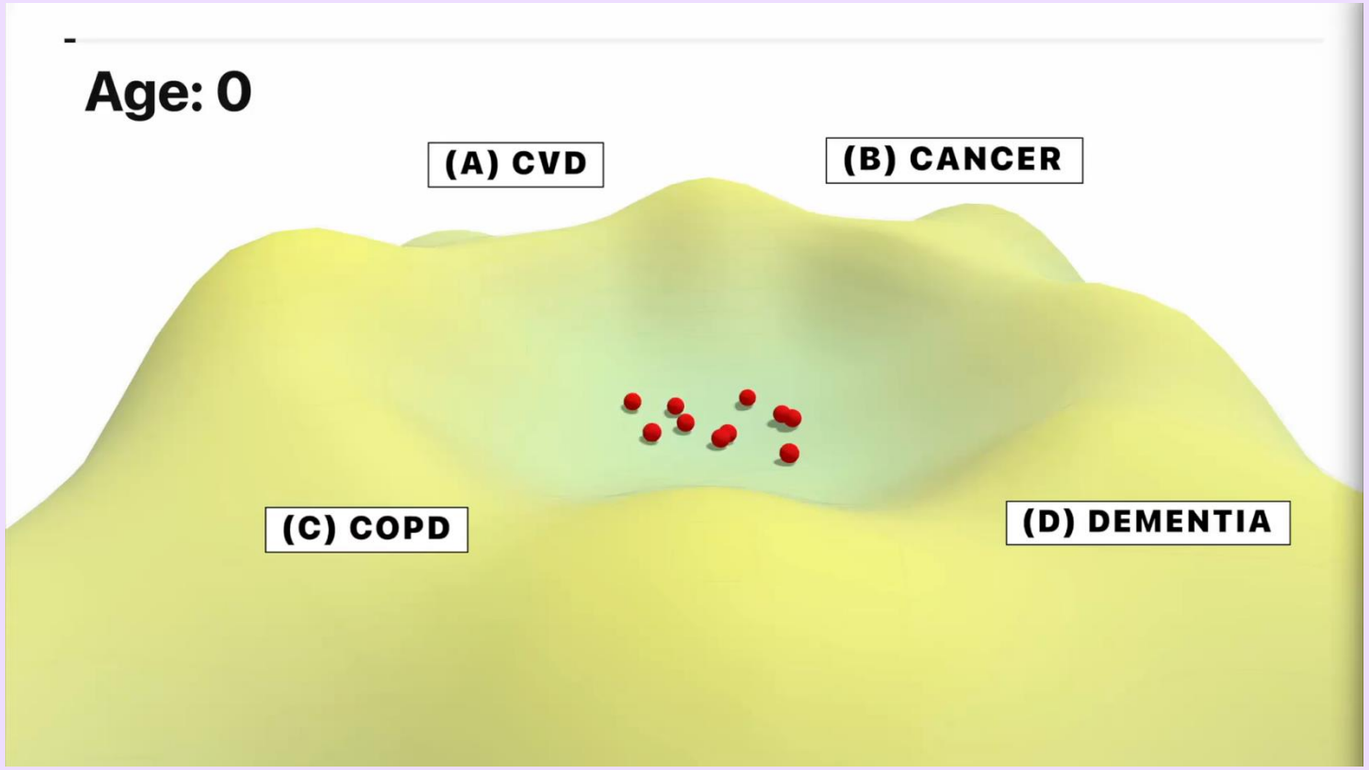
Clinical Biological Aging Clock for measuring Longevity

Turning standard blood data into a predictive, actionable roadmap for patient health

Beyond Clock

As we age, we lose resilience



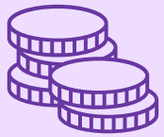
- Aging is the primary driver of disease
- The “Bounce Back” Factor: Youth is defined by the ability to recover rapidly from injury. Aging progressively compromises this natural repair mechanism
- As resilience fades, the body loses its capacity to return to baseline health, making us increasingly vulnerable

How do we measure aging?

Standard Care	*Precision Care with LinAge2*
Blood test results are in range **Diagnosis: Healthy** **Action: See you next year**	**Patient is aging 1.3 years faster than chronological age** **Primary Driver: High Albumin** **Action: Investigate inflammation/ liver stress**

Beyond Clock

Increasing healthspan has high economic value



$ 38 Trillion economic value added to the global economy for every **ONE YEAR** increase in healthspan

$ 367 Trillion for every **10 YEAR** increase in healthspan

https://pmc.ncbi.nlm.nih.gov/articles/PMC10154220/

Epigenetic vs Clinical Clock LinAge2

Feature	Epigenetic Clocks	LinAge2
Primary Data	DNA methylation patterns	Blood, urine, and clinical lab markers
Sample collection	Specialized DNA sampling	Standard clinical lab tests
Turnaround time	Depends on sequencing/assay	Standard lab timing
Interpretability for doctors	Black Box	Transparent via Prinicipal Components (PC)

Why aren't epigenetic tests reliable?

