invasive and non-invasive methods—have emerged.

Companies such as Neuralink, Synchron, Precision Neuroscience, and Neuracle (Borui Kang) are advancing research and development and clinical translation in areas such as motor function compensation, digital control, and stroke rehabilitation. Current challenges primarily center on implant safety, long-term signal stability, training costs, and individual differences.

Fig.10 Applications of Brain-Computer Interfaces Among the Elderly

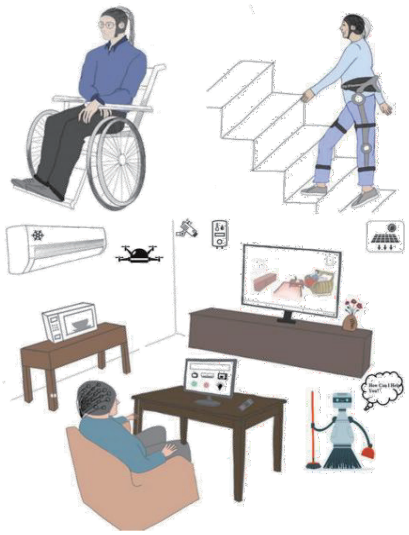


Figure source: Belkacem, A. N., Jamil, N., Palmer, J. A., Ouhbi, S., & Chen, C. (2020). Brain Computer Interfaces for Improving the Quality of Life of Older Adults and Elderly Patients. Frontiers in neuroscience, 14, 692. https://doi.org/10.3389/fnins.2020.00692

Internationally, the US FDA and relevant EU regulatory agencies have begun establishing review and regulatory requirements for BCIs and related products; in China, the regulatory framework for BCIs is also gradually being refined:

- **In 2024,** China's Ministry of Science and Technology issued the “Ethical Guidelines for Brain-Computer Interface Research”, focusing on the risks of invasiveness, informed consent, privacy, enhancement research, and vulnerable populations;
- **On March 13, 2026,** the National Medical Products Administration (NMPA) approved the registration of “Implantable Brain-Computer Interface System for Hand Movement Compensation”, with registration certificate No. 20263120537;
- **On June 29, 2026,** the NMPA announced that invasive/implantable BCIs are classified as Class III devices, with classification code 12-00.

Invasive BCIs still require specialized medical centers with capabilities in neurosurgery, medical device management, and long-term follow-up; meanwhile, applications targeting age-related declines in cognitive and motor function require further clinical evidence.

Source: Public information, literature review, TIMEPIE Research Institute analysis

3.4 Cutting-Edge Exploratory Technologies

From the perspective of longevity medicine, cryonics remains a highly experimental technology. It aims to preserve human tissue structure as much as possible through methods such as cryoprotection, perfusion, and cryogenic storage, in the hope that future medical advances may repair currently irreversible damage and enable revival.

3.4.3. Cryonics

The cryonics process at existing facilities typically includes on-call readiness, initial stabilization, transport, cryoprotective perfusion, programmed cooling, and long-term storage. Taking a publicly disclosed process as an example, after legal death is confirmed, staff rapidly lower the body temperature and support circulation. They then replace the blood with a cryoprotective solution and gradually cool the body to ultra-low temperatures by controlling the cooling rate, ultimately preserving it long-term in liquid nitrogen.

Fig.10 Standard Cryonics Procedures

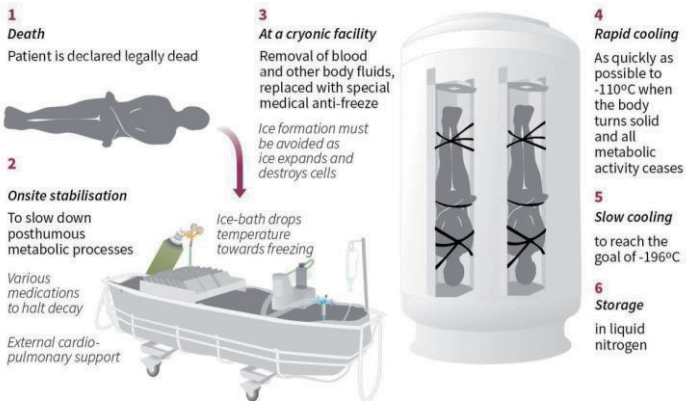
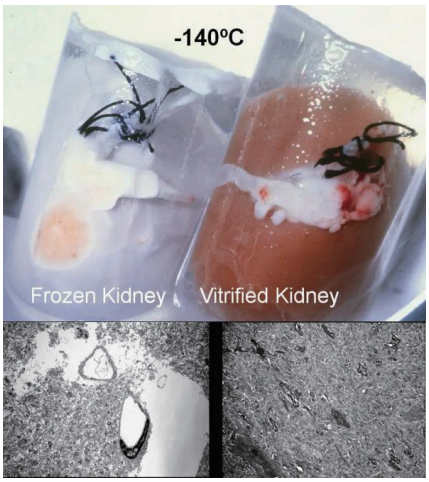


Figure source: Alcor Life Extension Foundation

Fig.11 Comparison of Low-Temperature Non-vitrified and Vitrified Structures



Lowering the temperature significantly slows biochemical reactions, while vitrification is used to minimize ice crystal formation during cooling and the resulting damage to cells and tissues. Vitrification achieves this by increasing the viscosity of the solution and controlling the cooling rate, allowing the sample to enter a glassy state without forming large amounts of ice crystals. This technique has already been applied in cryopreservation research involving red blood cells, ovaries, blood vessels, corneas, and certain other tissues and organs.

In addition to vitrification, techniques such as **controlled-rate freezing** have also been applied in cell and tissue preservation. By controlling the rate at which samples pass through temperature gradients, these methods reduce tissue damage during the freezing process. Related research has covered various tissues and organs, including the ovaries, liver, and heart. However, expanding from the preservation of cells and localized tissues to an entire human body requires addressing issues such as the toxicity of cryoprotectants, uneven perfusion, scale effects, and tissue damage caused during the cooling and thawing processes.

Source: Public information, literature review, company websites, TIMEPIE Research Institute analysis

3.4 Cutting-Edge Exploratory Technologies

Currently, cryopreservation is widely used for cells, blood, reproductive tissues, and certain organs and tissues; however, the functional revival of an intact human body following long-term cryopreservation has not yet been achieved.

3.4.3. Cryonics (2/2)

Since the 1970s, specialized service providers for human cryopreservation have gradually emerged, including Alcor and the Cryonics Institute in the United States, Tomorrow.bio in Europe, and the Shandong Yinfeng Life Science Research Institute in China.

In 2017, China completed its first whole-body cryopreservation procedure, marking the beginning of the practical application of this technology in the country. Existing institutions have primarily established service systems centered on post-mortem standby, transportation, perfusion, and long-term cryopreservation; however, to date, there have been no reported cases of a whole human body being successfully revived following long-term cryopreservation.

Table 21 Common Cryonics Companies and Their Basic Information

Company	Country	Founded	Patients	Cost	Key Features
Alcor	United States	1972	~248	$200,000	The oldest, largest, and most technologically advanced
Cryonics Institute	United States	1976	~250	$28,000	The lowest prices in the world; founded by the “Father of Cryonics” Robert Ettinger
KrioRus	Russia	2006	~108	~$36,000	Lower prices, facing a split
Tomorrow Bio	Germany/ Switzerland	2020	20 humans+ 10 pets	€200,000	Europe's first, venture-capital-backed, cryopreservation ambulance
Shandong Yinfeng Life Science Institute	China	2015	33	~¥300,000–500,000	The only provider in China and the first of its kind in Asia

Source: Public information, literature review, company websites, TIMEPIE Research Institute analysis

■ Summary

☐ The evaluation of anti-aging efficacy is shifting from “improvements in short-term indicators” to “actual health benefits”

In the past, many longevity interventions relied primarily on changes in mechanisms, biomarkers, or short-term physiological indicators as evidence of efficacy; however, these results can only demonstrate that the intervention produced some biological effect. With the increase in clinical studies involving human subjects, the focus of evaluation is shifting further toward endpoints that more closely reflect real health benefits, such as physical function, disease risk, functional disability, and quality of life. Building an evidence chain from mechanism to biomarkers, function, and long-term outcomes will be critical to distinguishing the maturity of different interventions.

☐ Currently applicable longevity interventions primarily build on “upgrades to long-term management tools” and “the expansion of established medical technologies”

Nutritional interventions are shifting from single-ingredient products toward multi-ingredient formulations, with a focus on human clinical evidence, precision nutrition plans, and long-term management. Behavioral interventions are evolving from general health advice into structured programs. Devices-based interventions are moving beyond hardware competition to parameter optimization, treatment design, and service development. Meanwhile, pharmaceuticals, hormones, cell therapy, and blood purification technologies —most of which rely on existing disease treatment and medical regulatory frameworks—are gradually being applied to longevity contexts. At this stage, the technological offerings in longevity medicine are primarily characterized by the recombination of existing tools, their earlier application and long-term deployment.

☐ Cutting-edge technology are entering human trials, but its primary application remains the treatment of diseases

Technologies such as gene therapy, partial cellular reprogramming, and brain-computer interfaces are gradually moving beyond the laboratory stage; however, current human clinical applications still primarily focus on specific diseases or functional impairments, such as glaucoma, optic neuropathy, paralysis, and stroke. Direct clinical evidence supporting the goals of “rejuvenation” and “life extension” in healthy individuals remains lacking. In the short term, these technologies are more likely to build safety and efficacy evidence through specific disease indications and functional recovery before expanding into broader longevity medicine applications.

Source: Public information, literature review, TIMEPIE Research Institute analysis

Chapter 4
Longevity Medicine — Market Demand and Industry Development Landscape



04

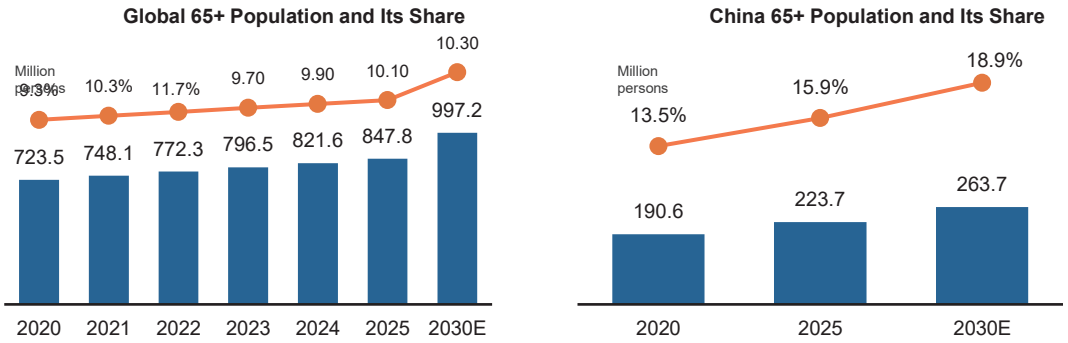
4.1 The Evolution of Core Anti-Aging Demands

As population aging and the chronic disease burden continue to deepen, anti-aging demand is shifting from pursuing a youthful appearance to extending healthspan and maintaining functional capacity and personal autonomy.

4.1.1. Compressing the Period of Living with Disease Has Become the Core Anti-Aging Demand

1 Longevity Becomes the Norm as Health Management Moves Upstream

Population aging continues to deepen globally and in China. From 2020 to 2025, the global population aged 65 and above grew from 723.5 million to 847.8 million, rising from 9.3% to 10.3% of the total population; over the same period, China's population aged 65 and above grew from 190.6 million to 223.7 million, with its share rising from 13.5% to 15.9%, above the global average. Meanwhile, according to the "Health Literacy of Chinese Citizens — Interpretation of Basic Knowledge and Skills (2024 Edition)" released by the National Health Commission in 2024, chronic diseases account for 88.5% of all deaths in China; the "Healthy China Action (2019–2030)" notes that major chronic diseases — cardiovascular and cerebrovascular diseases, cancer, chronic respiratory diseases and diabetes — account for more than 70% of the total disease burden, making them a major constraint on raising healthy life expectancy. The impact of chronic diseases thus lies not only in mortality risk but also in long-term illness and functional impairment, driving anti-aging demand from simply extending lifespan toward extending healthspan and compressing the period of living with disease.



2 Evaluation Criteria Shift: Youthful Appearance → Youthful Function

Traditional anti-aging mainly addresses visual age, whereas longevity medicine focuses more on healthspan and the long-term maintenance of bodily function. The World Health Organization (WHO) definition of healthy aging emphasizes that its core is developing and maintaining the "functional ability" that enables well-being in older age — an ability that includes not only meeting basic living needs, but also learning and making decisions, staying mobile, maintaining social relationships and participating in society. From this perspective, true anti-aging is not about making clients "look younger", but about helping them maintain mobility, judgment, self-care ability and their radius of life for longer. For high-net-worth individuals, a youthful appearance still has value, but youthful intrinsic function determines career continuity, family responsibilities, personal autonomy and quality of life in later years. Especially among entrepreneurs, executives and professionals, physical condition affects not only personal health but also long-term work efficiency, the stability of family roles and the ability to deploy wealth; "functional youthfulness" is therefore becoming a higher-level standard for evaluating anti-aging.



Business Logic Restructured: Procedure Consumption → Health Asset Management

As anti-aging goals shift from appearance improvement to healthspan extension, consumer demand is gradually extending from one-off procedures to long-term monitoring, risk assessment and continuous intervention. Compared with merely improving outward signs of aging, longevity medicine places greater emphasis on the continuous management of physical function and aging risks through testing, assessment, intervention and follow-up. As a result, the business model of anti-aging services is expected to gradually expand from single-procedure consumption to long-term health management covering "testing – assessment – intervention – follow-up".

Source: Public information, government official websites, literature review, Frost & Sullivan analysis

4.1 The Evolution of Core Anti-Aging Demands

The payers of longevity medicine are moving upstream from post-retirement populations seeking disease remediation to proactive health managers in their peak career and family-responsibility years, and further to younger customers focused on early prevention and daily anti-aging.

4.1.2. Shifting Payer Demographics: From Older Adults to the Affluent Core

The payer base of longevity medicine is undergoing a structural migration. Traditionally, anti-aging payers were concentrated among retired elderly populations, motivated mainly by remedial treatment after diagnosis. Today, the "affluent core" — people with health anxiety, wealth decision-making power, long-term payment capacity and risk-management awareness — is becoming the main source of incremental demand, and the payment logic has shifted upstream from "treating disease after it occurs" to "proactive management while function can still be maintained". This migration is not the exit of elderly customers, but a structural expansion of the payment base: the customer age range is moving younger, decision-making is shifting from passive to proactive, and the object of payment is shifting from single procedures to long-term health management.

The Elderly



- The elderly group mainly comprises retirees aged 65 and above, with some health decisions and payments made jointly with their children. Their anti-aging anxiety stems not from changes in appearance, but from the progression of chronic diseases, multimorbidity, declining mobility and cognition, and the disability, long-term care and family burden these may bring.
- For this group, the value of longevity is built on quality of life and autonomy: their core demands are stabilizing disease states, reducing complications, delaying functional decline, and extending as far as possible the time in which they can act independently, make their own decisions and participate in family life. Their decisions usually rely on physician advice, prior treatment experience and children's opinions; they place greater emphasis on safety, effectiveness and accessibility of services. Their payment behavior is mostly triggered by existing disease or functional problems, concentrating on disease management, nutritional support, functional rehabilitation and long-term care.

The Affluent Core



- The "affluent core" mainly comprises entrepreneurs, executives, professionals and household wealth decision-makers aged 35–60, who are at critical stages of career development, family responsibility and wealth management. Although obvious functional decline has not yet generally appeared, the reduced energy, sleep disorders, metabolic abnormalities and changes in cognitive efficiency brought by long-term high-pressure work make them more sensitive to sudden major illness and long-term health risks.
- For them, health problems affect not only personal quality of life but may also interrupt career continuity, family arrangements and wealth planning. Their core demand is therefore to identify risks early through systematic testing and to continuously maintain physical, cognitive, sleep and metabolic status, extending their cycle of high-quality work and life. Their decisions rely more on test data, medical evidence and endorsement by professional institutions, while they also value privacy protection, time efficiency, protocol interpretability and trackable outcomes. They readily accept comprehensive assessments, regular retesting, continuous intervention and membership-based services, making them the most certain core growth segment of longevity medicine.

Anti-Aging Newcomers



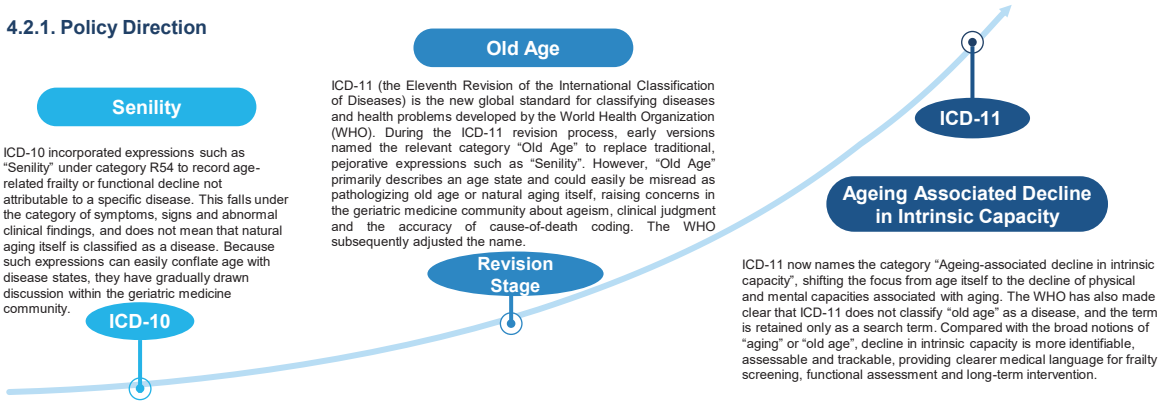
- "Anti-aging newcomers" are mainly high-income professionals aged 25–35, workers in emerging industries and young entrepreneurs. Although their overall disease burden is relatively low, high-intensity work, irregular routines and high-frequency exposure to health information make them attentive earlier to premature-aging signals such as skin laxity, hair loss, changes in body shape, insufficient sleep, persistent fatigue and declining attention, and their anxiety gradually extends to metabolic abnormalities, family medical history and future chronic disease risk.
- Their core demands combine appearance improvement, energy recovery, body-shape management and early prevention: building a personal health baseline through low-threshold testing and integrating anti-aging into daily lifestyles. Their decisions are more readily influenced by perceivable results, personalized experiences, technological attributes, brand identity and service convenience. At this stage they prefer lightweight testing, modular programs and staged plans, and remain relatively cautious about long-term, high-ticket services, but they hold long-term potential to progress from appearance-focused anti-aging to systematic health management.

Source: Public information, literature review, Frost & Sullivan analysis

4.2 Macro Industry Landscape

The WHO's classification adjustment for aging-related functional decline, together with the continued rollout of China's silver economy and proactive health policies, is jointly driving longevity medicine to expand from traditional elderly care toward risk identification, functional maintenance and proactive intervention.

4.2.1. Policy Direction



➢ **Global Proactive Health Concepts Resonate with China's Silver Economy Policies**

Global policy is forming two mutually reinforcing development threads. On one hand, the WHO, through ICD-11, has shifted the focus from age labels to aging-related decline in intrinsic capacity, bringing aging risk and functional status into a more standardized, quantifiable medical evaluation system. On the other hand, China and other major economies continue to strengthen healthy aging, disease prevention, early screening and advanced biotechnology deployment, extending health management from post-disease treatment toward pre-risk identification and intervention. For longevity medicine, this means policy support is gradually expanding from traditional elderly care and geriatric medicine to biomarker testing, functional assessment, digital monitoring and personalized intervention — although products such as drugs, medical devices and cell and gene therapies must still complete clinical validation and market access through their respective regulatory pathways.

Country	Document	Release Date	Policy Content	Policy Significance
China	Guiding Opinions of the General Office of the State Council on Developing the Silver Economy and Improving the Well-being of the Elderly	January 2024	Proposed 26 measures across four areas; explicitly called for developing the anti-aging industry, strengthening research on aging mechanisms and human aging models, promoting the application of gene technology, regenerative medicine, laser and radiofrequency technologies and molecular diagnostics, and developing early-screening products and services for geriatric diseases.	The first explicit inclusion of anti-aging in a national-level silver economy industry plan; policy support expanded from traditional elderly-care services to aging research, early screening, regenerative medicine and proactive health management, making it the most direct policy signal for China's longevity medicine industry
	"Healthy China 2030" Planning Outline	October 2016	Called for shifting from a "treatment-centered" approach to a "people's health-centered" approach, strengthening prevention-first principles, full life-cycle health management, chronic disease prevention and control, health technology innovation and health industry development.	Established the top-level logic of proactive health in China, moving medical services upstream from post-disease diagnosis and treatment toward risk identification, disease prevention and long-term health management, laying the demand and institutional foundation for longevity medicine.
United States	U.S. National Institute on Aging Strategic Directions for Research, 2020–2025	June 2020	Focused on the biology of aging, the common mechanisms linking aging and disease, and the maintenance of cognitive and physical function, promoting the translation of research findings into clinical interventions.	Laid a sustained research foundation for Geroscience, shifting the R&D logic from treating individual age-related diseases separately toward studying aging mechanisms to delay multiple age-related diseases and functional decline. The NIA's 2026–2030 strategy is still being updated as of this writing, so this document remains the most recent completed strategic plan.
European Union	Green Paper on Ageing	January 2021	Advanced health promotion, disease prevention, functional maintenance, independent living and active ageing across the full life cycle.	Moved aging upstream from a post-retirement care issue to long-term health and functional management beginning in young and middle adulthood.
United Kingdom	Fit for the Future: 10 Year Health Plan for England	July 2025	Drives the NHS toward three major shifts — "from hospital to community, from analogue to digital, and from sickness to prevention" — strengthening community care, digital tools, genomic medicine and predictive health management.	Moves public healthcare from reactive diagnosis and treatment toward prediction, prevention and personalized management, creating room for scaled application of continuous monitoring, early risk identification, precision prevention and home-based health management.
Japan	Health Japan 21 (Third Term)	Announced May 2023; implemented April 2024	With 2024–2035 as the implementation period, promotes healthspan extension, narrowing of health gaps, chronic disease prevention, lifestyle improvement, and coordinated governance of individual behavior and the social environment.	Strengthens continuous health monitoring and whole-population intervention, forming stable demand for health assessment, nutrition and exercise management, sleep management, digital health and corporate health management.
	Health Life Expectancy Extension Plan	May 2019	Proposed extending the national healthy life expectancy by more than three years by 2040, with a focus on healthy lifestyles, disease prevention, long-term care prevention, frailty intervention and dementia prevention.	Turned "extending healthy life expectancy" into an explicit national goal, moving services upstream from post-illness medical care toward frailty screening, exercise and nutrition intervention, and community health management.
South Korea	The 6th Comprehensive National Health Promotion Plan (HP2030, 2026–2030)	March 2026	Building on the fifth plan, further refines tasks in health promotion, disease prevention, healthy environment building and full life-cycle health management in response to population aging and the increase in chronic diseases.	Shows that South Korea's health policy is moving beyond general health promotion to address deep aging and the chronic disease burden, continuously reinforcing prevention, early management and a healthspan orientation.

Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.2 Macro Industry Landscape

China's longevity medicine regulatory system is taking shape at an accelerated pace: expert consensus continues to refine the evidence-based framework for aging interventions; group standards for longevity medicine services are driving industry standardization; and special medical pilot zones are accelerating the clinical translation and regulated application of frontier technologies.

4.2.2. The Evolution of Industry Standards

Current Status of Group Standard Development for Longevity Medicine in China

Expert Consensus as the Starting Point

The 2019 "Chinese Expert Consensus on Aging and Anti-Aging" systematically reviewed aging mechanisms, age-related diseases and potential intervention strategies, proposing that anti-aging is a proactive health strategy for delaying disease onset and functional decline and extending healthspan.

Intervention Management Further Standardized

The 2024 "Chinese Geriatric Clinical Expert Consensus on Pharmacological Intervention Research for Delaying Aging" further incorporated stem cell therapy into aging-delay strategies, while clearly noting that the field is still in its early research stage and urgently requires standardized management.

Breakthrough in Service Standards

In 2026, the "Standards for geriatric health service based on longevity medicine" (T/CAWAORG 058—2026) was officially released as China's first group standard for longevity medicine geriatric health services. It was developed by 26 experts in geriatric and general medicine together with 23 tertiary Grade-A hospitals and elderly-care institutions. The standard upgraded industry norms from "expert consensus" to a "group standard" for the first time, expanded the drafting body from a single society to collaborative participation by hospitals, elderly-care institutions and internet healthcare platforms, and focused on longevity medicine service processes in home-based elderly-care scenarios.

Current Shortcomings of Group Standard Development

Group standard development is still in its early stages, with three limitations:

- ✓ Standard supply is fragmented: existing norms are developed separately by industry associations or professional branches in geriatric medicine, anti-aging, aesthetic medicine and other fields, with no unified technical authority yet formed.
- ✓ Coverage is limited: existing standards focus on health management service processes, while unified operating norms are still lacking for core technical areas such as stem cell therapy and senolytic drugs.
- ✓ Group standards are voluntary in nature, with weak legal binding force, and remain some distance from national standards or mandatory norms.

Special Medical Pilot Zones as Pioneering Testing Grounds

2013

The State Council approved the establishment of the Hainan Boao Lecheng International Medical Tourism Pilot Zone, granting it nine supporting policies covering licensed medical care, licensed research, licensed operation and licensed international medical exchange, providing a pioneering platform for introducing internationally advanced medical resources into China.

2019

The National Development and Reform Commission, the National Health Commission, the National Administration of Traditional Chinese Medicine and the National Medical Products Administration jointly issued an implementation plan to vigorously develop high-quality medical tourism services, setting the staged goal of achieving "three synchronizations" — medical technology, equipment and drugs in sync with international advanced levels — by 2025.

2024

Hainan adopted the "Regulations of the Hainan Free Trade Port Boao Lecheng International Medical Tourism Pilot Zone on Promoting New Biomedical Technologies", establishing institutional arrangements for the clinical research, technology assessment, ethics review, translational application and risk management of new biomedical technologies, effective February 1, 2025, expanding the pilot zone from licensed access to innovative drugs and devices toward the translation of frontier medical technologies.

2026

The "Regulations on the Administration of Clinical Research and Clinical Translational Application of New Biomedical Technologies" officially took effect, establishing national-level systems for clinical research, technology assessment, ethics review, translational application and ongoing supervision. Over the same period, Lecheng's pioneering pilot results continued to emerge: as of June 2026, it had enabled the first domestic clinical application of more than 560 internationally innovative drugs and devices, and had cooperated with more than 180 pharmaceutical and device companies from over 20 countries.

Centered on the silver-haired population, the Lecheng Pilot Zone has formed an innovation mechanism resembling a "regional regulatory sandbox", supported by real-world data application and pioneering pilots of frontier technologies. While ensuring safety and control, it accelerates the clinical translation of innovative drugs, devices and new biomedical technologies, accumulating practical experience for improving relevant regulatory systems and for nationwide rollout.

Figure: Lecheng's Three Core Pilot Mechanisms

Core Mechanism	Details
Licensed Access	Allows eligible drugs and devices that are marketed overseas but not yet approved domestically and are urgently needed clinically to be used in designated medical institutions, enabling early identification of functional decline signals
Real-World Research	Explores converting usage data of licensed drugs and devices into real-world evidence to support domestic registration review
Clinical Translation of New Technologies	Promotes clinical research and translational application of new biomedical technologies under technology assessment, ethics review and risk management

Source: Public information, government official websites, literature review, Frost & Sullivan analysis

4.2 Macro Industry Landscape

Global aging-population expansion and upgrading health-management demand are driving the longevity industry to extend from traditional elderly care and disease treatment toward diversified scenarios such as early screening, risk management, functional maintenance and precision intervention.

4.2.3. Demand Foundation and Development Space of the Global and Chinese Longevity Industries

Demand Foundation of the Global Longevity Industry

- **Longevity Services Market: The Global Elderly Population Forms a Stable Demand Base**

The global population aged 60 and above is expected to grow from 1 billion in 2020 to 1.4 billion in 2030 and 2.1 billion in 2050; by 2030, one in six people worldwide will be aged 60 or older. The continuously expanding elderly population will drive growth in demand for longevity services such as health assessment, chronic disease management, rehabilitation support, functional maintenance and long-term follow-up.

- **Healthspan Management Market: A Gap Remains Between Added Years and Added Health**

The WHO notes that global lifespan extension has not brought a proportional increase in healthy life stages; added years may be accompanied by chronic disease, multimorbidity or declining physical function. The value focus of longevity services is therefore shifting from simply extending survival time toward reducing the risk of age-related diseases, delaying functional decline and extending healthspan.

- **Regional Increment of the Longevity Market: Extending from Single-Disease Treatment Toward Common Aging Mechanisms**

The Geroscience research framework proposed by the U.S. National Institutes of Health regards aging as an important common driver of multiple chronic diseases and functional disorders, exploring how intervening in aging-related molecular and cellular mechanisms can delay multiple diseases and functional decline. This paradigm is driving longevity medicine to deepen from general health management toward biomarkers, aging mechanisms and coordinated multi-disease intervention.

Development Space of China's Longevity Industry

- **Core Customer Base of Longevity Services: Over 300 Million Elderly People Form Scaled Demand**

At the end of 2025, China's population aged 60 and above reached 323 million, accounting for 23.0% of the total population; of these, 224 million were aged 65 and above, accounting for 15.9%. The enormous elderly population will continuously release demand for health checkups, early screening of geriatric diseases, chronic disease control, musculoskeletal and cognitive function maintenance, and rehabilitation management, driving services from one-off diagnosis and treatment toward long-term health management.

- **Upper-Level Space of the Longevity Industry: Silver Economy Expansion Provides the Market Foundation**

Public information from the National Development and Reform Commission shows that China's silver economy is about RMB 7 trillion in scale, accounting for about 6% of GDP; it is expected to reach about RMB 30 trillion by 2035, about 10% of GDP. The silver economy covers a broader scope than longevity medicine, but its expansion will provide greater payment and application space for anti-aging, medical health, rehabilitation management, intelligent monitoring and wellness services.

- **Longevity Medicine Technology Supply: Extending from Health Management Toward Risk Stratification and Precision Intervention**

National policy has incorporated aging mechanisms, human aging models, gene technology, regenerative medicine, genetic testing, molecular diagnostics and early screening of geriatric diseases into supported directions. China's longevity medicine technology supply is extending from traditional checkups and general health management toward aging-related risk identification, early screening, individualized intervention and long-term outcome tracking.

- **Longevity Service Models: Shifting from Single Products to Continuous Assessment and Dynamic Intervention**

Around healthspan improvement, four main commercialization scenarios are expected to take shape for longevity services in China:

Testing & Risk Stratification	Early Screening & Precision Prevention	Intervention & Functional Maintenance	Follow-Up & Outcome Validation
Comprehensive checkups, biomarker testing, aging risk and functional status assessment	Molecular diagnostics, early screening of geriatric diseases, and metabolic and cardiovascular-cerebrovascular risk management	Nutrition and exercise, musculoskeletal, cognitive, sleep and multimorbidity management	Digital monitoring, individualized follow-up, intervention outcome evaluation and dynamic protocol adjustment

Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.2 Macro Industry Landscape

The global longevity industry has formed a differentiated ecosystem: the United States drives frontier technology with capital, China is accelerating industry–academia–research–clinical collaboration, Europe is strengthening basic research, and Singapore is focusing on building clinical translation and professional service platforms.

4.2.4. Comparison of Global Longevity Industry Landscapes



China: Industry–Academia–Research–Clinical Collaboration Accelerating

✓ **National-level aging research layout gradually improving**

In 2026, the Institute of Aging and Health of the Chinese Academy of Medical Sciences and the School of Aging and Health of Peking Union Medical College were officially established, systematically deploying aging mechanism research, clinical translation and professional talent cultivation, and advancing China's aging research from scattered exploration toward systematic development.

✓ **Hospital resources and industrial technology connecting faster**

In 2025, Fudan University established the Longevity and Aging Research Institute under Zhongshan Hospital; in 2026 it further established a university–enterprise joint research center for longevity medicine, focusing on multi-omics aging risk assessment, targeted health intervention and digital-twin full-cycle health management, building a translational system connecting basic research, technology development and clinical application.



United States: High Concentration of Capital and Frontier Aging-Intervention Technologies

✓ **Large-scale long-term capital supporting foundational technology breakthroughs**

Altos Labs launched in 2022 with US$3 billion in committed capital, focusing on cellular rejuvenation, cellular resilience and intervention in age-related diseases. By bringing together top scientists and building large-scale research platforms, it has become representative of the high-capital-investment longevity biotech ecosystem in the United States.

✓ **Cellular reprogramming gradually moving from the laboratory to human studies**

NewLimit develops drugs that restore the function of aged cells through epigenetic reprogramming, completing a US$130 million Series B round followed by a US$45 million extension in 2025. In 2026, Life Biosciences' ER-100 was cleared to enter human studies, becoming the first epigenetic-reprogramming cellular rejuvenation therapy to enter human trials.



Europe: Strong Basic Research Clusters and Cross-Border Collaboration

✓ **High concentration of specialized aging research institutions**

Germany's Max Planck Institute for Biology of Ageing conducts basic research on the molecular, physiological and evolutionary mechanisms of aging, while the UK's Babraham Institute focuses on how epigenetics, cell signaling and the immune system change with age, together forming important pillars of European basic aging research.

✓ **Global companies incorporating Europe into their core R&D footprint**

In addition to its bases in the San Francisco Bay Area and San Diego, Altos Labs has built a research center in Cambridge, UK, and collaborates with Japanese research institutions, forming a cellular rejuvenation research network spanning the United States, Europe and Asia — demonstrating the appeal of Europe's scientific talent and academic clusters to global longevity companies.



Singapore: Integrating Basic Research with the Public Healthcare System

✓ **National-level platform focusing on translational research in healthy longevity**

In 2021, the National University of Singapore launched the Healthy Longevity Translational Research Programme, led by Professor Brian Kennedy, conducting research on the biology of aging, brain aging, vascular aging and multi-omics aging biomarkers, advancing aging interventions from experimental research toward human validation.

✓ **Public hospitals serving the human-intervention validation function**

The programme's clinical translation platform is located at Alexandra Hospital, conducting biomarker and nutrition, drug and exercise intervention studies in healthy populations, and exploring individualized prevention protocols through the Healthy Longevity Research Clinic — forming a translational chain of “basic research – human studies – clinical services”.

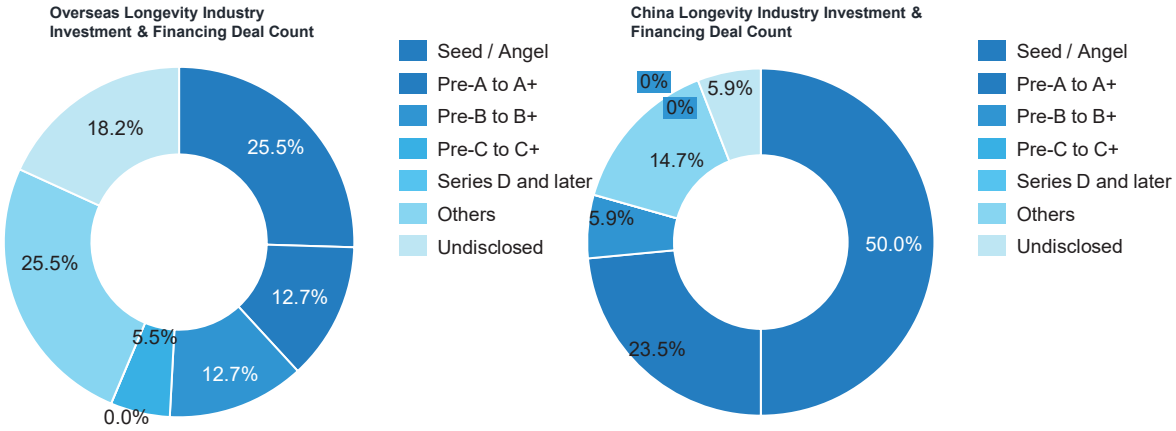
Source: Public information, government official websites, literature review, Frost & Sullivan analysis

4.3 Panorama of Investment and Financing in the Longevity Industry

Publicly disclosed deals show that the funding-stage distribution of the overseas longevity industry is relatively balanced, while the Chinese market is dominated by seed, angel and Pre-A rounds, reflecting that domestic projects are still in the early stages of incubation and business-model exploration.

4.3.1. Comparison of Overseas and Domestic Capital Investment Trends

1 Comparison of Investment & Financing Deal Counts: Overseas vs. China[1]



In terms of total deal volume, China's longevity industry recorded 25 investment and financing events, while overseas markets recorded 31 in total. As a single national market, China's deal count is already close to the overseas total, showing high capital activity and market concentration. By funding stage, Chinese investment is clearly concentrated in early rounds, while overseas markets show a relatively balanced stage distribution. This indicates that China's longevity industry is still in a phase of concentrated emergence of innovative projects and accelerating early-stage capital entry, whereas overseas markets have formed an investment structure with financing across multiple stages.

2 Overseas Investment Places Greater Emphasis on Technology Platforms

Platform value first

- Capital focuses more on whether a technology can continuously generate candidate products than on the returns of a single project.
- For example, a cellular reprogramming platform can simultaneously address multiple age-related diseases across immunity, metabolism and neurology, increasing technology reuse value and long-term valuation potential.

High tolerance for long R&D cycles

- Overseas funds generally accept longer R&D cycles and diversify failure risk through multi-pipeline portfolios.
- A small number of successful projects can cover overall portfolio returns, so they are more willing to support original technologies at early stages.

Early participation by pharmaceutical companies

- Major pharmaceutical companies such as Eli Lilly and Novo Nordisk have begun participating in longevity technology investment, hoping to secure innovative technology partnership opportunities early.
- This continuously drives the conversion of research results into new drug development and further raises industry attention.

3 The Chinese Market Emphasizes Industrial Implementation More

Demand-driven investment

- Domestic investment focuses on areas with existing market demand, such as health testing, regenerative medicine, medical aesthetics upgrades, smart elderly care and chronic disease management.
- Greater emphasis is placed on solving real medical and health-management problems rather than directly pursuing lifespan extension as a commercial goal.

Strong resource synergy

- Capital typically participates in project building together with hospitals, local industrial funds, pharmaceutical companies and medical groups.
- Financing often comes bundled with clinical resources, industrial park support, production capacity and channel partnerships, improving project conversion efficiency.

Commercial delivery becomes the focus

- As the industry matures, capital increasingly focuses on product registration progress, human study data and sustainable operating models.
- Conceptual innovation alone can no longer support high valuations; projects with genuine clinical evidence and viable business models are more likely to secure continued financing.

Note 1: Data sourced from the VCBeat Research official website; searched its investment & financing database using the keywords “longevity”, “anti-aging” and “aging”

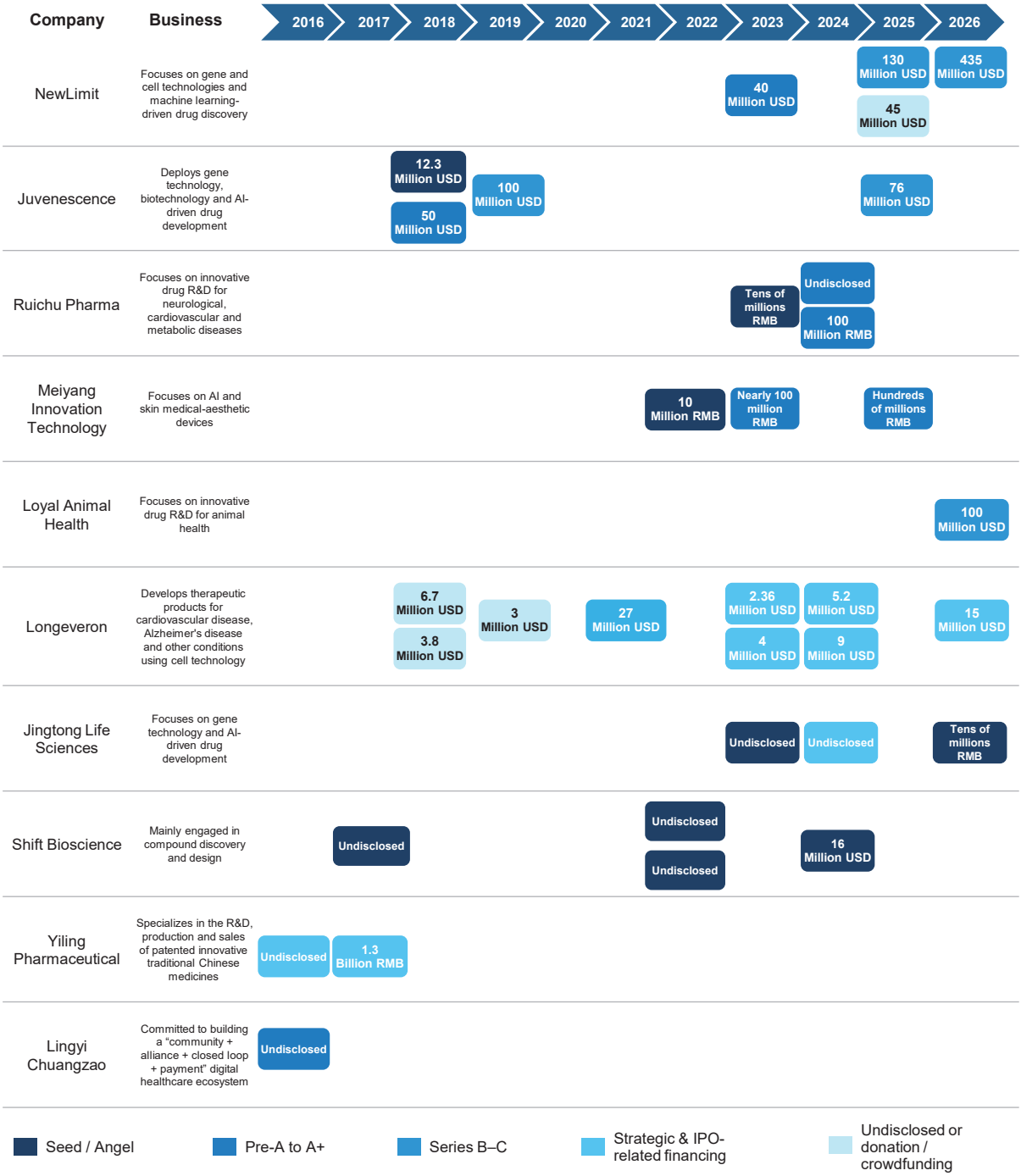
Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.3 Panorama of Investment and Financing in the Longevity Industry

Overseas capital is more willing to bear long-term R&D risk around aging mechanisms and platform technologies, while Chinese capital focuses more on clinical translation, consumer demand and industrial synergy. As human studies continue to increase, both markets are beginning to shift from concept investing to evidence investing.