Biological and Lifestyle Factors

Your epigenome is not a fixed, permanent record, it's a dynamic system that responds to your immediate environment and actions.

A test taken on Monday could be different from one taken on Friday for many reasons. (Diet, Stress, Exercise, Sleep, Environment).

The "Ruler" is inconsistent

Even if your biology was perfectly stable, the testing process itself introduces variability.

The way a sample (saliva or blood) is collected, how long it sits before being frozen, and how it's stored can degrade the DNA and introduce errors.

Too much fluctuation for Clinical Use

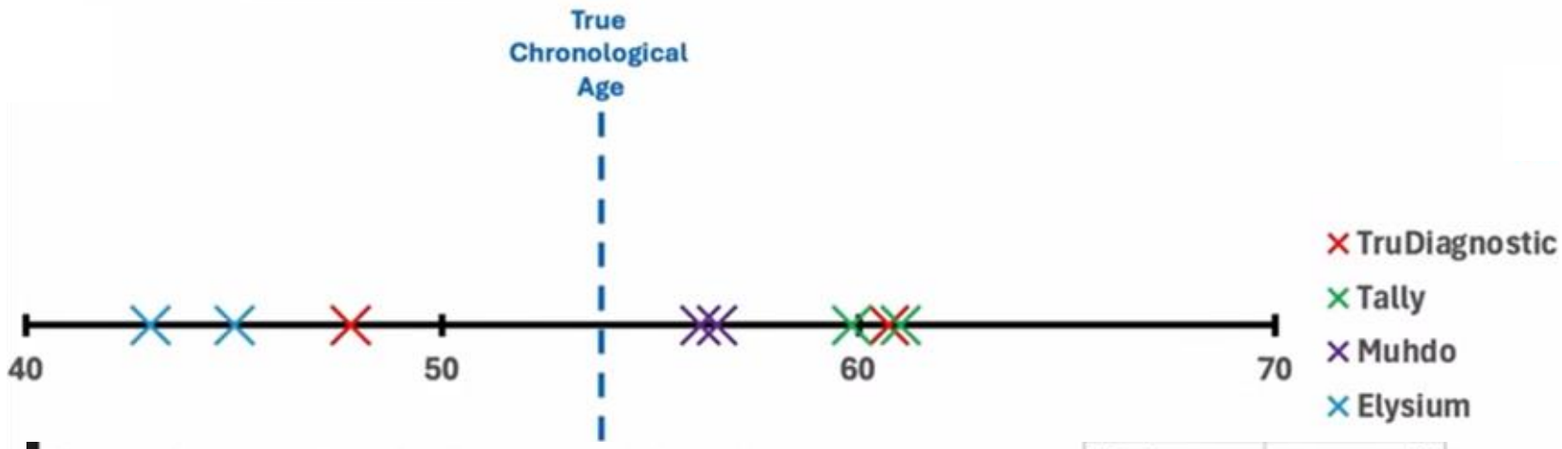
Epigenetic tests often pick up short-term biological noise from a patient's bad day, such as poor sleep, stress, illness or diet.

This makes it hard to tell whether a change reflects a real effect of a supplement or just temporary fluctuation.

No FDA Approval

Many companies in this space operate without transparency regarding their proprietary algorithms or data processing methods.

Consumer epigentic tests lack both accuracy and precision



True chronological age: 53.51
N=8 tests, 2 technical replicates x 4 companies
Mean epigenetic age: 53.8
Standard deviation: 7.4

Elysium	43
Elysium	45
TruDiagnosti	47.8
Muhdo	56.2
Muhdo	56.6
Tally Health	59.8333333
TruDiagnosti	60.73
Tally Health	61

Same person, same day, same DNA - yet results range from 43 to 61 years across companies

https://www.youtube.com/watch?v=NnWpkwUgCjs&t=1398s Optispan Podcast, 2024

Beyond Clock

The first and most accurate clinical Biological Aging Clock: LinAge2

Powered by NUS Science. Published in Nature Aging

What is LinAge2?

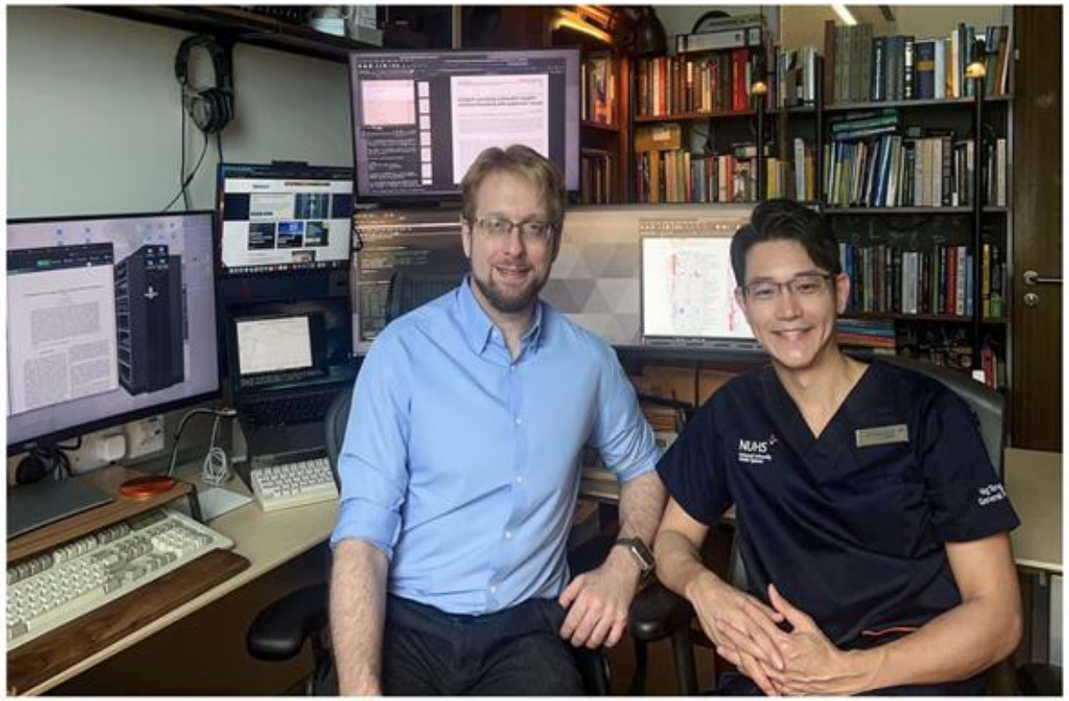
LinAge2 is a population-benchmarked **physiological aging assessment model** that transforms over **60 routine biomarkers** into a clear, interpretable measure of a person's **biological aging trajectory.**

Rather than labelling disease, it **quantifies system-level aging patterns** and identifies functional domains that require intervention.

This creates a **structured, data-driven framework** for proactive healthspan optimization and longitudinal tracking.

NUS Medicine researchers develop a better and more accurate biological ageing clock

Published: 09 Jun 2025



Associate Professor Jan Gruber, Department of Biochemistry, and Healthy Longevity TRP, NUS Medicine; and Dr Fong Sheng, Consultant in Geriatric Medicine, Ng Teng Fong General Hospital. Credit: NUS Medicine

Beyond Clock

Why it is better?

Systemic Interactions

We don't just look at cholesterol, we look at how cholesterol interacts with inflammation and kidney function to drive aging

Predicts Mortality

Trained on the biomarker patterns that lead to diseases which ultimately drive mortality

100% Actionable

If the biological age is high, you know which biomarker is driving it

USP

No DNA Required

Easier Clinic Integration & interpretation

Uses 60 common blood-based and clinical biomarkers

USP

LinAge2 groups together biomarkers into Principal Components (PCs)

No specialized tests required. Doctors already know how to interpret and treat!

INPUT

60 Standard Clinical Biomarkers (Lipids, Glucose, Inflammation, etc..)

OUTPUT

Actionable Biological Age & Disease Risk

Scan to see the full list of 60 clinical biomarkers and questionnaire

Or visit:
https://resources.beyondclock.com/latest/biomarker-list

Beyond Clock

What will the PCs show?

Which aging trajectory you are on

How fast you are aging compared to your peers

How much it contributes to your biological age

Better than ASCVD score!

The LinAge2 algorithm compares your biomarkers to people in your age group using data from the NHANES dataset

It then uses principal component analysis (a statistical method) to combine multiple biomarkers into a single, comprehensive score.

*** NHANES - National Health and Nutrition Examination Survey**

*** Principal Component Analysis (PCA), is a mathematical method used to simplify complex biological data**

Beyond Clock

Example of PC

Mapping Biological Age Impact

The matrix identifies PCs contributing most to biological aging, ranging from high-risk factors like **PC37F (+2.5 years)** to protective profiles like **PC35F (-4.4 years)**

Pinpointing Top Health Outcomes

The matrix highlights which specific principal components push the biological clock forward the fastest. For example: Osteoporosis (OP) and Lung Disease (COPD) are major risk outcomes for this person

Principal Component Risk Matrix

Rows show principal component contribution years across complication domains.