4.3.2. Primary Market Investment and Financing

Figure: Selected Primary-Market Investment and Financing Events in the Global Longevity Industry, 2016–2026



Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.4 Breakdown of the Longevity Medicine Value Chain

The longevity medicine value chain comprises upstream raw material suppliers, midstream data evaluation platforms/institutions and downstream service providers. Precision medical service models such as longevity clinics are receiving increasing attention and recognition.

4.4.1. The Longevity Medicine Value Chain

For longevity medicine, the complete industry chain consists of three closely linked core segments — upstream raw material suppliers, midstream data evaluation platforms/institutions, and downstream service providers — ultimately delivering complete services to end consumers.

1 Raw Material Suppliers & Longevity Testing

The upstream segment of the value chain includes suppliers that develop and produce core anti-aging raw materials, such as GeneHarbor, Niagen Bioscience and Kingdomway, which produce NAD+ precursors such as NMN; Bontac Bio-Engineering, which focuses on the extraction/synthesis of ginsenoside Rg3/Rh2 monomers; Pendulum, Moon Biotech and Novonesis, which provide probiotics; and Yiling Pharmaceutical, which engages in innovative traditional Chinese medicine R&D. Upstream raw material suppliers reduce the production cost of anti-aging ingredients through scaled production, providing a price advantage for the market rollout of longevity medicine products.

In addition, aging-testing technologies such as telomere testing and DNA methylation clocks are gradually being integrated into the upstream longevity medicine industry, working with raw material R&D teams to optimize ingredient synthesis pathways and improve screening efficiency. Longevity testing technology has become an important part of the upstream value chain of longevity medicine.

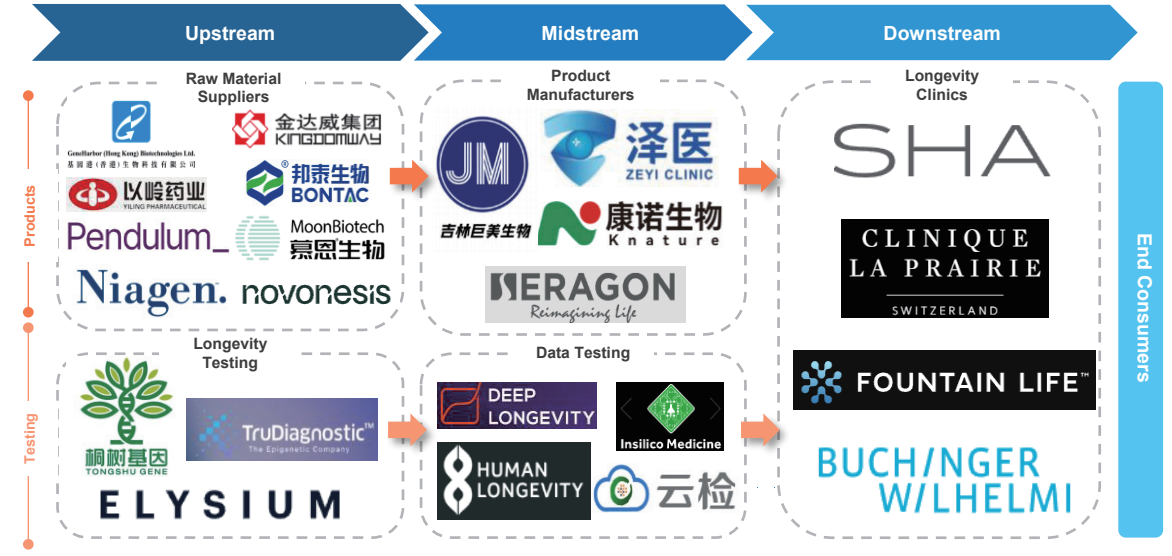
2 Product Manufacturers & Data Evaluation

The midstream segment includes major product manufacturers, which process anti-aging raw materials supplied upstream into anti-aging products with high bioavailability for use by downstream service institutions such as longevity clinics, forming a complete value chain on the product supply side.
In addition, various data evaluation platforms/institutions integrate biological data at the epigenetic and clinical levels, build quantitative aging assessment models using AI and other technical means, and provide personalized anti-aging medical services to downstream service institutions such as longevity clinics — completing full business support from upstream R&D/testing data to downstream clinical decisions and product services. Data evaluation platforms/institutions play a pivotal role connecting upstream and downstream in the midstream segment.

3 Longevity Clinics

Against the backdrop of a growing global longevity economy, downstream service providers such as medical institutions are gradually transforming from passive medical service providers toward proactive health and early disease management, aging intervention and early prevention. The integration of traditional medical aesthetics, health checkup and elderly-care industries has given rise to the innovative format of the “longevity clinic”. Top international longevity clinics represented by Clinique La Prairie in Switzerland and Fountain Life in the United States have set industry benchmarks through multi-dimensional quantitative assessment, full-cycle frontier interventions, and evidence-based, long-term operations. Meanwhile, China's public hospital system is building a model with Chinese characteristics for longevity medicine through anti-aging outpatient clinics and multidisciplinary team (MDT) consultations.

Figure: The Longevity Medicine Value Chain



Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.4 Breakdown of the Longevity Medicine Value Chain

Upstream raw material suppliers develop and produce ingredients through two technical routes — natural extraction and biomanufacturing; in addition, aging-testing technology provides a scientific yardstick for precision intervention.

4.4.2. Upstream of the Longevity Medicine Value Chain

Among upstream raw material suppliers in the longevity medicine value chain, two technical routes have taken shape: “natural extraction” and “biomanufacturing”. The natural extraction route is based on traditional plant deep-processing and modern separation technologies, retaining to a certain extent the complex natural biomacromolecules and composite activity of raw materials, and demonstrating multi-target synergy and systemic conditioning advantages in the development of ingredients such as ginsenosides, longevity strains and innovative traditional Chinese medicines. The biomanufacturing route adopts frontier technologies such as synthetic biology, enzymatic catalysis and metabolic engineering, excelling in directionally improving the purity of target molecules, breaking through raw material supply capacity bottlenecks and enabling green, environmentally friendly production — effectively achieving efficient, scaled mass production of core anti-aging substances such as NMN/NAD+ precursors and metformin. At present, both routes are well practiced in the raw material production industry and together constitute the ingredient foundation for current anti-aging product R&D.

Figure: Representative Ingredients of the Longevity Medicine Industry

Representative Ingredient	Mechanism of Action	Research Evidence
NAD+ Precursors (NMN, NA, etc.)	NAD+ is a core molecule that acts as a coenzyme in cellular redox reactions, and is also involved in mitochondrial energy metabolism and the maintenance of genomic stability. Studies show that the age-related decline in NAD+ levels is associated with downregulated mitochondrial energy production, oxidative stress, DNA damage, cognitive impairment and inflammatory diseases. NAD+ precursors slow these physiological and pathological processes by raising NAD+ levels in the body.	NMN treatment trials in wild-type mice showed that NMN significantly suppressed age-related weight gain in mice. Compared with the control group, the average body-weight reduction percentages in mice treated with 100 mg/kg/day and 300 mg/kg/day NMN were ***4%*** and ***9%*** respectively, with better insulin sensitivity.
Ginsenoside Rg3	Rg3 is a saponin compound extracted from ginseng, with anti-inflammatory, antioxidant and neuroprotective potential. Studies show that Rg3 can reduce the transcription of aging-related cellular genes by inhibiting the nuclear translocation of the transcription factor NF-κB. In addition, Rg3 can activate estrogen receptor-dependent PI3K signaling and AMPK pathways, promoting nitric oxide production and thereby regulating vascular tone, transmitting neural signals and enhancing immune function.	Cell culture experiments show that culturing with ginsenoside Rg3 improves the reduced cell proliferation rate caused by oxidative stress, with the proliferation rate of the Rg3 group recovering to ***27%***. The results indicate that Rg3 can prevent astrocyte senescence and reduce the inhibitory effect of senescent astrocytes on the growth of normal cells.
Probiotics	Probiotics are live microorganisms that confer health benefits on the host when consumed in adequate amounts. Common probiotics include Lactobacillus, Bifidobacterium longum and others. Some studies suggest that the gut microbiota is associated with aging and is a major determinant of late-life health. Improving the gut microbial environment through probiotics can effectively extend healthspan.	An animal study showed that the expression of cellular senescence markers and inflammatory factors p16Ink4a, p21Cip1 and IL-6 was negatively correlated with the abundance of Dorea genus microbes (next-generation probiotic candidates) in the ileum.
Chinese Herbal Medicines / TCM Preparations	Bioactive compounds in many natural plants have been found to have anti-aging properties, such as resveratrol and quercetin. In addition, the traditional decoction Sijunzi Tang can attenuate aging in the spleen and brain of mice through the mTOR pathway.	In a study on senescent cells, mice treated intermittently with oral dasatinib plus quercetin showed a ***36%*** higher survival rate and a mortality risk reduced to ***65%***, extending both healthspan and overall lifespan.

In addition, aging-testing technologies are gradually being integrated into the raw material R&D process of longevity medicine. By analyzing biomarkers such as specific epigenetic loci, aging-testing technologies can calculate the human body's “biological age”, providing a quantifiable scientific yardstick for validating ingredient efficacy and mechanisms of action.

- **Multimodal aging clocks:** integrate multi-omics data such as DNA methylation, RNA transcription, proteins and metabolites through deep learning to build a “digital aging twin” that predicts an individual's biological age and tracks the differential aging rates of different organs.
- **Organ-specific proteomic clocks:** by analyzing thousands of proteins in plasma, build aging clocks for ten organs including the brain, liver and vasculature, outperforming clinical and genetic risk factors in predicting disease onset, progression and mortality risk in advance.

Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.4 Breakdown of the Longevity Medicine Value Chain

Midstream data evaluation platforms and institutions in the longevity medicine industry effectively build an AI-driven closed-loop management system by connecting upstream raw material production and manufacturing with downstream service providers.

4.4.3. Midstream of the Longevity Medicine Value Chain

1. Product Manufacturers

The product conversion and manufacturing system sits at the core hub of the midstream segment, responsible for converting bioactive molecules of potential value from upstream basic research into end products that meet national regulatory requirements, have uniform and stable quality, and can be produced at scale.

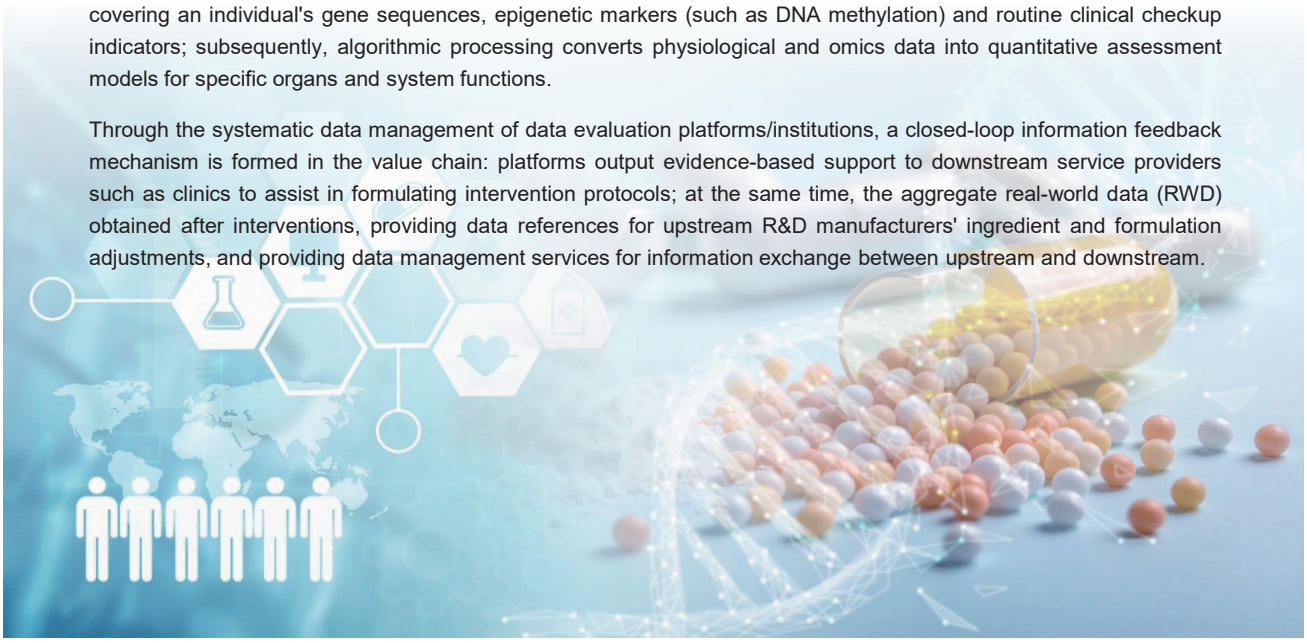
Figure: Core Functions of Product Manufacturers

R&D & Formulation	• **Synergy validation:** combinations of multiple active ingredients are not simple additions; in vitro/in vivo models are needed to verify whether synergistic, antagonistic or competitive relationships exist among them. • **Stability and compatibility**: interactions between different molecules may cause degradation; the design of the formulation system (e.g., oil-based/water-based, microencapsulation, liposomal encapsulation) directly affects potency retention over the product's shelf life. • **Dosage form innovation:** evolving from traditional tablets/capsules toward more efficient forms — sublingual administration can bypass hepatic first-pass effects, transdermal patches enable sustained-release delivery, and nano-formulations aim to improve the absorption of poorly soluble ingredients.
Production & Manufacturing	• **Own-brand manufacturers:** companies own their own brands and build their own production bases, integrating "R&D–production–sales" and controlling the entire value chain. • **Professional contract service providers (OEM/ODM):** own end brands or operate brand businesses independently, with the core business of providing R&D, formulation and production outsourcing services to other brand owners. • **Hybrid manufacturers:** both sell under their own brands and use spare capacity to undertake OEM/ODM orders.

2. Testing Data Analysis

On the testing side of the midstream segment, data evaluation platforms/institutions rely on AI algorithms and other systematic management technologies to achieve the conversion from data integration to quantitative assessment. First, at the data input end, data evaluation platforms/institutions systematically integrate a series of multimodal data covering an individual's gene sequences, epigenetic markers (such as DNA methylation) and routine clinical checkup indicators; subsequently, algorithmic processing converts physiological and omics data into quantitative assessment models for specific organs and system functions.

Through the systematic data management of data evaluation platforms/institutions, a closed-loop information feedback mechanism is formed in the value chain: platforms output evidence-based support to downstream service providers such as clinics to assist in formulating intervention protocols; at the same time, the aggregate real-world data (RWD) obtained after interventions, providing data references for upstream R&D manufacturers' ingredient and formulation adjustments, and providing data management services for information exchange between upstream and downstream.



Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.4 Breakdown of the Longevity Medicine Value Chain

At the downstream end of longevity medicine, the integration of traditional medical aesthetics, health checkup and elderly-care industries has formed the innovative format of the "longevity clinic". Diversified global longevity medical service complexes and the Chinese-characteristic public hospital model are bringing frontier anti-aging intervention services to a broader sub-healthy population.

4.4.4. Downstream of the Longevity Medicine Value Chain

At the downstream delivery end of the longevity medicine value chain, traditional healthcare, medical aesthetics, real estate and insurance sectors are accelerating cross-sector integration, forming the highly promising innovative format of the "longevity clinic". Globally, high-end medical institutions with deep professional backgrounds are transforming toward prevention and anti-aging on the strength of comprehensive checkup and disease assessment systems; meanwhile, medical aesthetics institutions, real estate groups and insurance companies are also building comprehensive longevity health spaces through customer sharing and business extension, achieving business transformation.

1 Professional Transformation of Medical Institutions

Among the world's top-ranked precision medicine clinics, a large number of institutions with long-standing professional medical backgrounds are gradually transforming toward longevity, anti-aging and disease prevention. This professional transformation is built on technical barriers and comprehensive assessment systems.

Multi-omics Data Processing Technology

Top international medical institutions are gradually building **massive individual-level biomedical databases** and fully introducing **multi-omics technologies** (genomics, epigenomics, metabolomics, etc.). By combining bioinformatics with deep neural networks (AI big-data processing technology), institutions can achieve **individualized prediction of organ-level aging**.

Cutting-Edge Medical Equipment

The transformation of professional medical institutions relies heavily on top-tier hardware. PET-CT scanners, dual-energy X-ray absorptiometry (DXA) systems, the da Vinci surgical robot and CyberKnife — the combination of such **high-end equipment** with AI big data enables clinics to perform whole-body tomographic imaging and **continuous non-invasive biomarker monitoring**.

Clinical-Grade Intervention Management

In the intervention and treatment stage, the services of professional institutions cover **targeted interventions** against hallmarks of aging such as mitochondrial dysfunction, cellular senescence and stem cell exhaustion, with specific programs including microecological engineering, personalized cell therapy, gene therapy and hormone therapy.

2 Medical Aesthetics, Real Estate, and Financial & Insurance Industries Entering the Longevity Healthcare Track

The global longevity market has attracted a large influx of non-traditional healthcare companies. Medical aesthetics institutions, real estate groups and financial & insurance giants are building a vast longevity health ecosystem through resource sharing and business extension.

- **Medical aesthetics institutions moving toward "cellular-level anti-aging":** traditional medical aesthetics institutions are undergoing a transformation toward endogenous anti-aging. In their business layout, cross-over medical aesthetics institutions have introduced longevity medicine service programs, such as stem cell facial rejuvenation services, microecological skincare interventions, and longevity technology-enabled drugs and minimally invasive procedures.
- **Real estate groups building comprehensive longevity and anti-aging spaces:** real estate groups are crossing over to build comprehensive longevity and anti-aging centers incorporating "frontier clinics" and "frontier health" facilities. These spaces integrate high-end residence, non-invasive biomarker monitoring, rehabilitation and medical intervention, completing the transformation from traditional real estate to full life-cycle health operation service providers.
- **Longevity asset management in the financial and insurance industries:** insurance and reinsurance institutions are undergoing a crossover from passive claims settlement to proactive health management. By cooperating with top longevity clinics, insurance institutions treat longevity derivative products as a new form of insurance and incorporate clients' healthspan into the scope of asset management. By funding frontier preventive medicine and early screening, insurance companies can effectively hedge pension payout risks and open up new business segments in the dual management of wealth and health for high-net-worth individuals.

China's current downstream longevity healthcare market features a public hospital-led model with Chinese characteristics. Public medical institutions represented by the Chinese PLA General Hospital (301 Hospital), drawing on their strong research capabilities in aging mechanisms and translational medicine, were among the first to open specialized anti-aging outpatient clinics, exploring the preliminary clinical application of advanced aging-intervention research results in a compliant and rigorous manner. Tertiary Grade-A hospitals represented by Xiangya Hospital and Zhongshan Hospital, relying on their existing geriatrics departments, have formed MDT (multidisciplinary team) longevity clinics with Chinese characteristics by bringing together nutrition, endocrinology, cardiology, rehabilitation and other departments, extending the served population from elderly patients to sub-healthy young and middle-aged people. However, current outpatient coverage remains limited, leaving broad room for future demand expansion.

Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.4 Breakdown of the Longevity Medicine Value Chain

The talent shortage in longevity medicine is essentially a structural imbalance — there is both a lack of anti-aging physicians who can translate basic research into clinical practice and a shortage of health management professionals who can deliver systematic intervention protocols.

4.4.5. Analysis of Talent Supply in the Longevity Medicine Industry

The shortage of supporting talent for longevity medicine is not simply a matter of “insufficient numbers”, but a deep structural shortage triggered by industrial transformation. This shortage is concentrated in two core dimensions: first, professional anti-aging physicians with clinical translation capabilities; second, health management professionals who can provide systematic intervention protocols.



Professional Anti-Aging Physicians: A Specialty Not Yet Formally Recognized

The shortage of supporting talent for longevity medicine is rooted, first of all, in a fundamental absence of disciplinary identity.

Although longevity medicine based on aging science is advancing rapidly at the basic research level, it has not yet been formally recognized as an independent medical specialty, and with that comes a complete absence of standardized curricula, assessment systems and practice certification. This institutional gap directly results in most clinicians' knowledge structures and thinking habits remaining anchored in the “disease treatment” paradigm, making it difficult to complete the cognitive leap toward “aging intervention” and “proactive healthspan management”.

The deeper bottleneck is that the industry urgently needs a type of interdisciplinary talent who can span the laboratory and the clinic — so-called “physician-scientists”. They must not only be proficient in clinical diagnosis and treatment, but also be able to translate frontier findings in aging biology — such as telomere dynamics, epigenetic modifications and chronic inflammation markers — into operable, verifiable daily intervention protocols. However, this kind of bridge talent connecting basic science and clinical practice can hardly be cultivated within the current medical education system. Precisely because of the urgency of this crisis, attempts to break the impasse have begun both domestically and internationally.

Internationally, the first doctoral program dedicated to longevity science was officially launched in 2026	Domestically, the industry is forming a landscape of exploration on multiple fronts
The Geneva College of Longevity Science (GCLS), a higher education institution dedicated to longevity science, jointly launched the “Doctor of Medicine — Longevity Science” program with Ovidius University of Romania in 2026 — the world's first doctoral program fully dedicated to longevity science. The program aims to cultivate “bridge talent” capable of translating frontier aging biology research into clinical diagnosis and treatment protocols, breaking the previous institutional vacuum in longevity medicine education and marking a turning point for talent cultivation toward “standardized institutionalization”. It also provides a paradigmatic reference for countries to establish localized certification systems.	Since the first cohort of the Xiangya Longevity Health Management Advanced Program at Central South University commenced in April 2026, two sessions had been successfully held as of June of the same year, with a fourth session already approved and planned, forming a mechanism for continuously producing talent. The curriculum takes “scientific anti-aging” as its main thread, systematically teaching frontier knowledge such as the fourteen hallmarks of aging, lifestyle medicine and regenerative medicine, and introducing AI tools into the entire assessment and intervention process, driving participants from “experience-driven” toward “data-driven” practice. In addition, the School of Health at Tianhua College of Shanghai Normal University and the “Future Medicine Center” at Shenzhen University of Advanced Technology have also made longevity and health a key focus.



Health Management Talent: A Dual Test of Quantity and Quality

The shortage of health management talent is essentially a systemic imbalance between rapidly growing industrial demand and a relatively lagging talent supply system, while there is a clear structural mismatch between the comprehensive capabilities of talent trained under traditional education models and the real needs of longevity medicine.

Figure: The Multi-Competency Profile of Health Management Talent



Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.5 Current Status and Future Trends of the Longevity Medicine Industry

In 2026, global longevity-related markets have formed a multi-tiered market landscape ranging from tens of billions to hundreds of billions of US dollars, with technological breakthroughs, population aging and capital investment jointly driving accelerated industry development.

4.5.1. Current Status of the Longevity Medicine Industry

Continuous Technological Breakthroughs

Longevity medicine has moved from “drug-centered interventions” to “multi-dimensional co-management”. Current global research revolves around the 14 core biological hallmarks of aging and has formed three clear technological pathways: lifestyle interventions (nutritional and behavioral reshaping), regenerative medicine (cell therapy, exosomes and organoid technologies), and pharmacological interventions (rapamycin, GLP-1, D+Q and partial reprogramming).

Figure: Main Intervention Pathways of Longevity Medicine

Based on nutrition, exercise, sleep and stress management, these approaches reduce the risk of age-related diseases and functional decline by improving metabolic homeostasis, cardiopulmonary fitness, muscle function, gut microecology and chronic inflammation. Caloric restriction, intermittent fasting, the Mediterranean diet, regular exercise and sleep optimization are currently the longevity interventions with relatively strong evidence and broad applicability.

mTOR inhibitors such as rapamycin have shown potential to extend lifespan and improve healthspan in multiple animal models; GLP-1 receptor agonists and SGLT2 inhibitors have shown metabolic, cardiovascular and renal protective effects in specific populations, and their impact on age-related disease risk and healthspan is drawing attention. NAD+ precursors can raise NAD+ levels in the body, but long-term clinical benefits remain to be further validated.



Technologies such as cell therapy, gene and epigenetic regulation, partial cellular reprogramming and tissue engineering are exploring ways to repair damaged tissues, restore cell function and reshape cellular states. Life Biosciences' ER-100 has entered Phase I clinical trials; NewLimit, Altos Labs and others are advancing cellular rejuvenation research in different tissues, but most directions remain in preclinical or early clinical stages.

Senolytics promote the selective clearance of senescent cells by intervening in their survival pathways. The dasatinib-plus-quercetin (D+Q) combination is a closely watched candidate that has undergone early human studies in certain age-related diseases, but its effects on delaying human aging and improving long-term clinical outcomes remain to be validated.

Expanding Market Demand

Three factors — demographic structure, consumer demand stratification and regional market landscape — overlap to jointly drive the continuous expansion of longevity medicine market demand.

Population Aging

In 2025, the global population aged 65 and above approached 850 million, and China's population aged 65 and above exceeded 220 million.
Medical resource consumption by the elderly is non-uniformly distributed, with per-capita medical spending typically several times that of other groups. By delaying the onset of age-related diseases, longevity medicine compresses the disease period of individual lives, thereby reducing average social medical costs. This logic constitutes the demand foundation for longevity medicine's transformation toward “medical-grade intervention”.

Consumer Demand Side

The demand side of the current longevity medicine market shows multi-layered differentiation. Large-scale commercialization of longevity medicine currently still relies on “scalably deliverable” categories such as technology hardware and remote services, rather than one-on-one consultations that depend heavily on expert resources.
The boundaries between layers are not fixed. As ingredient and testing costs decline and AI-assisted diagnosis penetrates, some services originally belonging to high-spending groups are gradually sinking toward middle-spending groups.

Regional Market Distribution

North America dominates the longevity and anti-aging therapy market, Europe ranks second, and Asia-Pacific is growing the fastest. North America's dominance stems not only from high per-capita healthcare spending but also from its original innovation in core technologies. Asia-Pacific's growth rate is mainly driven by the rigid demand of Japan's and China's deep aging, superimposed on the rapid awakening of middle-class health consumption.

Business Model Exploration

Global longevity medicine business models can be summarized into the following typical forms according to service depth, asset model and customer positioning. The models are not mutually exclusive, but overall, the higher the ticket price, the heavier the service and assets and the weaker the replicability; the lower the ticket price, the greater the reliance on scale effects and data flywheels.

	Lightweight Membership Model	Deep Diagnostics Model	Annual Concierge Model	Resort Luxury Model	Academic Public Model
Target Customers	Health-conscious general public	Middle-to-high-income health followers	High-net-worth individuals / Corporate health benefit programs	High-net-worth clients seeking top-tier health services	Chronic disease and sub-healthy populations
Asset Model	Asset-light (platform-based)	Medium-asset (clinic + equipment)	Asset-heavy (chain centers)	Asset-heavy (resort + hotel)	Public assets (public hospitals)
Core Barriers	Data scale + brand	Diagnostic depth + standardization	Closed-loop service system	Century-old brand + experience delivery	Credibility + research capability

Source: Public information, company official websites, literature review, Frost & Sullivan analysis

4.5 Current Status and Future Trends of the Longevity Medicine Industry

Three major barriers — scientific validation, regulatory frameworks and market trust — are shaping the industry's long-term direction.

4.5.2. Future Trends of the Longevity Medicine Industry

Clinical Validation Sends Positive Signals

Core Challenges in Clinical Validation:

- The time paradox: efficacy validation of anti-aging interventions requires long-term follow-up studies of 20–30 years, constituting a fundamental constraint on validation feasibility.
- Missing endpoints: major global drug regulators have not yet listed “aging” or its biological surrogate indicators as independent clinical indications.
- Biomarkers not yet regulator-validated: to date, no aging biomarker has been recognized by regulators as a “validated” surrogate endpoint or one “reasonably likely to predict clinical benefit”.

Positive Signals: Alternative Pathways Are Taking Shape

- “Stepping-stone indication” strategy: use specific indications already incorporated into regulatory review frameworks, such as frailty and sarcopenia, as entry points, gradually expanding to broader aging-intervention scenarios.
- Intrinsic capacity framework: the IC framework proposed by the WHO covers dimensions such as locomotion, cognition and vitality, quantifying healthy aging from the perspective of functional maintenance across multiple dimensions.
- Chinese regulatory innovation: in 2024, the CDE for the first time incorporated “delaying physiological functional decline in non-disease states” into the scope of fileable drug indications, providing an institutional basis for the clinical development of anti-aging drugs under the domestic review pathway.

Regulation Drives Compliant Industry Evolution

One future trend of longevity medicine is that tightening regulation is driving the industry from unregulated growth toward compliance and standardization.

Global regulation currently shows a differentiated evolution: the U.S. FDA is relatively cautious and has not yet accepted “aging” as an independent disease indication, but encourages filing approaches using specific geriatric syndromes as entry points; China's NMPA is more proactive, having incorporated “delaying physiological functional decline in non-disease states” into the scope of fileable indications in 2024; the EU's EMA has a well-developed framework but strict approval standards.

The positive effects of tightening regulation are emerging: Abu Dhabi issued the world's first longevity clinic standard in 2025, marking a breakthrough in basic industry norms from nothing to something; Chinese public hospitals have entered anti-aging outpatient services at prices far below those of foreign private clinics, pulling aging intervention back from an exclusive consumption of high-net-worth individuals into the public medicine agenda; capital and resources are gradually concentrating on leading compliant companies with complete clinical data and established regulatory communication channels.

Overall, tightening regulation raises entry barriers in the short term, but in the medium to long term it is essentially the necessary institutional foundation for eliminating speculation, protecting innovation and building public trust.

Consumer-Medical Convergence

Another future trend of longevity medicine is that the boundary between consumer healthcare and clinical medicine is blurring, and their convergence is reshaping the industry's service forms and business models.

On one hand, health-conscious populations' demand for delaying aging is no longer confined to traditional supplement consumption, but is gradually extending toward deep health management requiring medical-grade testing and intervention, driving the conversion of preventive medical services from “optional consumption” to “health necessity”. On the other hand, public medical institutions are proactively entering the aging-intervention field — previously dominated by the consumer market — by opening anti-aging outpatient clinics and introducing multidisciplinary consultation mechanisms, objectively endowing the field with stronger medical attributes and credibility.

Against this backdrop, the industry supply side has shown clear signs of convergence — the boundaries among functional foods, AI health assessment, wearable monitoring devices, clinical testing and physician prescriptions are gradually being bridged, forming a continuous service chain of “home self-testing – data upload – AI assessment – offline diagnosis and treatment – personalized intervention – dynamic retesting”.

Meanwhile, regulators in various countries are evaluating how to establish an independent management category for new intervention products that sit between “food supplements” and “drugs”. If relevant systems are implemented, they will further accelerate the institutional alignment of consumer-grade products with medical-grade services.

Overall, the market pull of consumer demand and the professional endorsement of the medical system are forming a two-way drive, jointly pushing longevity medicine to evolve from a marketing-driven “anti-aging consumer goods” market toward an evidence-driven “healthspan management” track.

Source: Public information, company official websites, literature review, Frost & Sullivan analysis

Summary

Core anti-aging demand is shifting from youthful appearance to youthful function, with the payer base moving steadily toward the affluent core

Against the backdrop of deepening population aging and chronic disease burden, anti-aging demand is migrating toward extending healthspan and maintaining functional capacity and personal autonomy. The WHO “healthy aging” framework emphasizes that developing and maintaining the “functional ability” that enables well-being in older age is the core goal of anti-aging. Anti-aging evaluation criteria are moving up from short-term visible improvements to levels closer to real health benefits, such as metabolic capacity, cardiopulmonary endurance, muscle mass, sleep quality, cognitive efficiency, immune homeostasis and radius of life. On the payment side, payers are also moving upstream toward the “affluent core” — with health anxiety, wealth decision-making power and long-term payment capacity — and toward “anti-aging newcomers” focused on early prevention. The business logic is expanding from single-procedure consumption toward long-term health management covering “testing – assessment – intervention – follow-up”.

Policy, capital and the value chain resonate as the global ecosystem takes differentiated shape

Longevity medicine is evolving in parallel toward standardized medical language, institutionalized industry norms and normalized access for frontier technologies. Progress on these three fronts is mutually reinforcing: classification standardization provides quantifiable yardsticks for assessment, group standards provide unified norms for service processes, and Lecheng's three mechanisms provide institutional channels for clinical research and translational application of frontier technologies — together forming the access foundation for the industry to move from concept to scaled implementation. On the capital side, both domestic and overseas markets are notably active, but Chinese investment remains concentrated in early rounds, reflecting that the industry is still in a stage of model exploration; overseas capital is more willing to bear long-term R&D risk around aging mechanisms and platform technologies. Along the value chain, the upstream has formed two routes — “natural extraction” and “biomanufacturing” — with aging-testing technology providing a yardstick for ingredient screening and efficacy validation; midstream data evaluation platforms rely on AI algorithms to connect R&D with downstream service delivery, forming a closed feedback loop; downstream, traditional medical aesthetics, health checkups and elderly care are integrating to form the new “longevity clinic” format, with non-traditional players such as medical aesthetics and insurance companies accelerating their crossover. Globally, a differentiated ecosystem has taken shape — the United States emphasizes capital and technology, Europe basic research, Singapore clinical translation, and China industry–academia–research–clinical collaboration — and longevity clinics are becoming an important service vehicle for industrial implementation.

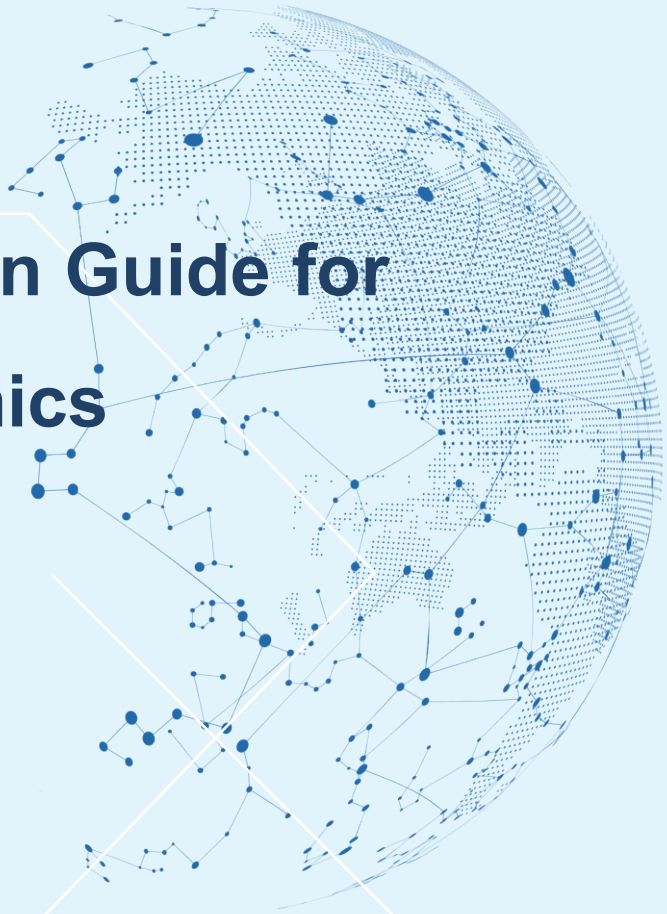
Anti-aging consumer goods are advancing toward healthspan management, with regulation and talent as key variables

In clinical work, efficacy validation of anti-aging interventions often requires 20–30 years of follow-up, and major global regulators have not yet listed “aging” as an independent indication; the “stepping-stone indication” strategy is becoming the mainstream breakthrough. In 2024, the CDE for the first time incorporated “delaying physiological functional decline in non-disease states” into the scope of fileable indications, and Abu Dhabi issued the world's first longevity clinic standard in 2025. Tightening regulation raises entry barriers in the short term, but in the medium to long term it will eliminate speculation and build public trust. The boundary between consumer healthcare and clinical medicine is blurring, preventive medical services are converting from “optional consumption” to “health necessity”, and a continuous service chain of “home self-testing – AI assessment – offline diagnosis and treatment – personalized intervention – dynamic retesting” is taking initial shape. The talent gap is significant: longevity medicine has not yet been recognized as an independent medical specialty, with standardized curricula, assessment and practice certification all absent, and “physician-scientists” with clinical translation capabilities remain scarce. There is also a clear mismatch between the five comprehensive competencies required of health management talent — interdisciplinary knowledge, data literacy, tool application, communication & guidance, and systems integration — and traditional training pathways. Explorations such as international longevity science doctoral programs and domestic longevity health management advanced programs are gradually supplementing the relevant talent cultivation systems.

Source: Public information, company official websites, literature review, Frost & Sullivan analysis

Chapter 5

Implementation Guide for Longevity Clinics



05

5.1 Longevity Medicine Transformation Pathways for Existing Healthcare Providers

Implementing longevity medicine does not require building from scratch. Existing providers—including medical aesthetics, health screening, and traditional healthcare—could leverage their established clients, capabilities, and resources to forge tailored transformation pathways.

5.1.1. Transformation Logic for Medical Aesthetics and Other Consumer Healthcare Providers

Aesthetic providers hold strong client and rejuvenation foundations for longevity expansion, yet face notable capability gaps in systemic care.

Existing Strengths

Mature Client Operations

Serving clients with strong health-consumption willingness and purchasing power. They have developed mature membership and client engagement systems, providing a solid base for long-term health services.

Strong Foundation in Aesthetic Interventions

Equipped with energy-based devices (lasers, radio frequency, ultrasound) and experience in skin assessment, tissue repair, and localized functional improvement.

These capabilities could support services in aesthetic rejuvenation, skin health, and body management.

Core Capability Gaps

Assessment Remains Localized

Current services focus on skin, contours and appearance, without assessing biological aging, missing systemic drivers like metabolic dysregulation, hormonal imbalances, and chronic inflammation.

Relatively Narrow Professional Mix

Clinical teams concentrates on dermatology and plastic surgery, lacking functional medicine, endocrinology, and geriatrics specialists.

Additional capabilities are needed in medical risk identification, chronic disease management, and integrated health assessment.

Service Delivery Remain Dominated by Procedures & Treatment Courses

Delivery remains organized around individual procedures and treatment courses, rather than closed-loop, continuous care driven by longitudinal physiological data.

Transformation Logic

Aesthetic providers can build on rejuvenation strengths by adding **professional capabilities in** systemic assessments, functional maintenance, and nutrition, exercise, and lifestyle support. Disease assessment, prescription drugs, hormone therapies, and other medical interventions should remain under qualified physician oversight, including indication assessment and risk management.

Building on their existing capabilities, these providers are well positioned to develop a longevity medicine model that integrates aesthetic rejuvenation with functional maintenance, gradually expanding from localized aesthetic improvement to comprehensive health management.

Source: Public information, literature review, company websites, TIMEPIE Research Institute analysis

5.1 Longevity Medicine Transformation Pathways for Existing Healthcare Providers

Transformation priorities depend on existing capabilities. Health screening centers should expand diagnostics and data into post-screening care.

5.1.2. Transformation of Health Screening Centers toward Longevity Health Management

Health screening centers, with established testing systems and longitudinal health data, are well positioned to extend longevity medicine from risk identification to ongoing health management.

Existing Strengths

Mature Testing and Risk Identification

Laboratory platforms, imaging equipment, and standardized screening workflows enable systematic collection of baseline health information, including disease risks, metabolic status, and organ function.

Strong Longitudinal Health Data Assets

Repeated screenings generate continuous health records, providing a data foundation for tracking long-term biomarker changes, support risk stratification and follow-up management.

Core Capability Gaps

Inadequate Post-Screening Service Follow-Through

Services often end with report delivery and abnormality alerts, and specialist referral, lacking continuous tracking of health trajectories and intervention outcomes.

Insufficient Translation of Data into Clinical Action

While screening centers can identify numerous risk signals, limited capabilities in result integration, ongoing physician evaluation, and follow-up management leave the long-term clinical value of screening data underutilized.

Transformation Logic

The priority is strengthening post-screening follow-through to convert diagnostic assets into risk stratification, clinical judgment, and continuous care. Large chains can leverage scale for standardized, scalable risk management, while physician-rich providers can address complex conditions through deeper, longitudinal care.

5.1.3. Extending "Preventive Care" Capabilities for TCM and Other Traditional Healthcare Providers (1/2)

By year-end 2024, over 95% of China's secondary and tertiary public TCM hospitals had established 'preventive care' departments. Amid rising demand for chronic and life-cycle healthcare services, TCM providers—backed by mature long-term conditioning—are initially equipped to expand into longevity health management.

Source: Public information, literature review, company websites, TIMEPIE Research Institute analysis

5.1 Longevity Medicine Transformation Pathways for Existing Healthcare Providers

Traditional healthcare providers can reinforce "Preventive Care" through quantitative assessment and modern medical collaboration.

5.1.3. Extending "Preventive Care" Capabilities for TCM and Other Traditional Healthcare Providers (1/2)

Existing Strengths

Strong Holistic Health Management Philosophy

TCM emphasizes constitution identification, holistic health management, and prevention before disease onset, possesses mature service experience in long-term health maintenance and functional improvement.

Extensive Experience in Long-Term Health Management and Chronic Care

Certain traditional providers have established stable service settings across chronic condition management, rehabilitation, and sub-health regulation, providing the foundation to expand into continuous health management.

Core Capability Gaps

Insufficient Objective Quantification Capabilities

Assessments rely primarily on pattern differentiation, symptom changes, and subjective feedback, lacking continuous tracking of clinical metrics, functional status, and long-term risks.

Service Delivery Remains Largely Episodic

Dominated by single-session care, seasonal wellness programs and short-term projects. Workflows lack structured mechanisms for periodic reassessment, protocol adjustments, and long-term tracking.

Interdisciplinary Collaboration Needs Strengthening

A shortage of interdisciplinary expertise and collaboration restricts integrating traditional therapies with modern diagnostics, functional management, and frontier technologies.

Transformation Logic

Traditional healthcare providers can build on holistic care and preventive health services by adding quantitative assessment and modern risk identification, linking pattern differentiation with clinical measures, functional status, and long-term changes.

Integrating Chinese herbal medicine and acupuncture with nutrition, exercise, rehabilitation, and lifestyle management can support an integrated TCM–Western medicine longevity model centered on “pattern differentiation-based care and quantitative tracking.

Source: Public information, literature review, company websites, TIMEPIE Research Institute analysis

5.2 Service Design and Delivery System of Longevity Clinics

Whatever their capability starting points or transformation pathways, existing providers ultimately need to package assessment, intervention, and continuous management into consistently deliverable service products. Product design must ensure clinical safety and accommodate individual differences, while balancing practical execution with long-term management.

5.2.1. Assessment and Intervention Configuration Framework (1/2)

Longevity medicine addresses multisystem risks and long-term functional changes, requiring clinical judgment to integrate disease status, functional reserves, lifestyle, and environmental factors. Functional medicine emphasizes the long-term impact of health history and living environments on physiological function, serving as a reference framework to integrate multidimensional information into individualized care. Practical application should strictly adhere to standardized clinical practices and evidence-based evaluation to support risk identification and protocol formulation.