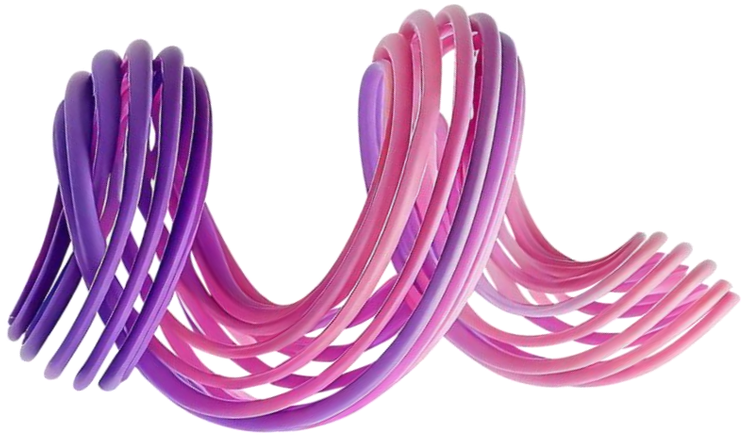
PC	PCTL	DISTRIBUTION	AGE IMPACT (95% CI)	OP	THIN	COPD	CVRF	CLD	ORGAN	SMOKER	CA	PAD	CCF	CVD	DM	HLD	CVA	OBESE	CKD	OA	HTN	CI	OLD
				2.8	0.7	0.5	0.2	0.1	-0.1	-0.6	-0.7	-1.1	-1.8	-2.3	-2.4	-3.1	-3.8	-4.0	-4.3	-4.7	-6.6	-7.0	-7.1
PC37F	100.0%		+2.5 Yrs (2.5 - 2.5)								2.5			2.5									
PC20F	86.2%		+1.6 Yrs (0.2 - 3.0)	1.6	1.6	1.6								1.6		1.6							
PC38F	92.4%		+1.4 Yrs (0.9 - 1.9)		1.4	1.4				1.4													
PC28F	85.5%		+1.4 Yrs (1.1 - 1.7)		1.4						1.4			1.4	1.4								
PC6F	81.4%		+1.0 Yrs (1.0 - 1.0)	1.0			1.0			1.0	1.0			1.0				1.0	1.0	1.0			1.0
PC24F	70.3%		+0.8 Yrs (0.5 - 1.0)		0.8					0.8	0.8											0.8	0.8
PC4F	47.6%		+0.4 Yrs (0.3 - 0.4)	0.4			0.4				0.4			0.4				0.4	0.4	0.4		0.4	0.4
PC2F	46.9%		+0.1 Yrs (0.1 - 0.1)	0.1	0.1	0.1	0.1	0.1			0.1			0.1					0.1	0.1		0.1	
PC23F	45.5%		+0.1 Yrs (-0.1 - 0.3)		0.1					0.1	0.1			0.1					0.1				0.1
PC1F	18.6%		-0.1 Yrs (-0.3 - 0.1)				-0.1		-0.1		-0.1			-0.1				-0.1				-0.1	
PC31F	44.1%		-0.2 Yrs (-0.2 - -0.2)	-0.2	-0.2	-0.2								-0.2		-0.2			-0.2	-0.2		-0.2	
PC39F	21.4%		-1.0 Yrs (-1.0 - -1.0)											-1.0				-1.0		-1.0	-1.0		-1.0
PC11F	24.1%		-1.1 Yrs (-1.3 - -1.0)				-1.1					-1.1		-1.1						-1.1		-1.1	
PC22F	6.2%		-1.8 Yrs (-2.1 - -1.5)										-1.8					-1.8	-1.8		-1.8		
PC13F	24.1%		-2.4 Yrs (-2.6 - -2.2)			-2.4					-2.4			-2.4				-2.4				-2.4	
PC32F	0.7%		-3.8 Yrs (-4.4 - -3.2)							-3.8					-3.8		-3.8		-3.8	-3.8	-3.8		-3.8
PC35F	1.4%		-4.4 Yrs (-4.5 - -4.4)		-4.4						-4.4			-4.4		-4.4						-4.4	-4.4

LEGEND

OP: Osteoporosis **THIN**: Thin Phenotype **COPD**: Chronic Obstructive Pulmonary Disease **CVRF**: Cardiovascular Risk Factors **CLD**: Chronic Liver Disease **ORGAN**: Multi-organ Impairment **SMOKER**: Smoker Phenotype **CA**: Cancer **PAD**: Peripheral Arterial Disease **CCF**: Congestive Cardiac Failure **CVD**: Cardiovascular Disease **DM**: Diabetes Mellitus **HLD**: Hyperlipidemia **CVA**: Cerebrovascular Accident **OBESE**: Obese Phenotype **CKD**: Chronic Kidney Disease **OA**: Arthritis **HTN**: Hypertension **CI**: Cognitive Impairment **OLD**: Obstructive Lung Disease

Get a quick overview of the main PC drivers

LinAge2 moves beyond isolated blood test results to provide a comprehensive view of a patient's health by identifying the specific biological markers increasing their biological age