Table 1 Assessment and Intervention Configuration Framework for Longevity Clinics

Configuration Module	Assessment Entry Point	Deliverable Interventions	Periodic Reassessment and Application Boundaries
Baseline clinical assessment and disease risk management	Medical history, medications, routine laboratory tests, and disease risk screening	Standardized management of pre-existing conditions, vaccinations, and necessary nutritional and lifestyle modifications	Follow-up assessment driven by clinical metrics and disease management targets, in accordance with existing clinical practice guidelines
Functional reserve and lifestyle assessment	Body composition, muscle strength, gait/balance, cardiorespiratory fitness, sleep, and lifestyle	Exercise, nutrition, sleep, weight management, and rehabilitation support	Focus on functional changes and implementation outcomes; abnormal results are triaged into corresponding specialty care pathways
Biological age and emerging biomarkers	DNA methylation clocks, multi-omics, and other emerging aging biomarkers	Primarily used to support risk communication, protocol prioritization, and longitudinal monitoring	Not intended for disease diagnosis or lifespan prediction; testing provides configuration value only if results can alter subsequent management
Targeted medical interventions	Targeted assessments based on explicit symptoms, disease risks, or functional deficits	Hormone therapy, pharmacotherapy, rehabilitation medicine, sleep medicine, etc.	Require clear indications, contraindications, efficacy endpoints, and discontinuation criteria, overseen by corresponding specialist physicians
Exploratory and frontier technologies	Considered only when baseline assessments are insufficient and clear clinical indications exist	Select novel pharmaceuticals, cellular and regenerative technologies, blood-related technologies, etc.	Deploy prudently based on certainty of evidence and regulatory requirements, with rigorous informed consent, risk monitoring, and referral exit mechanisms

Source: Public information, literature review, TIMEPIE Research Institute analysis

5.2 Service Design and Delivery System of Longevity Clinics

Clinics should define their assessment and intervention scope based on licensed specialties, professional teams and technical capabilities, selecting modules tailored to client health. While specialized capabilities and advanced technologies create institutional differentiation, baseline risk identification, clinical judgment, and safety management remain the universal foundation. Issues exceeding institutional scope require specialist collaboration or referral.

5.2.1. Assessment and Intervention Configuration Framework (2/2)

Diagnostics and interventions should link directly to clinical decision-making. Additional testing needs to inform risk evaluation, protocol selection, or periodic reassessment , while interventions are delineated by clinical indications, certainty of evidence, and potential risks. Over time, follow-up results feed back into clinical judgment to maintain, adjust, or discontinue protocols, integrating diverse technologies into a continuous health management process.

5.2.2. Staffing and Role Configuration Framework (1/2)

Staffing configuration requires clearly defining the boundaries between clinical decision-making and operational execution.

Lead physicians are responsible for clinical judgment, protocol approval, and necessary adjustments; nurses, pharmacists, nutritionists, and therapists carry out care within their licensed scopes; and case managers, health coaches, and member services coordinate follow-up, health data collection, and non-clinical support. Commercial staff (sales, channels, billing) handle introductions, scheduling, and settlement, but should not participate in medical decisions regarding diagnostics, prescriptions, or treatments.

Table 2 Role Types and Responsibility Boundaries for Longevity Clinics

Role Type	Primary Responsibilities	Staffing Model	Responsibility Boundaries
Medical Director	• Clinical quality oversight • Clinical practice standards • Major risk management	May be concurrently held by a senior lead physician	Manage clinical quality and resolve major medical risk events
Lead Physician	• Comprehensive clinical judgment • Protocol approval • Reassessment adjustments • Referral approval	Staffed with one or more physicians based on client volume	Lead clinical judgment and approve protocols; ensure treatment adjustments are physician-determined
Specialist Physician	• Managing organ-system-specific conditions and complex disease risks	In-house collaboration, part-time engagement, or external partnerships	Provide specialist medical consultations to be integrated into the unified care protocol

Source: Public information, literature review, TIMEPIE Research Institute analysis

5.2 Service Design and Delivery System of Longevity Clinics

In multidisciplinary care, responsibilities and decision rights should be clearly defined across intervention proposal, medical review, implementation, alongside escalation of abnormal findings and accountability tracking. This ensures nutrition, exercise, medications, and technologies are uniformly integrated into clinical decision-making and medical documentation.

5.2.2. Staffing and Role Configuration Framework (2/2)

Table 2 Role Types and Responsibility Boundaries for Longevity Clinics

Role Type	Primary Responsibilities	Staffing Model	Responsibility Boundaries
Pharmacists, Nutritionists, and Rehabilitation Specialists	• Medication management • Nutritional, exercise, and rehabilitation support	Full-time, part-time, or external partnerships	Deliver services within licensed scopes of practice; clinical decisions require physician approval
Case Managers/ health management staff	• Client follow-up • Reassessment reminders • Task coordination • Health data collection	Initially may be concurrently held by nursing or health management staff	Coordinate and manage care; do not independently perform diagnosis, prescribing, or treatment adjustments
Member Services / Operations Personnel	• Service introductions • Membership benefits administration • Non-clinical support	Configured based on the business model	Introduce service offerings; make no recommendations regarding diagnostic tests, medications, or treatments
Quality and Compliance Personnel	• Clinical quality assurance • Infection control • Pharmaceutical, medical device, and policy governance	Initially may be concurrently held by relevant management roles	Oversee quality compliance; ensure sales or revenue targets never override clinical judgment

Source: Compiled by the TimePie Research Institute

5.2 Service Design and Delivery System of Longevity Clinics

A longevity clinic's operational viability hinges on whether its licensing, governance, and external safeguards cover its actual scope of practice.

5.2.3. Basic Operational Requirements (1/2)

Operationally, the facility must align its clinical entity, service liabilities, and operational mechanisms, ensuring assessments, interventions, and follow-up care are sustainably delivered within a stable medical framework.

☐ Scope of Services Management

Longevity clinic development pathways vary: providers can select appropriate medical operating structure, in-house capabilities, or external partnerships based on their resources. However, as service expand to encompass medical assessment, risk evaluation, and intervention management, providers must delineate service boundaries and corresponding liability models.

For clinical services, offerings must match licensing, registered scopes, and staff competencies, backed by a clear chain of medical liability.Under the *Regulations on the Administration of Medical Institutions*, medical institutions should be legally registered or filed as required and provide services within their approved or registered scope of diagnosis and treatment. Physicians, nurses, and other healthcare professionals should comply with relevant requirements, including the *Physicians Law of the People's Republic of China* and *Regulations on Nurses*, and perform their duties within registered scopes of practice. Additionally, specialized medical technologies must be evaluated under the *Administrative Measures for the Clinical Application of Medical Technologies*, accounting for technological attributes, application scope, and the institution's own capabilities.

For non-core capabilities, providers can leverage compliant partnerships. However, collaboration scopes, liability boundaries, and service handoffs must be defined in advance, ensuring relevant results are integrated into the overall health management process.

☐ Clinical Safety Management (1/2)

Characterized by long service cycles, multi-step interventions, and frequent dynamic adjustments, longevity medicine requires providers to implement end-to-end quality management, ensuring client status changes are continuously documented to guide subsequent clinical decisions.

The *Measures for Medical Quality Management* establish that healthcare facilities hold primary accountability for medical quality, while the *Key Points of the Core Systems for Medical Quality and Safety* further mandate standards across key areas: first-visit physician responsibility, consultations, medical records management, critical value reporting, and the management of new technologies and clinical projects. Longevity clinics must embed these requirements into operational workflows tailored to their care models.

Source: Compiled by the TimePie Research Institute

5.2 Service Design and Delivery System of Longevity Clinics

Longevity clinics need to solidify operational foundations to ensure initial assessments, intervention protocols, and subsequent management maintain stable coordination.

5.2.3. Basic Operational Requirements (2/2)

☐ Clinical Safety Management (2/2)

Table 3 Operational Monitoring Dimensions for Longevity Clinics

Monitoring Dimension	Key Metrics	Primary Purpose
Service Continuity	Follow-up completion rate, reassessment completion rate, loss-to-follow-up rate, and service interruptions	Evaluate whether care management is sustained
Clinical quality	Abnormal finding management rate, referral completion rate, adverse events, and client complaints	Identify clinical risks and service gaps
Service timeliness	Report turnaround time, consultation response time, and appointment waiting time	Detect workflow bottlenecks
Resource utilization	Physician working hours, nursing workload, appointment utilization rate, and equipment utilization rate	Support optimal resource allocation

In longitudinal health management, providers need to maintain continuity across assessments, clinical judgment, and protocol adjustments.For significant risks, client status changes, or issues exceeding clinical capabilities, corresponding re-evaluation, consultation, and referral mechanisms should be established to ensure clients are navigated into appropriate clinical care pathways.

☐ Ongoing Management Capabilities

Given longevity medicine's long-term nature, providers must build information and management capabilities supporting continuous care—accumulating multi-stage health data, assessment findings, and service records into traceable client health profiles. As ongoing care continuously generates diagnostic, functional, and service records,Providers should leverage electronic medical records (EMRs), health profiles, or digital platforms for unified storage and related management, ensuring multi-stage data can be queried, retrieved, and leveraged to support clinical judgment.

As client volume scales, digital systems further support follow-up reminders, task management, and quality monitoring, improving information handoff efficiency across roles. When handling health data and sensitive personal information, providers are required to delineate data usage scopes and access permissions in accordance with the *Personal Information Protection Law* and the *Norms for the Application and Management of Electronic Medical Records (Trial)*.

Source: Compiled by the TimePie Research Institute

5.2 Service Design and Delivery System of Longevity Clinics

Once configuration boundaries and staffing divisions are defined, clinics should structure them into stable, repeatable workflows.

5.2.4. Standardized Workflows and Personalized Management (1/3)

Public practices in China and abroad shows that despite varying models and cycles, workflows share a stable core structure: progressing from service intake and medical assessment to protocol delivery and periodic reassessment.

Domestically, the Anti-Aging MDT Clinic at Xiangya Hospital, Central South University, covers multidimensional evaluation, consultations, supplemental testing, physiological age assessment, intervention, and follow-up. Meanwhile, the health management and full-course management model at West China Hospital of Sichuan University further connects pre-screening assessment, intelligent guidance, result interpretation, abnormality alerts, online follow-up, and expedited referrals, with disease-specific case managers handling scheduling, data, and coordination.

Globally, workflows share similar features despite diverse models: Clinique La Prairie defines testing scope after initial consultation, delivering comprehensive reports and lifestyle guidance; Chi Longevity formulates multidisciplinary action plans, including reassessment after six months for select tiers; and Buchinger Wilhelmi integrates physician consults, daily nursing checks, and 24/7 medical oversight into structured residential pathways.

Although assessment scopes and interventions may vary, key steps—information collection, clinical judgment, protocol approval, implementation management, and periodic review—should remain standardized, with clearly defined role accountabilities and risk protocols. Upon this shared workflow, specific protocols are tailored to individual risks, health goals, and practical conditions.

Unified clinical workflows ensure stable delivery, while individualized protocols configure interventions around risk priorities, phased goals, and practical conditions. Longevity clinical clients often present with multiple abnormal metrics, functional problems, and lifestyle risks. Converting all issues into simultaneous interventions can lead to protocol stacking, inflating the implementation burden and complicating efficacy evaluation.

Protocols should prioritize risk first: Existing diseases that have not yet been appropriately managed should first enter standard clinical pathways, after which current-cycle priorities are selected from modifiable risks and functional problems.

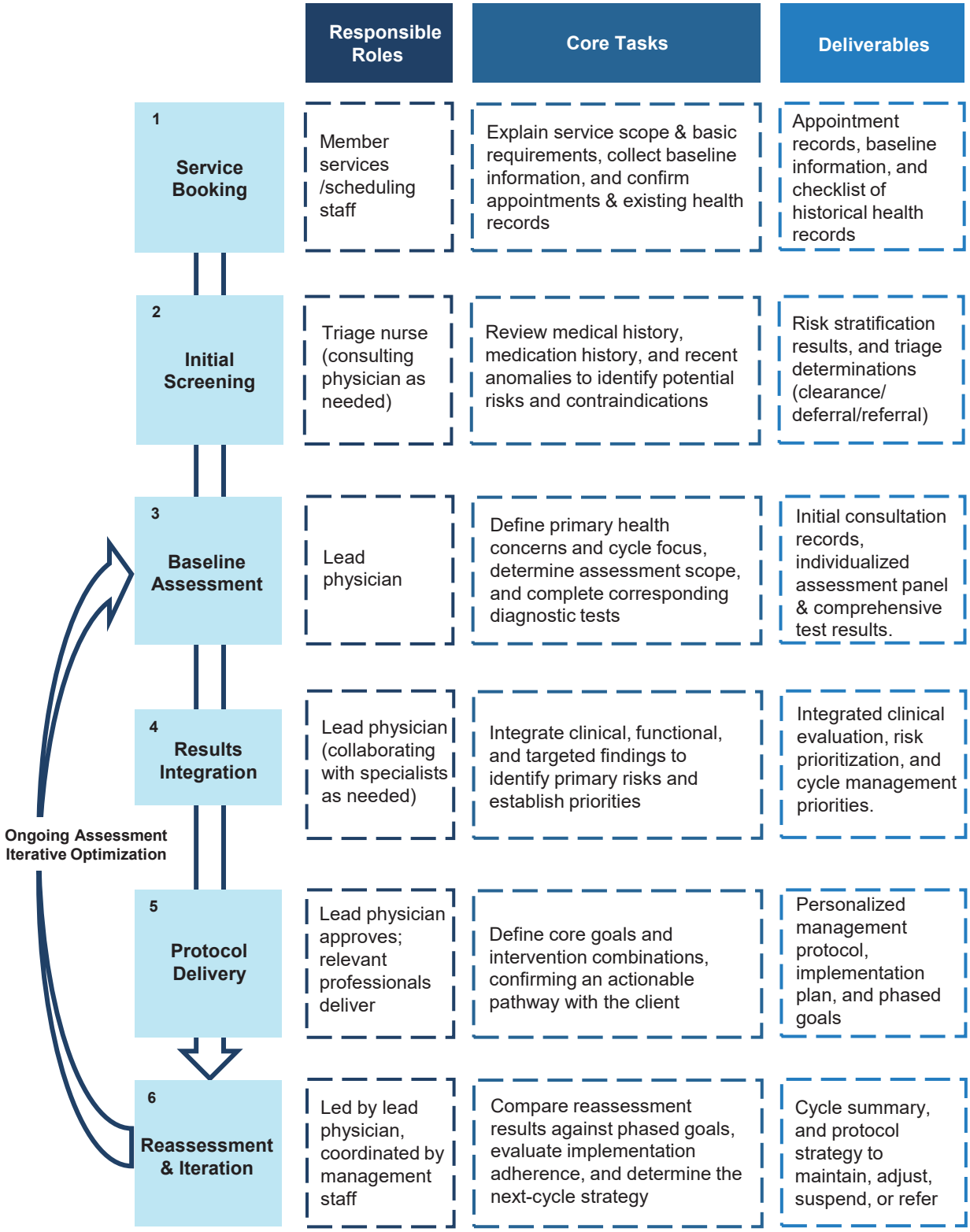
In principle, a single care cycle should focus on one to two primary goals. Secondary goals are included only to support primary targets, reduce safety risks, or improve adherence; deferred issues should be documented with clear follow-up observation plans.

Source: Compiled by the TimePie Research Institute

5.2 Service Design and Delivery System of Longevity Clinics

5.2.4. Standardized Workflows and Personalized Management (2/3)

Fig.1 Standardized Service Workflow for Longevity Clinics



Source: Public information, literature review, company websites, TIMEPIE Research Institute analysis

5.2 Service Design and Delivery System of Longevity Clinics

Individualized protocols also require trade-offs based on the client's time, budget, and practical conditions. Grounded in clinical safety and primary goals, providers should prioritize essential components directly tied to current management priorities, curbing the stacking of low-priority items.

5.2.4. Standardized Workflows and Personalized Management (3/3)

Overall, longevity clinic standardization requires unified clinical checkpoints, decision rules, and feedback mechanisms, while personalization configures protocol components within this framework based on risk prioritization, phased goals, and practical conditions. Different providers can further develop differentiated product pathways aligned with their clinical capabilities, target populations, and resources.

Table 4 Adjustment Framework for Individualized Protocols in Longevity Medicine

Protocol Components	Adjustment Rules	Primary Basis	Non-Negotiable Boundaries and Guardrails
Foundational medical care and safety management	Baseline requirements remain relatively consistent	Clinical scope and client baseline risk	Physician accountability, standardized medical records, risk identification, anomaly resolution, and informed consent
Current-cycle management priorities	Individualized focus, ranked by priority, with no more than three core priorities	Risk severity, room for improvement, health needs, and client goals	Prioritize unmanaged pre-existing conditions and major clinical risks
Nutrition, exercise, and other supportive measures	Selected on demand, goal-oriented	Contribution to current-cycle goals, client adherence, and evidence-based support	Avoid stacking interventions unrelated to primary goals; deploy only safe, evidence-supported interventions
Targeted testing and intervention programs	Conditional access, credentialing controls	Medical necessity, target population, levels of evidence, provider capabilities, and cost-effectiveness	Services involving medical acts require credentialed physician decision-making and informed consent
Follow-up and reassessment plan	Dynamic adjustment, stratified management	Risk level, intervention components, and biomarker changes	Key reassessment checkpoints and result feedback must be predetermined; follow-up interruptions require activating loss-to-follow-up protocols
Anomaly management and referral	Tiered response, dynamic assessment	Client baseline risk and the risk profile of deployed interventions	Red-flag warnings require prompt evaluation, suspension, or referral; acute and critical care must not be delayed

Source: Public information, literature review, TIMEPIE Research Institute analysis

5.2 Service Design and Delivery System of Longevity Clinics

With assessment and intervention offerings, staffing, workflows, and individualized protocols defined, providers must determine whether current capabilities can sustain ongoing implementation.

5.2.5. Three Stages of Service Implementation

As client volume scales, care cycles lengthen, and service complexity rises, required organizational and delivery capabilities progressively expand across three stages.

Minimum Viable Configuration

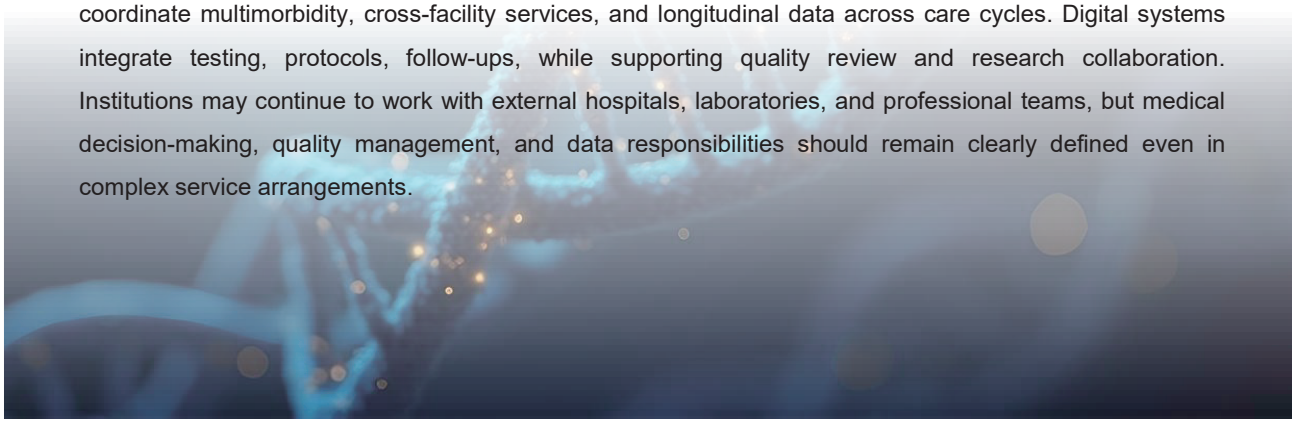
This stage centers on establishing a foundational clinical closed loop within defined service boundaries. Providers should delineate medical director and lead physician accountabilities, complete essential initial screening, results synthesis, and protocol formulation, and maintain standardized records, informed consent, and referral pathways. External partnerships (laboratories, imaging) can supplement specialized testing, provided all findings and subsequent care integrate into a unified medical documentation and accountability framework.

Stable Delivery Configuration

As client volume and service offerings expand, priorities shift to service standardization and team collaboration. Providers need to establish unified protocol versions, reassessment schedules, and professional delivery boundaries, ensuring consistent delivery quality despite staff turnover or business growth.

Comprehensive Capability Configuration

Targeting complex clients and multi-setting care, this stage relies on mature interdisciplinary teams to coordinate multimorbidity, cross-facility services, and longitudinal data across care cycles. Digital systems integrate testing, protocols, follow-ups, while supporting quality review and research collaboration. Institutions may continue to work with external hospitals, laboratories, and professional teams, but medical decision-making, quality management, and data responsibilities should remain clearly defined even in complex service arrangements.



Source: Public information, literature review, TIMEPIE Research Institute analysis

5.3 Operating Models for Longevity Clinics

Based on existing practices in China and abroad, longevity clinics can be broadly grouped into five representative operating models.