PC28F - Biological age increased by 1.4 yrs

Your Percentile 85.5%

CONTRIBUTION BREAKDOWN

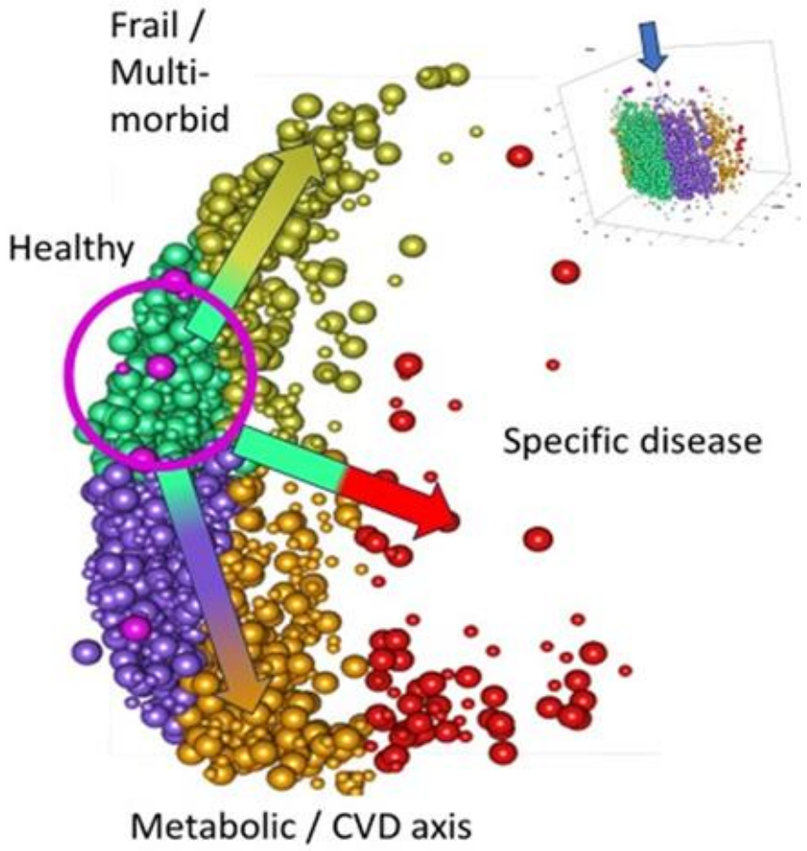
- Vitamin B12 · 18.0%
- Glucose, Serum (Fasting) · 10.3%
- Lactate Dehydrogenase · 8.6%
- Body Mass Index · 5.6%
- Hemoglobin · 4.8%
- Others · 15.9%
- Creatinine · 10.3%
- Urine Albumin/Creatinine Ratio · 10.1%
- Hematocrit · 7.9%
- C-Reactive Protein · 5.0%
- Basophils Percentage · 3.6%

BIOMARKER	VALUE	OPTIMAL RANGE	CONTRIBUTION (%)
Vitamin B12 LBDB12SI	835.00 pmol/L HIGH	145.00 - 569.00	18.0
Creatinine LBDSCRSI	0.84 mg/dL	0.50 - 1.60	10.3
Glucose, Serum (Fasting) LBDSGLSI	5.50 mmol/L	4.10 - 6.10	10.3
Urine Albumin/Creatinine Ratio crAlbRat	1.91 µg/mg	0.00 - 31.00	10.1
Lactate Dehydrogenase LBXSLDSI	182.00 U/L	135.00 - 225.00	8.6
Hematocrit LBXHCT	44.30 %	37.00 - 47.00	7.9
Body Mass Index BMXBMI	19.60 kg/m²	18.50 - 24.90 Target 22.00	5.6
C-Reactive Protein LBXCRP	0.60 mg/L	0.00 - 5.00	5.0
Hemoglobin LBXHGB	14.40 g/dL	11.50 - 16.00	4.8
Basophils Percentage LBXBAPCT	1.00 %	0.00 - 1.00	3.6

Showing 10 measured biomarkers

Compare yourself to peers your age and gender to understand how you're aging

Mapping Distance from the Healthy Baseline



Beyond the Biological Number

Healthspan Extension

The LinAge2 acts as a GPS for health, identifying which specific physiological systems are deviating from the norm

Mapping Disease Trajectories

Aging in place

Clinicians can see if a patient is trending towards frailty, metabolic decline or specific chronic conditions based on their unique blood profile

Quantifying the Healthy Gap

Optimal baseline

By measuring the distance between a patient's current data point, the clock provides a precise metric for how far an individual has drifted from an optimal biological baseline

Beyond Clock

Quantifying the Aging Process

Detect invisible Risk

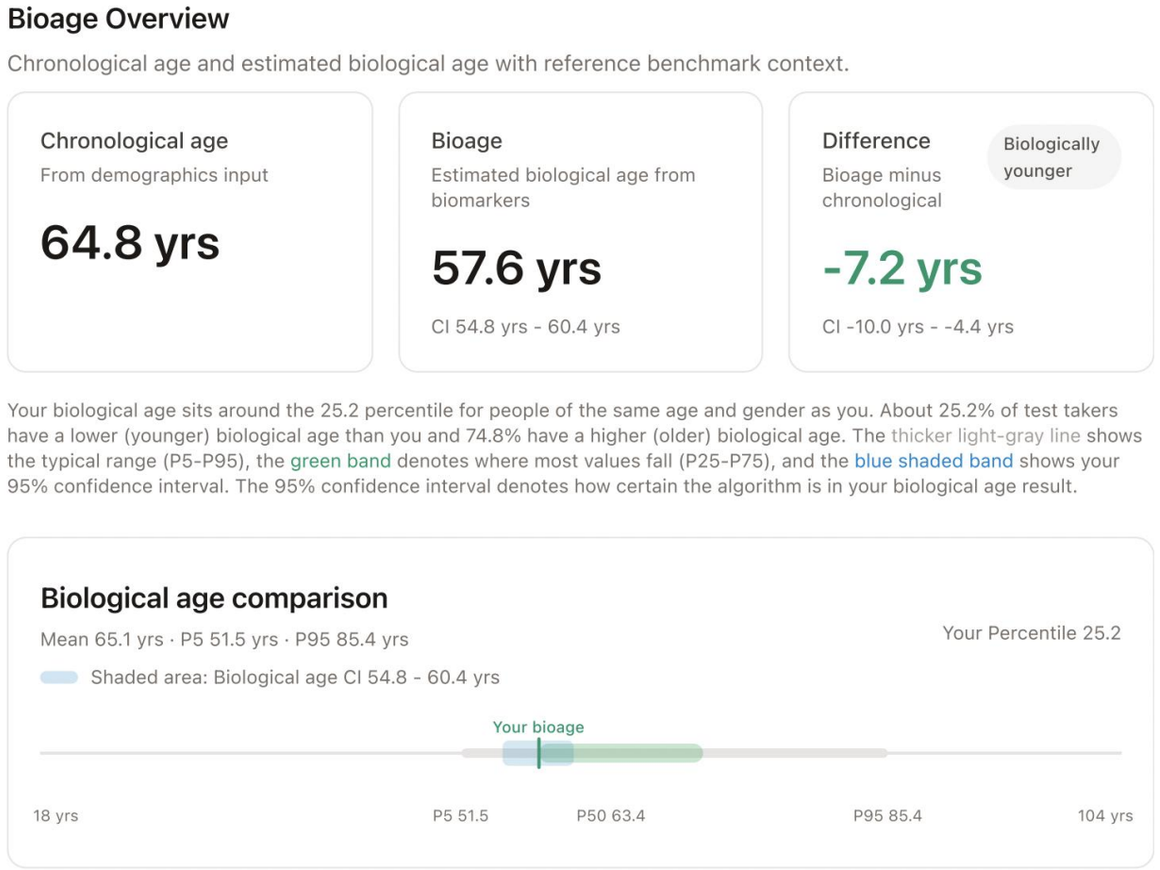
Identify patients with accelerated aging who otherwise look “healthy” on standard physicals

Pinpoint the Root Cause

See exactly which biomarkers are driving the aging, so you know which ones to address

Validate your protocol

Use the biological age score as an objective “scoreboard” to prove to the patient that your interventions (diet, supplements, drugs) are working

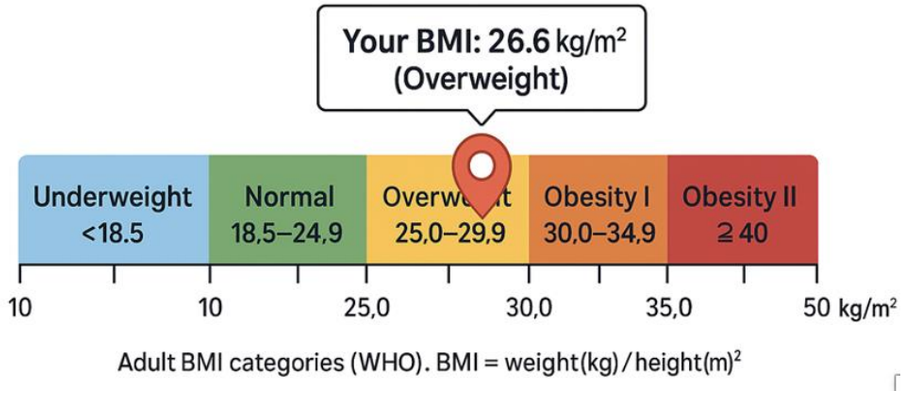


Case Study: 50 year old man regular health check

Essential health screening & prevention milestones

Recommendations Following guidelines for individuals at average risk, with no known conditions	Age (years)		
	40–49	50–64	65 & up
Obesity Body Mass Index (BMI)	Once a year		
High Blood Pressure Blood pressure measurement	Once every 2 years		
High Cholesterol Lipid profile	Once every 3 years		
Diabetes Fasting blood glucose or Glycated Haemoglobin (HbA1C)	Once every 3 years		

1



Adult BMI categories (WHO). BMI = weight(kg) / height(m)²

Regular Health Check

Outcome: Slightly overweight (BMI: 26.6)