☐ Case Studies of Representative Longevity Clinic Models (1/7)

Table 5 Five Representative Operating Models for Longevity Clinics

Model Type	Key Features	Current Challenges	Representative Examples
Hospital-Affiliated Longevity Care Model	Leverages a hospital's established specialty systems, diagnostic capabilities, and referral networks to embed longevity services into current clinical settings such as health management, geriatric medicine, or multidisciplinary team (MDT) care.	While multidisciplinary consensus is relatively easy to achieve, care breakpoints frequently emerge in lead physician accountability, cross-specialty protocol integration, out-of-hospital tracking, and reassessment data loop-back.	解放军总医院 医学院 CHINESE PLA GENERAL HOSPITAL CHINESE PLA MEDICAL SCHOOL; 北京老年医院 Beijing Geriatric Hospital; BPC LONGEVITY CLINIC; VITALLIFE; 华西医院 WEST CHINA HOSPITAL OF SICHUAN UNIVERSITY; 中南大学湘雅医院 XIANGYA HOSPITAL OF CENTRAL SOUTH UNIVERSITY; SHEBA LONGEVITY Longer. Better. Life; PURA LONGEVITY CLINIC
Urban Longitudinal Care Clinic Model	Uses physical outpatient clinics as the primary setting, establishing long-term client relationships through phased protocols, annual memberships, and ongoing follow-up.	As service volume scales, disconnects easily emerge among physician decisions, membership benefits, and multi-role delivery, placing high demands on continuous lead physician oversight, case management, and closed-loop anomaly resolution.	CellCare 美田医疗 研源健康; SinoUnited Health 瑞盈医疗; RYOYI 領医; 卓尔荟; NEXT|HEALTH; CHI LONGEVITY™ AGE BETTER THROUGH SCIENCE; HUMANAUT HEALTH™
Medical Wellness Destination Model	Integrates medical assessment with accommodation, nutrition, exercise, and recovery within a residential stay of several days to weeks.	Demands heightened on-site medical responsibility during the stay, while requiring solutions for overnight response, emergency transfers, post-departure follow-up care, and heavy fixed costs.	博鳌一龄生命养护中心 BOAO YILING LIFE CARE CENTER; LANSERHOF; CLINIQUE LA PRAIRIE; SHA WELLNESS CLINIC; BUCH/NGER W/LHELMI; nescens swiss anti-aging science; CHENOT
Advanced Diagnostics-Led Model	Establishes a service gateway via advanced imaging, genomics, multi-omics, or high-density testing, extending downstream care through physician interpretation and phased reassessment.	High-density screening may identify frequent abnormalities and incidental findings, requiring structured mechanisms for results synthesis, prioritization, downstream care, and reassessment.	HUMAN LONGEVITY; NEKO HEALTH; FOUNTAIN LIFE; BIOGRAPH
Advanced Clinical Capabilities-Led Model	Leverages regenerative medicine, cell-based technologies, or other specialized clinical capabilities to create a differentiated service entry point, connecting downstream assessment, re-testing, and risk management.	Integrating new technologies requires concurrently defining target populations, contraindications, implementation criteria, efficacy evaluations, alongside robust adverse event management and referral mechanisms.	AVIV Aviv Clinics Brain Performance for Life; 5 Star Medical Group; EXTENSION HEALTH

Source: Public information, company websites, TIMEPIE Research Institute analysis

5.3 Operating Models for Longevity Clinics

Different operating models emphasize distinct service gateways, resource structures, and ongoing care approaches. Drawing on representative practices in China and abroad, the following section further outlines their core characteristics and capability-building priorities.

☐ Case Studies of Representative Longevity Clinic Models (2/7)

■ Hospital-Extension Model

Operating primarily on the established clinical infrastructure of general or specialty hospitals, the Hospital-Affiliated Longevity Care Model reorganizes assessment and intervention resources previously distributed across geriatrics, health management, preventive medicine, and specialized departments into a unified pathway for long-term health management. The hospital's existing laboratory and imaging services, specialty care, pharmacy governance, emergency services, and referral networks can directly provide a foundation for safe medical care. Consequently, new development priorities center on comprehensive assessment, MDT synergy, and out-of-hospital continuous care.

Real-world implementations demonstrate distinct extension pathways. In Israel, Sheba Longevity Center leverages a major medical center to establish centralized assessment, multidisciplinary analysis, physician follow-up, and continuous monitoring. In China, Xiangya Hospital of Central South University integrates clinical specialties via its Anti-Aging MDT Clinic; meanwhile, West China Hospital of Sichuan University draws upon the National Clinical Research Center for Geriatric Diseases to translate comprehensive geriatric assessment, functional maintenance, and proactive health technologies into clinical practice.

The Blueprint Paracelsus Longevity Center has established a model combining a "listed company × Swiss system × tertiary hospital": relying on Huapont Life Sciences' more than 30 years of experience in the healthcare industry and its medical resources, the center has introduced the Swiss Paracelsus integrative medicine framework, backed by Chongqing Songshan Hospital as its clinical guarantor. Emphasizing "personalization built upon a hospital-grade safety foundation," Blueprint Paracelsus has served over 10,000 Chinese entrepreneurs and families, exhibiting development hallmarks of membership-based retention, standardized productization, and long-term care.

On this foundation, Blueprint Paracelsus has built the CLEAR Five-Dimensional Intervention System, Eight Health Centers, and Tier 1–4 Stratified Protocols, connecting assessment, protocol design, clinical intervention, continuous tracking, and phased reassessment through a "Measure–Intervene–Remeasure" closed loop. Its flagship program, the "Baodi Plan", is an intensive 3-day, 2-night health management program. It establishes an individual baseline through clinical laboratory tests, functional medicine testing, and related risk assessments. Following in-hospital intensive interventions, it transitions into three months of nutritional support, home lifestyle management, and health concierge follow-up. This exemplifies the pathway for hospital systems to extend from episodic medical services to continuous, in-and-out-of-hospital health management.

Source: Public information, company websites, TIMEPIE Research Institute analysis

5.3 Operating Models for Longevity Clinics

Urban longitudinal care clinics establish long-term service gateways through membership models, chains, specialized services, or existing client bases, yet ongoing management hinges on stable clinical capabilities.

☐ Case Studies of Representative Longevity Clinic Models (3/7)

As these services mature, the hospital-affiliated longevity care model can evolve from one-off MDT evaluations toward cross-specialty longitudinal care, out-of-hospital continuity, and longitudinal health data integration, with research-capable institutions further bridging clinical practice and research resources. The core advantage of this model lies in its comprehensive medical resources; its primary operational challenge remains how to transform fragmented hospital specialties into a unified, continuous long-term health management system.

■ Urban Longitudinal Care Clinic Model

Operating through standalone clinics, polyclinics, or private healthcare networks, the Urban Longitudinal Care Clinic Model establishes sustained client relationships typically anchored in multi-month care plans or annual memberships, integrating physician follow-ups with nutrition, exercise, and other supportive therapies into a single care cycle. Advanced diagnostics and infrequently needed specialty services are strategically outsourced to external partners, effectively controlling initial capital expenditure. Existing practices exhibit different approaches to service packaging.

Chi Longevity connects physicians, health coaches, and other professional support through tiered assessments and continuous care plans, featuring structured phased reassessments. Meanwhile, Next Health leans more toward a membership model and annual health plans, organizing diagnostics, physician reviews, and ongoing management into a standardized long-term service.

In China, scalable urban longitudinal care clinic networks are beginning to emerge. Leveraging Beauty Farm's established consumer healthcare foundations, Cellcare healthcare centers has established a chain of outpatient clinics across major first- and second-tier cities, including Shanghai, Beijing, Shenzhen, Chongqing, and Wuhan, reaching a total of 13 medical clinics as of August 2026.

In its service architecture, Cellcare healthcare centers centers on functional medicine, incorporating multidimensional health assessments, individualized interventions, and longitudinal tracking into continuous health management, while progressively expanding from sub-health management into longevity medicine services.

Building upon this foundation, Cellcare healthcare centers has further developed a specialized focus on women's health. Its Women's Specialized Care Center draws on gynecological theory and clinical expertise to assess and address women's health needs related to the endocrine and reproductive systems across different stages of life, establishing a differentiated practice model of "Functional Medicine + Women's Specialty."

Source: Public information, company websites, TIMEPIE Research Institute analysis

5.3 Operating Models for Longevity Clinics

Beyond leveraging established hospital systems and urban clinics to deliver long-term care management, some longevity clinics forge differentiated pathways centered on specialized service settings, advanced assessment capabilities, or distinct medical technologies, thereby shaping different resource allocation models and capability-building priorities.

☐ Case Studies of Representative Longevity Clinic Models (4/7)

Urban longitudinal care clinics can also achieve market differentiation through structured medical methodology and standardized delivery. The RYOYI Health & Anti-Aging Center integrates Japanese early-screening principles, French preventive medicine methodology, in-house diagnostic capabilities, and long-term reassessment mechanisms into a cohesive urban continuous care system. The center proposes the longitudinal management of client "Health Capital," embedding preventive medicine, biological monitoring, functional medicine, and long-term medical follow-up into a unified methodological framework. Its standard operating procedures (SOPs) cover patient enrollment, biological assessment, aging risk stratification, clinical decision logic, intervention prioritization, and ongoing monitoring and adjustments, forming a service pathway of "comprehensive medical assessment — aging risk profiling — personalized medical strategy — long-term follow-up management." In clinical delivery, select disease screenings are completed via external medical resources, while in-house clinical teams handle aging-related evaluations, individualized interventions, and follow-up reassessments, with Chinese and French physicians and multidisciplinary teams jointly formulating care protocols. In addition, RYOYI's existing medical aesthetics business has accumulated tens of thousands of high-net-worth clients and a robust peer-referral network, providing an established client base and an enduring service gateway for its health and anti-aging offerings.

As footprints and client volume scale, unified assessment logic, lead physician accountability, and cross-role collaboration become essential to maintaining service consistency.



■ Medical Wellness Destination Model (1/2)

The Medical Wellness Destination Model integrates clinical care, lodging, nutrition, exercise, and rehabilitation into multi-day or multi-week residential stays. Unlike episodic urban clinics, this controlled environment enables intensive lifestyle and medical interventions with continuous adherence monitoring.

Representative institutions illustrate different approaches to this model. Clinique La Prairie’s 7-day Revitalisation Program integrates lab and age-related testing, physician follow-up, nutrition, exercise, and recovery into a single cycle, with an on-site medical center and clinical team connecting lodging directly to comprehensive medical capabilities; Buchinger Wilhelmi specializes in medically supervised fasting across three structured phases—preparation, fasting, and re-feeding—recommending a minimum stay of approximately 11 days to allow continuous clinical observation and daily regimen adjustments. Domestically, Boao Yiling Life Care Center leverages Boao Lecheng's medical and wellness environment, integrating medical care, rehabilitation, and residential living into a practice with distinctive Chinese characteristics of “clinical care + wellness residency”

Source: Public information, company websites, TIMEPIE Research Institute analysis

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◻ Case Studies of Representative Longevity Clinic Models (5/7)

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Domestically, Boao Yiling Life Care Center leverages Boao Lecheng's medical and wellness environment, integrating medical care, rehabilitation, and residential living into a practice with distinctive Chinese characteristics of "clinical care + wellness residency".

This model demands maintaining continuous medical support throughout the stay. Because clients reside on-site for extended periods and engage in multi-modal programs, facilities must delineate shifts and accountabilities for physicians, nurses, and allied staff, while establishing overnight response, emergency protocols, and hospital referral pathways.

Furthermore, non-clinical offerings—lodging, dining, fitness, and recovery—need to remain coordinated with medical requirements to prevent different service components from operating independently. As services mature, providers should also bridge the post-stay care gap, extending short-term intensive interventions into longitudinal health management through discharge planning, remote follow-up, or partnerships with clients' local healthcare providers.

■ Advanced Diagnostics-Led Model

This model deploys high-density, multidimensional health assessments as its primary service gateway, utilizing advanced imaging, genomics, biomarkers, and functional testing across one or a few concentrated sessions to construct a comprehensive individual health profile, thereby supporting downstream risk evaluation and ongoing health management.

Representative institutions have developed distinct approaches to in-depth assessment. Human Longevity, Inc. (HLI) integrates whole-genome sequencing, whole-body MRI, blood biomarkers, and proteomics into a unified framework, synthesized by physicians alongside longitudinal data.

Fountain Life anchors its services in advanced diagnostics—including whole-body and brain MRI, cardiovascular imaging, and metabolic screening—connecting testing to physician management and repeat evaluations via a membership model.

Source: Public information, company websites, TIMEPIE Research Institute analysis

5.3 Operating Models for Longevity Clinics

Beyond leveraging established hospital systems and urban clinics to deliver long-term care, select longevity clinics forge differentiated pathways centered on specialized service settings, advanced assessment capabilities, or distinct medical technologies, thereby shaping unique resource allocation models and capability-building priorities.

◻ Case Studies of Representative Longevity Clinic Models (6/7)

NekoHealth adopts a more lightweight technological pathway, utilizing proprietary equipment to capture skin, cardiovascular, circulation, body composition, and blood metrics within approximately one hour, delivering clinical interpretation during the same visit, with abnormal findings routed to specialist review or referral.

Domestically, Baijia Medical exemplifies HLI's localized implementation: its '100+' program incorporates whole-genome sequencing, whole-body and brain MRI, and blood biomarkers into comprehensive evaluations, supported by private physician management, periodic tracking, and specialist collaboration.

As testing dimensions expand, abnormal results and incidental findings may also multiply, placing heightened demands on clinical interpretation, risk prioritization, and downstream management. Providers need to establish structured anomaly stratification, specialist review, and reassessment mechanisms to translate vast testing datasets into clear, actionable, and trackable clinical decisions.



■ Innovative Clinical Capability-Driven Model

These providers typically establish a differentiated service gateway around specialized, high-barrier technologies that demand stringent medical licensing and risk governance, such as regenerative medicine and blood purification.

In contrast to models anchored in comprehensive assessments, client demand here is primarily triggered by a specific proprietary technology. Consequently, providers should build indication evaluation, clinical assessment, and follow-up care around this core capability, embedding specialized therapies into a complete healthcare delivery system.

Tokyo's Clinic 9ru, part of 5STAR MEDICAL GROUP, exemplifies a relatively comprehensive model driven by innovative clinical capabilities. The group unites precision assessment, individualized medical decision-making, regenerative medicine, cell processing, and continuous care management into an integrated ecosystem.

The Prevention Clinic Tokyo establishes individual health baselines through examinations including MRI, CT, and DWIBS, together with the Longevity Panel. Clinic 9ru delivers subsequent regenerative interventions, with physicians formulating and dynamically adjusting individualized protocols based on diagnostic findings. Furthermore, specialized Cell Processing Centers (CPCs) in Ginza and Osaka oversee cell culture, processing, and quality management, creating robust clinical synergy across diagnostics, therapeutics, cell manufacturing, and longitudinal follow-up.

Source: Public information, company websites, TIMEPIE Research Institute analysis

5.3 Implementation Pathways for Longevity Clinics

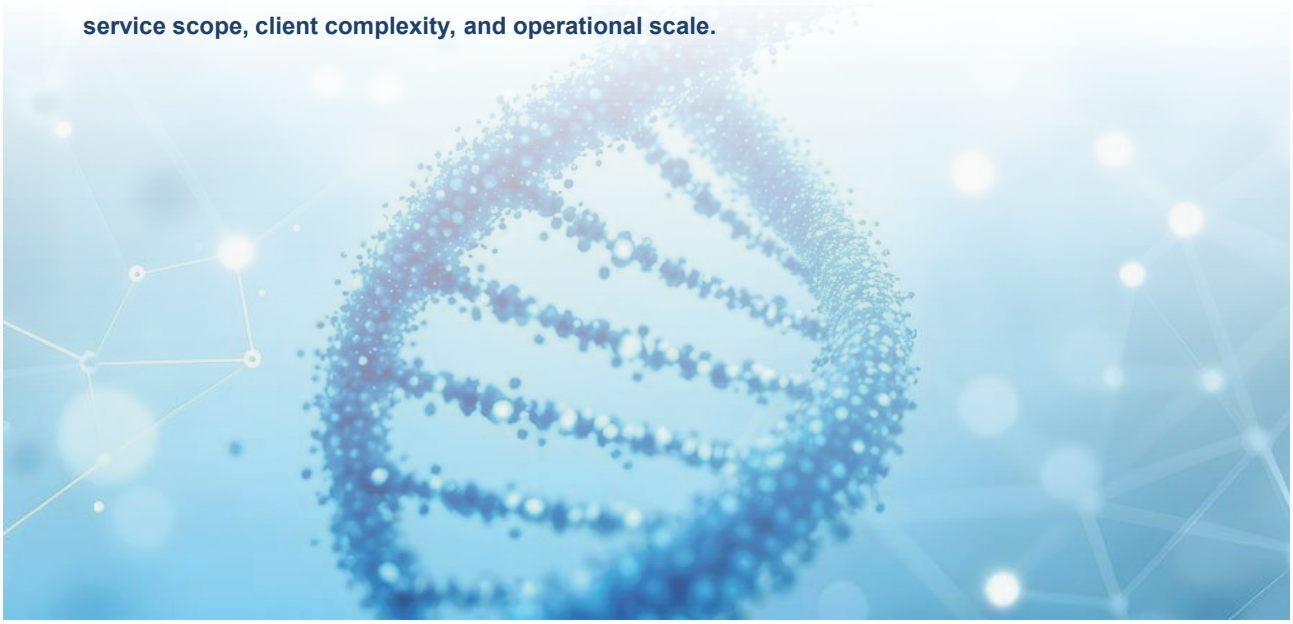
Beyond leveraging established hospital systems and urban clinics to deliver long-term care, select longevity clinics forge differentiated pathways centered on specialized service settings, advanced assessment capabilities, or distinct medical technologies, thereby shaping unique resource allocation models and capability-building priorities.

◘ Case Studies of Representative Longevity Clinic Models (7/7)

In clinical application, 5STAR MEDICAL GROUP delivers comprehensive longevity medicine by synthesizing aging biomarker panel diagnostics with regenerative therapeutics, microRNA (miRNA) analysis, and seven specialized exosome therapy protocols (derived from supernatants of bone marrow, amniotic membrane, placenta, umbilical cord blood, dental pulp, and adipose tissue, alongside induced pluripotent stem cell [iPS cell] supernatants), combined with senolytic therapies (senescent cell clearance). In parallel, it continues to develop new cell culture technologies.

Capability building for this model centers on technology application boundaries and clinical risk control. As specialized services expand, providers must concurrently delineate target populations, contraindications, delivery criteria, and efficacy evaluation methodologies, while establishing adverse event protocols and essential referral pathways. Technological capabilities can provide a basis for differentiation, but the model's long-term sustainability depends on whether these technologies can be consistently integrated into ongoing medical management.

Overall, the five pathways reflect distinct primary service gateways and resource structures. While real-world providers often exhibit hybrid models—layering pathways as they mature—capability investments should prioritize critical links tied to their core model. Providers can then progressively refine medical responsibilities, risk mitigation, and continuous delivery based on service scope, client complexity, and operational scale.



Source: Public information, company websites, TIMEPIE Research Institute analysis

Summary

Existing Healthcare Providers Serve as a Vital Foundation for Longevity Clinic Transformation

Medical aesthetics, health screening, and traditional healthcare providers have respectively accumulated capabilities in client operations, longitudinal health data, and long-term conditioning, offering distinct starting baselines when expanding into longevity medicine. Medical aesthetics providers can expand from aesthetic rejuvenation into systemic functional maintenance; health screening centers can extend diagnostic capabilities into precision health management and early disease intervention; and TCM providers can further reinforce quantitative assessment and continuous tracking.

Service Design Is Shifting from Intervention Stacking to Risk Prioritization and Phased Goal Management

Longevity clients often present concurrently with multiple abnormal biomarkers, functional decline, and lifestyle risks. Service design requires prioritizing pre-existing conditions and major clinical risks before defining phased priorities based on room for improvement, focusing on up to three primary goals per care cycle. Critical checkpoints—including information collection, clinical judgment, protocol approval, delivery, and reassessment—should maintain procedural consistency, while specific interventions are flexibly adjusted based on risk priorities, health goals, and practical conditions.

Stable, Continuous, and Replicable Delivery Systems Are Becoming Key Capabilities for Longevity Clinic Expansion

Providers across the five models—Hospital-Affiliated Longevity Care, Urban Longitudinal Care, Medical Wellness Destination, Advanced Diagnostics-Led, and Advanced Clinical Capabilities-Led models—have established differentiated service gateways and resource organization approaches. As operational scale expands, providers universally face challenges regarding unified clinical decision-making, multidisciplinary collaboration, abnormal finding resolution, reassessment feedback, and cross-site quality consistency.

Source: Public information, literature review, TIMEPIE Research Institute analysis

Chapter 6

Analysis of Selected Case Studies



06

Perfect (China) Co., Ltd.

Founded in 1994 and headquartered in Zhongshan, Guangdong, Perfect (China) Co., Ltd. is a foreign-invested health and wellness technology company. Alongside its ongoing digital transformation, the company has developed commercial applications centered on Perfectus CMH™-8, exploring multi-ingredient formulations and their synergistic effects across multiple targets to address vascular aging.