Case Study

Blood pressure is within the normal range, but on the higher end

Essential health screening & prevention milestones

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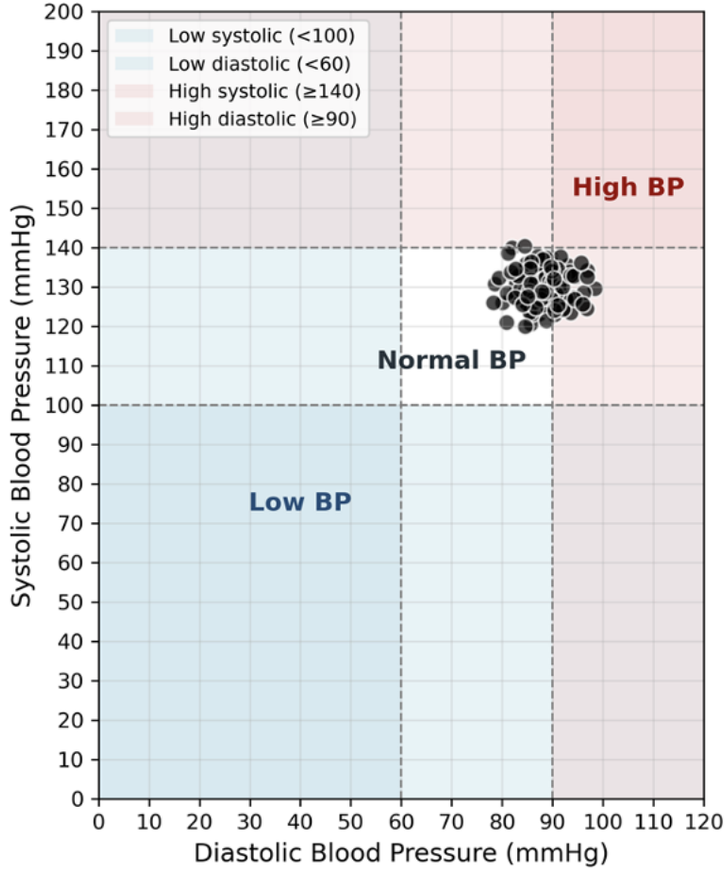

Case Study

Cholesterol is normal according to the blood test results

Essential health screening & prevention milestones

Recommendations Following guidelines for individuals at average risk, with no known conditions	Age (years)		
	40–49	50–64	65 & up
Obesity Body Mass Index (BMI)	Once a year		
High Blood Pressure Blood pressure measurement	Once every 2 years		
High Cholesterol Lipid profile	Once every 3 years		
Diabetes Fasting blood glucose or Glycated Haemoglobin (HbA1C)	Once every 3 years		

LDL Cholesterol (Direct)	1 Aug 2025	
2.64 mmol/L		Normal
Triglycerides	1 Aug 2025	
0.43 mmol/L		Optimal
Total Cholesterol	1 Aug 2025	
4.86 mmol/L		Normal

Case Study

Only 2% of chance getting ASCVD. Everything looks normal based on the regular blood tests

Essential health screening & prevention milestones

Recommendations Following guidelines for individuals at average risk, with no known conditions	Age (years)		
	40–49	50–64	65 & up
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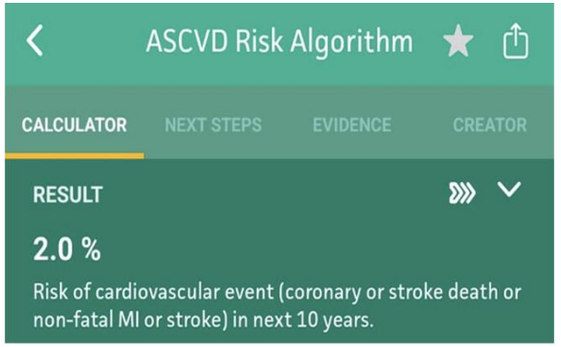


Feedback from the health counselling

"Lose some weight"

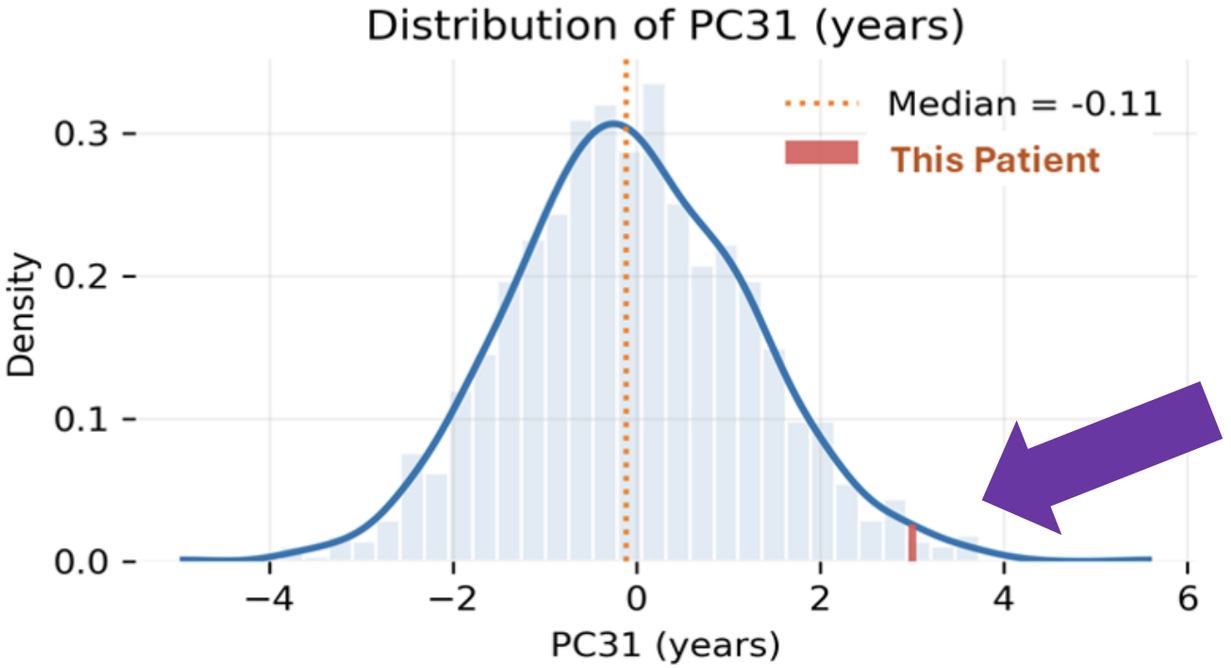
"Change your diet"