Corporate Scale and R&D Capabilities

RMB 10 billion+	Cumulative Investment
73.3+ hectares	Total Site Area
540+	Accredited Laboratory Testing Items
10000+	Service Centers
4 R&D areas	Bioactive Peptides, Natural Botanicals, Traditional Chinese Medicine, Microecology



R&D Platforms and Corporate Recognition

High-Tech Enterprise ; National Intellectual Property Demonstration Enterprise; Guangdong Specialized, Refined, Distinctive and Innovative SME ; Guangdong Province Aloe and Bioactive Peptide Engineering Technology Research and Development Center ; Guangdong Provincial Enterprise Technology Center ; Guangdong Provincial Doctoral Workstation; among others

ISO 9001 Quality Management System Certification
ISO 14001 Environmental Management System Certification
HACCP Food Safety Management System Certification
ISO 22716 / ASEAN GMPC Cosmetics Good Manufacturing Practices Certification

Perfectus CMH™-8: Ingredients and Formulation Research

Key Ingredients & Combinations	Research Focus	Scientific Evidence / Findings
Pumpkin Seed Protein Peptides	Vascular Endothelial Function	• ACE inhibition rate: 74% • Modulation of NO, ET-1, TNF-α and CAT
Panax notoginseng Stem and Leaf Extract Powder	Microcirculation, Vascular Structure and Elasticity, and Inflammation	• Reduced blood viscosity • PWV reduced by 37.8% • Modulation of IL-6, TNF-α, MMP-2 and MMP-9
Wampee Fruit Powder	Vascular Aging–Related Changes	• PWV reduced by 48.2% • Modulation of p53, p16, and SASP
Osmanthus Extract + Pumpkin Seed Protein Peptides	Vascular Endothelial Function	• Improvements in vessel diameter, blood flow velocity, and cardiac output in an Ang II–induced zebrafish model of vascular aging

Data sources: Perfect Life Health Technology Research Institute, third-party sources, cell-based assays, zebrafish studies and animal experiments.

Core Strengths and Competitive Advantages

Signature Ingredients

Controlled Sourcing
Standardized sourcing and processing of pumpkin seed protein peptides, with controls from cultivation and field management through harvest.

Authentic Origin
Notoginseng stems and leaves from Wenshan, Yunnan, are selected for their distinctive active-compound profile to develop a signature botanical extract.

Scientific Formulation

The formula uses a multi-target, synergistic design across three areas: vascular endothelium, vascular elasticity and microcirculation. Synergistic effects have also been investigated for selected ingredient combinations.

Notoginseng Stem-and-Leaf Extract Powder + Astragalus
Microvascular regeneration / microcirculation perfusion
Osmanthus Extract + Pumpkin Seed Protein Peptides
Vasomotor function / blood-flow velocity

Patent Support



Pumpkin Seed Protein Peptides
An invention patent has been granted for the dual-enzyme hydrolysis process.

Vascular Aging–Related Compositions
Invention patent applications cover the preparation and use of core formulations, forming a technology portfolio of vascular aging–related compositions.

Scientific Publications



Related studies published in journals including *Journal of Ethnopharmacology* and the *Journal of Functional Foods*, providing a research basis for related ingredient development.

Multiple product innovation awards have been received.

Source Company materials, and analysis by the TIMEPIE Research Institute

Gnosis by Lesaffre

Gnosis by Lesaffre is the human health business unit of Lesaffre. Drawing on the Group's 173 years of fermentation expertise, it develops ingredients and solutions for longevity clinics and the dietary supplement industry through microbial fermentation and biotransformation.

173 Years of Fermentation Expertise

Fermentation Technology

173 Years of Fermentation Expertise
Developing Health Ingredients Through
Microbial Fermentation and Biotransformation

Three Ingredient Categories

Active ingredients, probiotics, and nutritional yeasts.

Group R&D Resources

10 R&D centers;

700+ R&D specialists;

90+ innovation projects with universities and research centers.

1882 First sales of Red Star yeast.

2007 Entered the human health market.

2014 Acquired Omniabios and its SAMe production capabilities.

2018 Completed the acquisition of Gnosis Advanced Biotech. Creating Gnosis by Lesaffre.

2021 Acquired NattoPharma AS, expanding its nutrition and health business.

2024 Launched LANDKIND® Pure Salidroside, expanding its biotechnology-derived ingredient portfolio.

2026 Capacity expansion at Denain, France, for MyCondro™ fermentation-derived chondroitin sulfate.



Ingredients and Health Applications

Quatrefolic® 5-MTHF Glucosamine Salt

Women's Health Across the Lifespan | Cardiovascular Health | Antioxidant Support

Direct Absorption: 5-MTHF is highly water-soluble and is described as the only known folate form capable of crossing the blood-brain barrier. It can be directly absorbed by the body without metabolic conversion. Peak plasma levels of (6S)-5-MTHF are approximately **three times** those of synthetic folic acid.

Comprehensive, Lifelong Health Support: 10 studies across seven countries involving 1,600+ participants, covering pregnancy, cardiovascular health, menopause management, and cognition.

Quatrefolic® The 4th generation folate

MenaQ7® Natural Fermented Vitamin K2 (MK-7)

Bone Health | Cardiovascular Health

Natural Origin: Produced through natural fermentation, combining high product quality with sustainability.

Enhanced Absorption: Vitamin K2 in the MK-7 form is characterized by near-complete absorption. Compared with other forms of vitamin K2, it has higher bioavailability and the longest residence time in the bloodstream.

Scientific Validation: Supported by extensive clinical research, with more than 22 clinical studies and recognition from numerous experts. Fermentation, purification and the development of multiple dosage forms enhance ingredient purity and product versatility.

MenaQ7 NATURAL VITAMIN K2 AS MK-7

Emothion® Next-Generation Premium Glutathione

Antioxidant Support | Skin & Liver Health | Exercise Recovery

Patented Structure: Next-generation premium glutathione featuring a unique patented crystalline form.

High Bioavailability: Supported by two clinical studies, with demonstrated increases in glutathione levels at the cellular level.

Four Key Benefit Areas: 1. Antioxidant balance and enhanced skin radiance and clarity; 2. Cellular detoxification and liver health; 3. Enhanced energy, exercise performance and recovery; 4. Longevity and neuroprotection.

Clinical Bioavailability: ***+69%*** vs. Standard Glutathione

emothion CELL POWER WITHIN – RADIATING BEYOND

Lynside® Saccharomyces boulardii Probiotic

Gut Health | Immune Support

Patented Strain: *Saccharomyces boulardii* CNCM I-3799, a probiotic yeast with good tolerance to gastric acid and bile salts, helping maintain high survival rates in the gastrointestinal tract.

Multiple Mechanisms:1.Colonization Resistance, Competes with intestinal microorganisms for nutrients and functional niches. 2. Immune Exclusion, Helps prevent microorganisms from invading and crossing the intestinal barrier. 3. Mucosal Immunity, Helps defend against infection at sites of pathogen entry.

Scientific Validation: 70+ clinical studies, including one proprietary study on acute diarrhea in children.

3–5-Year Shelf Life: Excellent stability across various packaging conditions; suitable for capsules, powders and tablets.

Lynside *S. boulardii* CNCM I-3799

Source: Company materials, and analysis by the TIMEPIE Research Institute

infinityseek

infinitySeek

Research Foundation

Through its Longevity Lab and collaboration with international organizations including Germany's Lipidomix and SGS, infinityseek translates evidence-based life science into precision nutrition solutions

Asia-Pacific Presence

Featured at the World Biotechnology Congress in Singapore, the Greater Bay Area International Omega-3 Science and Industry Conference, and its Shanghai brand launch, with coverage from over 100 media outlets worldwide.

Industry Recognition

Recipient of the Anti-Aging Brand Innovation Star Performer award at the 2026 Hurun Best of the Best Awards and recognized among the iSEE Top 100 Innovative Brands.

Distribution Network

Available through Douyin, JD.com, Tmall, Xiaohongshu, and WeChat, with products featured in Tmall Heybox.

Anti-Aging Science

SPMs (Specialized Pro-Resolving Mediators)

Derived from unsaturated fatty acids, SPMs activate inflammation-resolution pathways, clear inflammatory debris and help resolve chronic inflammation. Animal studies reported a 35% reduction in aging-related inflammatory factors and a 22% increase in telomerase activity after eight weeks of supplementation.

Polar Lipids

Conventional triglyceride-form Omega-3 requires digestion before absorption. Polar lipids have both water- and fat-affine regions, resembling cell membrane lipids. This structure facilitates intestinal uptake and enhances the bioavailability of EPA and other active components.

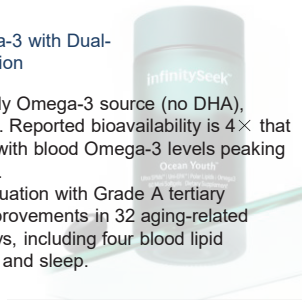
Urolithin A

Modulates the longevity-associated SIRT1 signaling pathway, modulates the aging clock, restores disrupted biological rhythms and slows ovarian functional decline. Reported anti-aging potential approximately 9× that of NAD+ precursors, supported by 750+ publications, 45+ clinical studies and 250 patents on urolithins.

Featured Products

Ocean Youth™
Flagship Product

Third-Generation Omega-3 with Dual-Target EPA + SPMs Action



- Combines an EPA-only Omega-3 source (no DHA), SPMs and polar lipids. Reported bioavailability is 4× that of high-purity fish oil, with blood Omega-3 levels peaking two hours after intake.
- A 100-participant evaluation with Grade A tertiary hospitals reported improvements in 32 aging-related measures over 56 days, including four blood lipid markers, skin, energy and sleep.

Ovary Youth™
Women's Health Formula

Hormone-Free Formula with Three Complementary Mechanisms



- **Preserve:** Urolithin A maintains follicular dormancy and protects ovarian reserve
- **Energize:** Patented ubiquinol, vitamin E, active folate and vitamin B12 support mitochondrial energy and revitalize the ovarian environment.
- **Balance & Glow:** Chasteberry supports menstrual regularity; aronia delivers radiant complexion; lemon balm and magnesium glycinate promote relaxation and restful sleep.

Research Findings & User Feedback

LDL Cholesterol ***-37.14%***
Fatigue ***-80%***
Natural Defenses ***+66%***
Memory ***+38%***
Dry Eyes ***-56%***



Better Sleep & Emotional Stability ***96.4%***
Feeling Lighter & Improved Complexion ***75%***
Rosier, Brighter Complexion ***67.9%***
Improved Skin Radiance ***78.6%***
Smoother, More Refined Skin ***64.3%***



100% Reported Benefits Across Six Areas

Mental Clarity / Energy / Stress Relief / Restful Sleep / Firmer Skin / Stronger Hair

Urolithin A: Pioneering Ovarian Anti-Aging
Over 1,000 Supporting References and Credentials

Passed 223 SGS Safety Tests
No Hormones, Allergens or Prohibited Additives

**Sources: Third-party human evaluations and published literature*

Cellcare healthcare centers: A Benchmark for Scalable Health Management

Supported by BFG Meitian Group's consumer healthcare ecosystem and chain operations, Cellcare healthcare centers has built a clinic network across China's tier-one and tier-two cities. Its growing expertise in functional medicine, integrative medicine and women's health makes it a benchmark for professional health management at scale.

Brand Milestones



2022 Specialized Care and Research Infrastructure
Established the Cellcare healthcare centers Women's Special Care Center and the Fudan–Jinbo Functional Protein Education Base.



2022.7 Research Milestone
Research on women's reproductive mucosal health received first prize in a national key research project under the National Health Commission's 14th Five-Year Plan.



2024
Expanded to over 10 clinics across major tier-one and tier-two cities in China.

2015
Cellcare healthcare centers was founded.



2018
The first Cellcare healthcare centers health management center opened in Shanghai.



2023.5
Invited to serve as a council member of the newly established Functional Medicine Branch of the Beijing Association of Holistic Integrative Medicine.



2023.11
Joined the Chinese Maternal and Child Health Association.

Looking ahead
Continue to expand the brand portfolio and clinic network while strengthening digital collaboration and health management capabilities.



Cellcare healthcare centers serves women seeking premium healthcare through a clinic network spanning China's major tier-one and tier-two cities, including Shanghai, Beijing, Shenzhen, Chongqing and Wuhan. The network reached 13 clinics as of August 2026.

Clinical Expertise and Services

Subhealth Assessment and Intervention

Conducts functional medicine testing and multidimensional assessments across metabolism, immunity, sleep and stress, and cardiovascular health to guide targeted interventions.

Digital Health Management

Integrates precision testing data, expert clinical pathways, and clinical cases. AI models support health status analysis and personalized care planning, with long-term tracking, outcome feedback, and dynamic adjustments.

Integrative Medicine Clinics

Combines clinical and functional medicine with multidisciplinary expertise to provide integrated health management for people with chronic conditions, those undergoing rehabilitation, and individuals with complex health needs.

Women's Specialty Care

Addresses women's health needs across different life stages through a dedicated Women's Specialty Care Center that combines functional medicine with gynecological expertise.

50+ Multidisciplinary Expert Team

Experts trained at institutions including China Medical University, Peking University Health Science Center and Illinois State University bring years of experience in functional medicine, regenerative medicine and specialized women's care to support personalized treatment plans.

10+ Patent Filings and Certifications

Ongoing R&D and commercialization of technologies related to health management.



100+ Research Publications

Ongoing research output in functional medicine and related health management fields.

Source: Company materials, and analysis by the TIMEPIE Research Institute

Cellcare healthcare centers: A Benchmark for Scalable Health Management

CellCare 美田医疗——研源健康

Building on its scale, Cellcare healthcare centers differentiates itself through group synergies, specialist women's care and digital health management. Its Women's Special Care Center was an early adopter of integrating gynecology with clinical anti-aging practice, addressing endocrine and reproductive health needs across women's life stages.

Building the Group's Health Management Ecosystem

Dual Beauty + Dual Wellness, Extending Customer Lifetime Value

Through BFG Meitian Group's nationwide network and brand synergies, Cellcare healthcare centers integrates healthcare into the Group's beauty–aesthetic medicine–healthcare service chain. It connects the existing customer base with clinical expertise and health management services, extending care from everyday wellness to specialist medical services.

Functional Medicine × Women's Specialty Care: Health Across Life Stages

Cellcare healthcare centers's Women's Special Care Center was among the early specialist providers to integrate gynecology with clinical anti-aging practice. Combining gynecological expertise, functional medicine testing and multidisciplinary care, it assesses and addresses endocrine and reproductive health needs, building a portfolio of products and services across women's life stages.

As an early entrant in gynecological medical R&D, Cellcare healthcare centers connects advanced research with clinical practice, collects real-world clinical data and contributes to industry standardization, providing practical models for implementing technologies and services.

From Precision Testing to Personalized, Adaptive Care

Cellcare healthcare centers's proprietary AI models combine precision testing data, expert clinical pathways and clinical cases to support personalized care planning. By linking assessment, tailored interventions, long-term monitoring and outcome feedback, they enable adaptive health management with 24/7 intelligent support.

BFG Meitian Group's Operating Network

100+ *Cities*

700+ *Stores*

1 M+ *Annual Customer Visits*

Cellcare healthcare centers Business Growth

2025 Revenue ***RMB 3.3 M***

Revenue Growth ***62.2%*** YoY

Women's Special Care Revenue Growth ***64%*** YoY

13 Clinics as of August 2026

Functional Medicine Revenue Growth ***101%*** YoY

From Precision Assessment to Personalized Care

Precision Assessment	Health Analysis	Personalized Planning	Targeted Intervention	Dynamic Management
Multidimensional testing; functional medicine assessment; health risk identification	Integrate test data; assess individual health status and potential concerns	Specialist care; nutritional support; lifestyle management	Tailor interventions to individual health needs	Long-term monitoring; outcome feedback; plan adjustments

Case 01 Biological Age Management

Multidimensional health assessments quantify individual health status and inform targeted health management plans.

Multidimensional Testing → Biological Age Assessment → Health Analysis → Personalized Care

Assessment Areas
Biological age · Gut microbiota · Metabolic status · Physical function

Management Areas
Nutritional support · Metabolic management · Lifestyle interventions · Long-term monitoring

Case 02 Energy Drip

Personalized IV nutrient therapy delivers vitamins, minerals, coenzymes and other functional supplements directly into the bloodstream for distribution to target cells, tissues and organs.

Needs Assessment → Specialist Plan → Formulation → Ongoing Adjustment

According to company materials, direct delivery into the bloodstream bypasses digestion, offers ***90% ~ 100%*** absorption, and avoids gastrointestinal discomfort associated with oral supplementation.

Minimal Loss, Efficient Delivery

Direct Nutrient Delivery

Energy Drip offers 30+ personalized protocols, tailored to different health needs and adjusted according to assessment results.

Source: Company materials, and analysis by the TIMEPIE Research Institute

RYOYI

Founded in 2018 and based in Beijing's central business district, RYOYI is a medical service provider established to international standards. Drawing on Japanese medical aesthetics and clinical practice, it offers Japanese-style aesthetic and medical care, alongside a multidimensional approach to health management at the cellular level.

From Aesthetic Care to Long-Term Health Management

Initially guided by natural aesthetics and Japanese-style precision medicine, RYOYI has incorporated French preventive medicine, functional medicine, biological monitoring, and long-term medical follow-up. Its focus has expanded from external rejuvenation to managing the aging process and long-term health trajectories, with ongoing assessment and intervention centered on each individual's Health Capital.

01 Long-Term Health Management

The focus extends beyond visible signs of aging to the aging process itself. As individual interventions often have short-term effects, the emphasis shifts from one-off treatments to ongoing management of aging.

02 Long-Term Management of Health Capital

Each individual's Health Capital serves as the focus of long-term management. Preventive medicine, biological monitoring, functional medicine, and long-term medical follow-up are integrated into a unified methodology, supported by ongoing assessment and follow-up.

03 Upholding Medical Principles

Medical expertise and safety boundaries come first. Care plans and treatment selection prioritize individual needs and clinical judgment, avoiding unnecessary or excessive interventions.

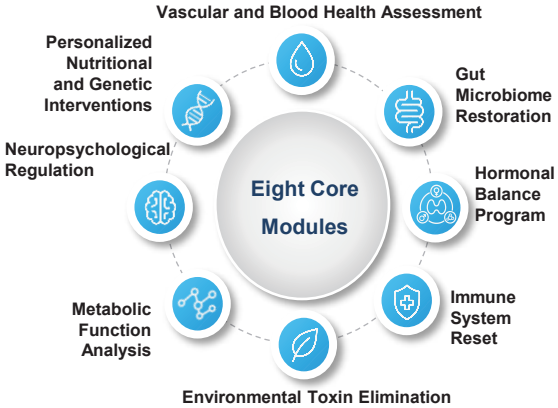
04 Physical Function and Quality of Life

Care focuses on physical function and quality of life, with individualized assessment and follow-up covering muscle mass, hormonal status and cognitive health.

Natural Aesthetics | Japanese-Style Concierge Care | Advanced Technologies | Cross-Disciplinary Innovation | Medical Safety | Science-Based, Personalized Health Management | Ethical Medicine, Do No Harm

Core Strengths

RYOYI integrates multisystem health assessment, functional medicine testing, risk stratification and personalized interventions within one care framework. Standard operating procedures (SOPs) and ongoing follow-up support long-term management.



Precision Testing

Endocrine Testing | Digestive Function Testing | Immune Testing | Immune Status Assessment | Stress Hormone Testing

Combines EIS, the IHMS intelligent health management system and functional medicine testing to assess and monitor cardiovascular, metabolic, immune, respiratory, digestive and neurological health, as well as fatigue.

Precision Anti-Aging Unit: Monitoring → Assessment → Intervention

Test results guide personalized nutrition and lifestyle management plans.

SOP-Based Clinical Framework

Standardized workflows strengthen clinical consistency, safety, reproducibility and long-term follow-up.

Patient Enrollment → Biological Assessment → Aging Risk Stratification → Clinical Decisions, Intervention Priorities → Ongoing Monitoring, Adjustment

Established Service Capabilities | Sino-Japanese Collaborative Care | Personalized Care Plans | Japanese-Style Concierge Service

Source: Company materials, and analysis by the TIMEPIE Research Institute

RYOYI

RYOYI integrates aesthetic medicine, anti-aging care, functional medicine and multispecialty services. It operates eight directly managed locations, including a 5,000 m² facility in Beijing's CBD, and has served tens of thousands of high-net-worth clients. New clients come primarily through established relationships and referrals, while visits by entertainment figures and related events have strengthened brand recognition among this clientele.

Health Management Programs and Services

One-Year Personalized Health Management Program

Combines multidimensional health assessments, personalized care planning and ongoing follow-up.

One-Year Care Plan

Structured planning, ongoing support and monitoring.

Blood Testing Based on Clinical Needs

Testing frequency is determined by the physician based on individual needs.

Monthly In-Person or Video Consultation

Review progress and adjust the plan.

Comprehensive Health Check

Assess overall health status.

Personalized Interventions & Follow-Up

Tailor and continually refine care.

Physical Intervention Equipment Matrix

RYOYI's physical intervention portfolio spans light, oxygen, heat and magnetic modalities, with light therapy, oxygen, cryotherapy and flotation chambers supporting light exposure, oxygen-based care, cold stimulation and relaxation.

Selected according to individual assessments and health needs, these technologies complement nutritional, lifestyle and medical interventions.

Signature Aesthetic Procedures

Japanese-Style Sakito Double-Eyelid Surgery | Japanese-Style Orbital Fat Repositioning | RYOYI Lift&lighten | Japanese-Style Sub-Brow Lift | Venus Custom Breast Enhancement | Natural-Looking Rhinoplasty

Clinical Team and Expertise

RYOYI connects international specialists with local multidisciplinary physicians across assessment, care planning and follow-up, maintaining specialist involvement throughout the care pathway.

19 + Featured Physicians and Experts

10 years+ Clinical Experience of Chinese/Japanese Physicians

10k + Clinical Cases per Physician

French Medical Team Visits Beijing ***1–2 Times Monthly***

Foreign experts participate in academic exchanges and case consultations. All clinical treatments are prescribed and performed by licensed local physicians.

International Clinical Team

Physicians from mainland China, Japan, and the Taiwan region of China combine Japanese medical techniques with natural aesthetics to deliver care tailored to individual features.

Experienced Clinicians

Each physicians bring over 10 years of clinical experience and 10,000 cases, combining medical knowledge with practical expertise in assessment and treatment planning.

Integrated Multidisciplinary Care

RYOYI describes its multimodal health management model as integrating AI. Traditional Chinese and Western medicine specialists collaborate to tailor care to individual needs and health profiles.

Advancing Clinical Innovation

Physicians participate in Chinese and Japanese medical conferences and professional exchanges to explore advances in rejuvenation and related fields.

Featured Experts



Dr. Claude Chauchard

French Preventive Medicine Specialist; Founder, International Institute for Preventive Anti-aging Medicine

Holds a medical doctorate from the University of Montpellier, with training in endocrinology, biology and sports medicine. His LCDPI approach addresses seven areas: cell membranes; DNA; mitochondria and oxidative stress; hormonal pathways; immune balance; glucose pathways and cellular metabolism; and inflammation. His team contributes to RYOYI's personalized anti-aging plans.



Dr. Hirokazu Takazawa

Clinical Director, RYOYI Aesthetic Clinic; Director, Prime Ginza Clinic

A graduate of Kyoto University's Faculty of Medicine and former surgeon at Kyoto University Hospital, he has served as RYOYI's Clinical Director since 2018, with extensive experience in Japanese aesthetic medicine and rejuvenation.

Source: Company materials, and analysis by the TIMEPIE Research Institute

BPC Longevity Clinic

BPC LONGEVITY CLINIC

Borui Lantu is a premium anti-aging medicine brand under Huapont Life Sciences (002004.SZ). It draws on nearly 70 years of integrative medicine at Switzerland's Paracelsus Clinic, with clinical support from Chongqing Songshan General Hospital. Its five-dimension CLEAR framework and eight health centers provide personalized longevity care for high-net-worth individuals across chronic condition management, longevity therapies, environmental health, behavioral support, and risk assessment, guided by a "measure–intervene–remeasure" cycle.

Four Pillars

Industry Experience

30+years

Huapont Life Sciences · 002004.SZ
Over 30 years of experience spanning health and wellness, pharmaceuticals, medical services, hotels, and tourism.

Medical Heritage

nearly 70years

Paracelsus · Est. 1958
Founded in Switzerland in 1958, Paracelsus Clinic brings nearly 70 years of integrative medical practice.

Clinical Support

400+Medical Professionals

Chongqing Songshan General Hospital
with 40+ clinical departments and 35 professors and doctoral supervisors

Ecosystem Vision

EVERlife

EVERlife Village
An envisioned integrated destination combining a longevity museum, longevity and anti-aging services, medical care, and health-focused retail

The CLEAR Five-Dimension Intervention Framework

Chronic Care
Systematic management of chronic disease risks, including metabolic and cardiovascular conditions

Risk Assessment
Multidimensional testing to establish an individual health baseline



Action
Lifestyle guidance and behavioral support

Longevity Therapy
Targeted application of emerging longevity therapies

Environment
Management of environmental exposures and optimization of living environments

An integrated framework for long-term health management that combines risk assessment, chronic care, medical interventions, environmental factors, and lifestyle management.

The Measure–Intervene–Remeasure Cycle

1. **Comprehensive Assessment** — Establish an individual health baseline
2. **Personalized Planning** — Develop a personalized intervention plan
3. **Intervention Delivery** — Implement the planned interventions
4. **Progress Tracking** — Monitor key health indicators over time
5. **Reassessment & Refinement** — Reassess outcomes and adjust the plan

Reproductive and Endocrine Center

Reproductive & Endocrine Center | Brain & Neurological Health Center | Gut Microbiome Center | Musculoskeletal Strength Center | Immune Balance Center | Blood Anti-Aging Center | Cardiovascular & Cerebrovascular Center | Liver & Metabolic Health Center

Source: Company materials, and analysis by the TIMEPIE Research Institute

BPC Longevity Clinic

Building on its five-dimension CLEAR framework and eight health centers, Borui Lantu offers Tier 1–4 programs tailored by intervention intensity and duration. Each member undergoes a multidimensional baseline assessment. Functional medicine and clinical physicians then develop a personalized plan, delivered with the support of a tertiary general hospital.

Tier 1–4 Programs

TIER 4 | 7 Days

Introductory Experience Initial Assessment

Personalized Health Checkup;
Swiss Liver & Gallbladder Detox;
Swiss Immune Detox;
Cardiovascular Maintenance;
Metabolic Fat Burning

TIER 3 | 30 Days

Health Optimization Improved Well-Being

Brain Health;
Liver Health
Gallbladder Health;
Gut Health
Lung Health
Bone Health;
Peiyuan Program

TIER 2 | 90 Days

Chronic Condition & Risk Management

Metabolic Syndrome;
Prediabetes;
Deep Liver Detoxification;
Cardiovascular Function Optimization;
Lung Health & Inflammation Management;
Gut Microbiome Restoration
Knee Function Restoration

TIER 1 | Annual Program

Precision Anti-Aging Long-Term Management

Gut Microbiota Engraftment;
Cardiovascular Rejuvenation Plan;
Endocrine Renewal Plan;
Precision Anti-Aging for Men;
Precision Anti-Aging for Women

Assessments and Interventions

Health Status Mapping

A proprietary Health Status Indicator Matrix maps measures into six categories, including disease, chronic conditions, abnormal results, and optimal results. It builds a dynamic personal baseline, identifies current health status, and uses optimal results to guide an actionable longevity and anti-aging plan.

Swiss Dark-Field Live Blood Analysis

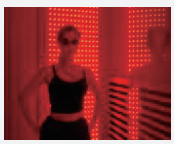
Live cell morphology;
Oxidative stress assessment;
Before-and-after comparisons;
Visualization of health risks related to intestinal permeability, inflammation, toxins, and aging



Longevity Technology Interventions

Advanced longevity technologies target cellular energy metabolism, oxidative stress balance, and immune regulation. Repeat assessments verify intervention outcomes and guide ongoing functional improvements, making anti-aging measures quantifiable, trackable, and actionable.











Selected Programs

Program 1: Body Cleanse

nearly 30	12	4 Stages
Environmental Contaminants Addressed	Body Systems Supported	Proprietary Detox Protocol

Proprietary Four-Stage Detox Protocol

DETECT | Precision Assessment

Establish baseline aging markers for before-and-after comparisons

DETOX | Systemic Detoxification

Coordinate blood, gut, and skin pathways to remove inflammatory markers and disease-causing substances

ACTIVATE | Cellular Activation

Activate cellular repair to enhance cell function and systemic regeneration

RESTORE | Long-Term Restoration

Provide targeted nutrition during the enhanced absorption window and rebuild healthy habits.

Client Case | Reduced Systemic Burden After One Treatment

Ferritin ↓29%; LDL-C ↓47%; triglycerides ↓37% (returning to the normal range); whole-blood viscosity ↓13%. Third-party testing reportedly quantified the removal of nine toxic elements, including aluminum, nickel, mercury, and lead.

Program 2: U.S. Medical-Grade Nutrient Interventions

Guided by precision testing of functional imbalances, functional medicine specialists prescribe personalized nutrients alongside dietary and behavioral management, providing comprehensive support beyond supplementation.

Program 3: Bioidentical Hormone Balancing

Aging marker assessments identify underlying hormonal imbalances. U.S.-certified functional and anti-aging medicine specialists personalize bioidentical hormone plans to regulate endocrine axes, emphasizing safety and absorption while supporting energy, mood, and a more youthful state.

Note: This page is based on materials provided by the institution and is intended to describe its health management services and representative programs. It does not constitute medical diagnosis or treatment advice, nor does it guarantee therapeutic outcomes.

Source: Company materials, and analysis by the TIMEPIE Research Institute

Yiling Pharmaceutical—A Leader in TCM-Based Healthy Aging

Yiling Pharmaceutical advances TCM-based anti-aging through innovation and evidence-based research. Its achievements include a National Key R&D project, 14 related invention patents, and recognition among the "Top 10 Advances in Longevity Medicine" in 2025. Guided by the Essence-Qi-Spirit Theory of Qiluo Doctrine, its Bazi Bushen Capsules research spans preclinical studies to clinical practice.

A Systematic Approach to Aging Research

01 Original Theory
Essence-Qi-Spirit Theory of Qiluo Doctrine

02 Evaluation System
21 aging models
21 evaluation indicators

03 Animal Studies
1,200 aging animals
Full-lifespan research

04 Human Evidence
530-Patient Multicenter RCT

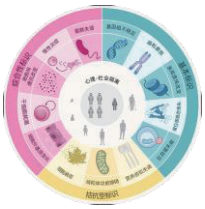
05 Clinical Application
Guideline & Consensus Adoption

Bazi Bushen Capsules: Key Anti-Aging Studies

Research Focus	Key Findings	Representative Publications
Reproductive Aging	Activates AMPK–SIRT3 signaling, regulates mitochondrial homeostasis and autophagy, alleviates endometrial cell senescence, and improves embryo implantation and fertility.	*iMeta (2026)* IF=44.4, CAS Q1 Top
Inflammaging	Significantly delays chronic stress-induced systemic aging. female mortality decreased from 72% to 28%; results on frailty index, mortality, and lifespan exceeded those of NMN.	*Exploration (2026)* IF=30.4
Vascular Aging	Improves vascular endothelial autophagy and delays vascular aging via the SIRT3–DHRS2 pathway.	*Phytomedicine (2025)* IF=7.9, SCI Q1
Systemic Aging	Modulates DNA methylation patterns, reduces epigenetic age, improves memory and muscle endurance, and extends healthspan.	*Biomedicine & Pharmacotherapy* IF=7.4, SCI Q2
Vascular & Metabolic Aging	Increases estrogen levels, reduces atherosclerotic plaque area, and lowers vascular event risk.	*Frontiers in Pharmacology* IF=6.0, SCI Q2
Clinical Research	A multicenter, randomized, double-blind RCT involving 530 participants found improvements in premature-aging symptoms after 12 weeks; telomerase activity increased by 76.7%.	*Phytomedicine (2024)* IF=7.9, SCI Q1
Other Aging Mechanisms	Reduces brain senescent cells and improves cognitive function; alleviates muscle atrophy and enhances strength, endurance, and balance; mitigates oxidative stress and cellular senescence via KEAP1–NRF2 signaling; and regulates gut microbiota, inflammation, and intestinal barrier function to support immune homeostasis.	*Pharmaceutical Biology; Journal of Cellular and Molecular Medicine*; *Phytomedicine; Frontiers in Microbiology; Cancer Letters* and other leading journals

Evidence Across 11 Aging Mechanisms

- ✓ **Overall physiological benefits:** Improves psychological frailty, physical function, and exercise endurance
- ✓ **Multi-system intervention:** Covers 12 aging-related physiological systems
- ✓ **Molecular and cellular mechanisms:** Scientific evidence established for 11 of the 14 hallmarks of aging



Telomere protection
Epigenetic regulation
Mitochondrial homeostasis
Senescent cell clearance
Stem cell vitality
Intercellular communication regulation
Chronic inflammation suppression
Extracellular matrix protection
Gut microbiome remodeling
Enhanced cellular autophagy
Improved cellular energy metabolism

Clinical Evidence & Guideline Recognition

◆ **Clinical Research**
A 530-participant, multicenter, randomized, double-blind, placebo-controlled RCT led by Xiyuan Hospital of the China Academy of Chinese Medical Sciences forms the core of the clinical evidence base. Published results establish a multi-system evidence chain, with efficacy and safety rigorously evaluated.

◆ **Guidelines & Expert Consensus**
It is cited in national disease–syndrome integrated guidelines for diabetes with osteoporosis, TCM management of older-adult diabetes (2024), type 2 diabetes-related cerebral small-vessel cognitive impairment, and menopausal syndrome; the Expert Consensus on TCM Interventions for Aging (2024); the TCM–Western medicine urogenital disease consensus; the China Longevity Medicine and Anti-Aging Industry White Paper; and basic standards for anti-aging medicine clinics. Further guidelines are in development.

Source: Company materials, and analysis by the TIMEPIE Research Institute

5STAR MEDICAL GROUP

5 Star Medical Group

5STAR MEDICAL GROUP provides advanced longevity medicine, integrating precision assessment, diagnostics, prevention, regenerative medicine, cell processing, and research to develop continuously refined, personalized longevity care plans.

Group Structure & Service Portfolio

5 STAR MEDICAL GROUP

Integrating precision screening, cell processing, and longevity research into a unified medical network.

Three Core Medical Divisions

THE PREVENTION CLINIC TOKYO

Precision Health Screening & Risk Assessment

Advanced imaging and multidimensional testing establish a personalized baseline for longevity care

CLINIC 9ru

Regenerative Medicine, Anti-Aging & Aesthetic Medicine

Delivers personalized interventions following precision screening, connecting regenerative medicine with long-term health management.

BiOSTYLE CLINIC

Cell Therapy & Cell-Processing Infrastructure

Its large-scale cell culture and processing facilities support cell processing, quality control, and related medical services.

Group-Level Capabilities

CPC | GMP-Compliant Cell Culture & Processing Facilities

Group-wide cell-processing infrastructure supporting cell culture, processing, quality control, and safety management across medical institutions.

miRNA & Exosome Research | Next-Generation Cell Medicine

Research into exosomal miRNA libraries, cellular states, and autologous adipose-derived mesenchymal stem cells.



Core Competitive Advantages

01 Integrated Longevity Medicine Model

- Integrated care combining precision screening, blood conditioning, and stem cell-based therapies
- Multidimensional assessment with the Longevity Panel
- Dynamic feedback loop: Measure → Plan → Verify → Update
- Not just what to administer, but how to design care

02 Integrated Clinical & Cell Processing Infrastructure

- An integrated group-wide pathway linking screening, treatment, and CPC facilities
- CPC facilities in Ginza and Osaka, among the largest privately operated on-site facilities
- Specified cell processing facilities notified to Japan's Ministry of Health, Labour and Welfare
- End-to-end management by 10 cell culture specialists

03 Multidisciplinary Collaboration

- Around 80 professionals, including physicians, cell culture specialists, and nurses
- Physicians and academic experts with backgrounds at institutions including the University of Tokyo
- Cross-disciplinary collaboration for personalized care
- Multilingual services and international medical coordination

04 Research for Next-Generation Cell Medicine

- Six proprietary stem cell culture supernatant formulations
- In-depth analysis of exosomal miRNA profiles
- Research into exosome therapy and cell reconditioning
- From "what to administer" to "what information to convey"

Source: Company materials, and analysis by the TIMEPIE Research Institute

5STAR MEDICAL GROUP

5 Star Medical Group

Through THE PREVENTION CLINIC TOKYO, CLINIC 9ru, and BiOSTYLE CLINIC, 5STAR MEDICAL GROUP integrates comprehensive checkups, regenerative medicine, and cell processing across a continuum of assessment, prevention, treatment, and ongoing management.

Clinical Divisions and Core Services

01 THE PREVENTION CLINIC TOKYO

4F, The Peninsula Tokyo | Members-Only Precision Health Screening Center

- ✓ **Four Precision Checkup Packages** Multidimensional whole-body health risk assessment in 4–6 hours
- ✓ **Multidisciplinary Referral Network** Access to institutions including Nippon Medical School Hospital, Keio University Hospital, and Japanese Red Cross Medical Center for further evaluation and treatment
- ✓ **iPS Cell Banking** Stores iPS cells from an earlier stage of life as a potential cell resource for future regenerative medicine
- ✓ **Advanced Screening Capabilities**
  - **Cancer-Associated mRNA Analysis** Analysis of cancer-associated mRNA to support early risk assessment
  - **DWIBS Whole-Body Imaging** Contrast-Free Whole-Body MRI for Cancer Screening
  - **AI-Assisted Brain Health Assessment** MRI-based assessment of brain atrophy and cognitive risk
  - **LOX-index** Blood biomarkers for assessing ischemic stroke and heart attack risks

02 CLINIC 9ru

The Peninsula Tokyo | Regenerative Medicine | Anti-Aging | Aesthetics

- ✓ **Cell Therapies**
  - **Autologous Adipose-Derived Stem Cell Therapy** Uses a Non-Cryo protocol that avoids cryopreservation to preserve cell freshness and viability
  - **Stem Cell Culture Supernatant Therapy** Offers six types of cell-derived culture supernatants, selected according to treatment goals.
  - **Dermal Fibroblast Therapy** Uses cultured autologous postauricular skin cells for skin rejuvenation and age-related care
  - **NK Cell Therapy** Uses a Non-Cryo protocol to enhance NK-cell activity, with the aim of inhibiting cancer cell proliferation
- ✓ **Blood Purification** **DFPP (Double Filtration Plasmapheresis)**
  Uses double-filtration technology to purify plasma and remove selected blood components or substances
- ✓ **Aesthetic Medicine** **Personalized Skin Treatments**
  Personalized treatments for acne, UV damage, pigmentation, wrinkles, and skin laxity, including HIFU, picosecond laser, photorejuvenation, and HydraFacial

03 BiOSTYLE CLINIC

Ginza | Osaka | Japan's Largest Regenerative Medicine Clinic

- ✓ **Cell Therapies** Autologous stem cell culture therapy; stem cell-conditioned medium therapy; NK cell therapy
- ✓ **In-House Cell Processing**
  - **Three Dedicated Cell Culture Rooms** An integrated workflow covering cell collection, culture, processing, and subsequent preparation
  - **Seven Types of Culture Supernatant** In-depth miRNA research across a broad range of culture supernatants, described as one of Japan's widest selections
  - **iPS Cell Culture Supernatant** A next-generation cell-free approach supported by miRNA-related research
  - **NK Cell Bank** Cryopreservation in liquid nitrogen at −196°C for up to 10 years, providing a potential cell reserve for future treatment
- ✓ **NMN, PRP & Vascular Care** Integrated anti-aging care combining multiple approaches to address different aspects of aging
- ✓ **Specialist Medical Network** Supported by specialists and partner institutions in Japan's regenerative medicine field

Source: Company materials, and analysis by the TIMEPIE Research Institute

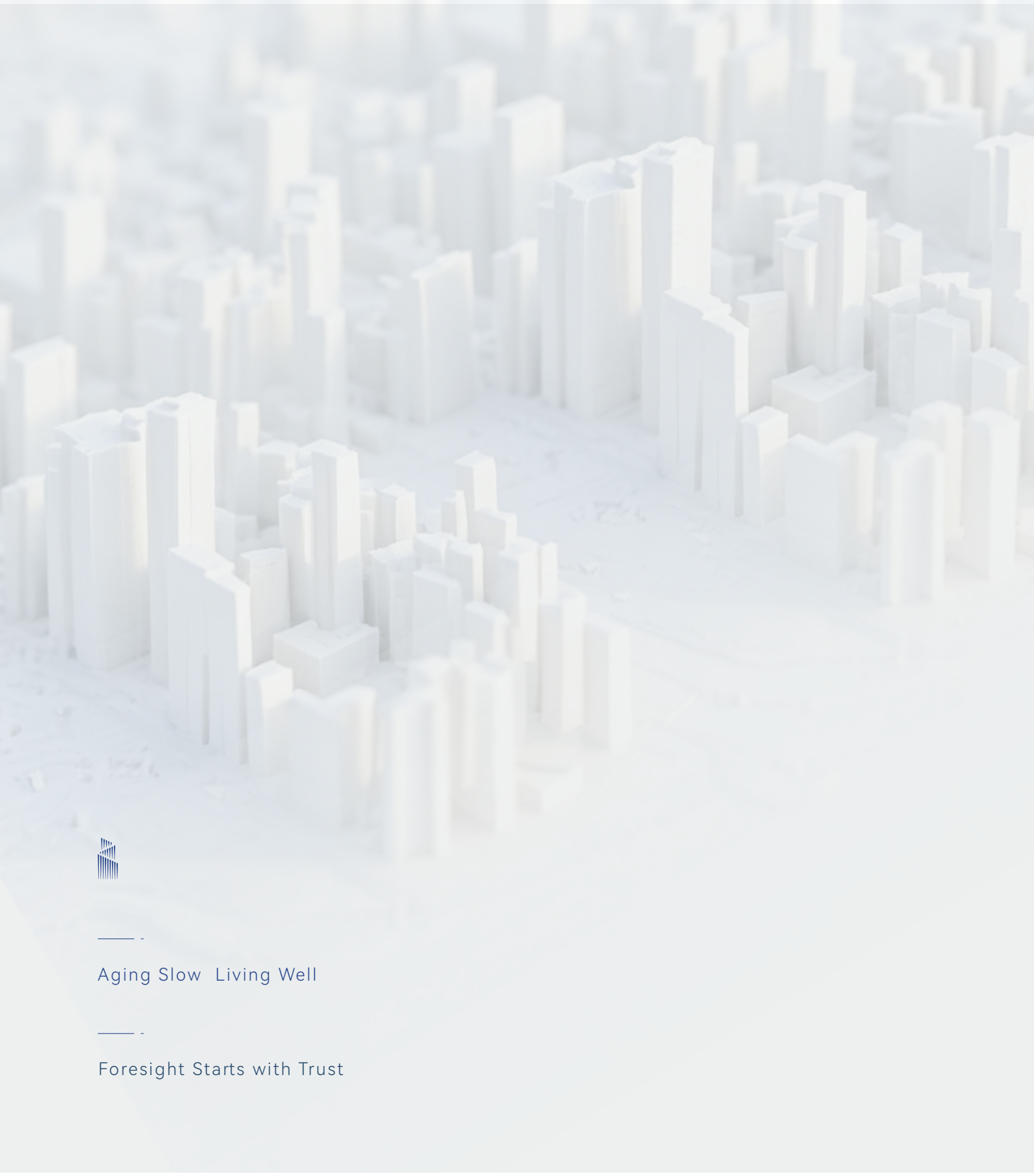
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Aging Slow Living Well

Foresight Starts with Trust