Let's have a look at what LinAge2 discovered

Case Study

LinAge2 analysis predicted a much higher actual risk

Patient has a 150% higher risk of cardiovascular disease compared to his peers in his age group



Case Study

Blood sugar/insulin isn't stable, even with medications

The report notes "unexpected metabolic dysregulation" despite using Acarbose (a medication used to prevent blood sugar spikes after meals).

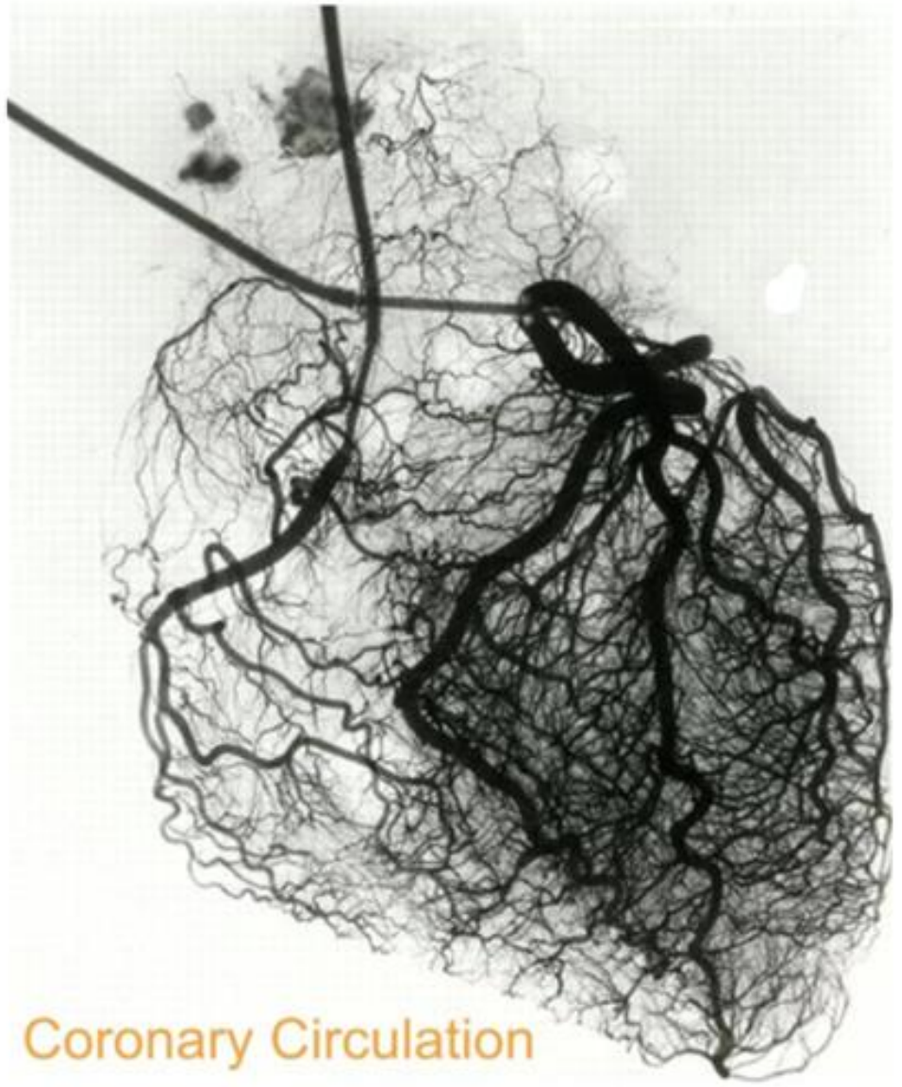
Even with help from medication, the body isn't processing energy or sugars as efficiently as it should.

This "dysregulation" can act like a slow-burning fire that contributes to artery damage over time.

Case Study

Coronary CT Angiogram revealed and confirmed early coronary artery disease

Plaque is already starting to build up in the heart's arteries



Case Study 2

Accuracy Gap compared with other clocks

Patient : Chronological Age 72 years

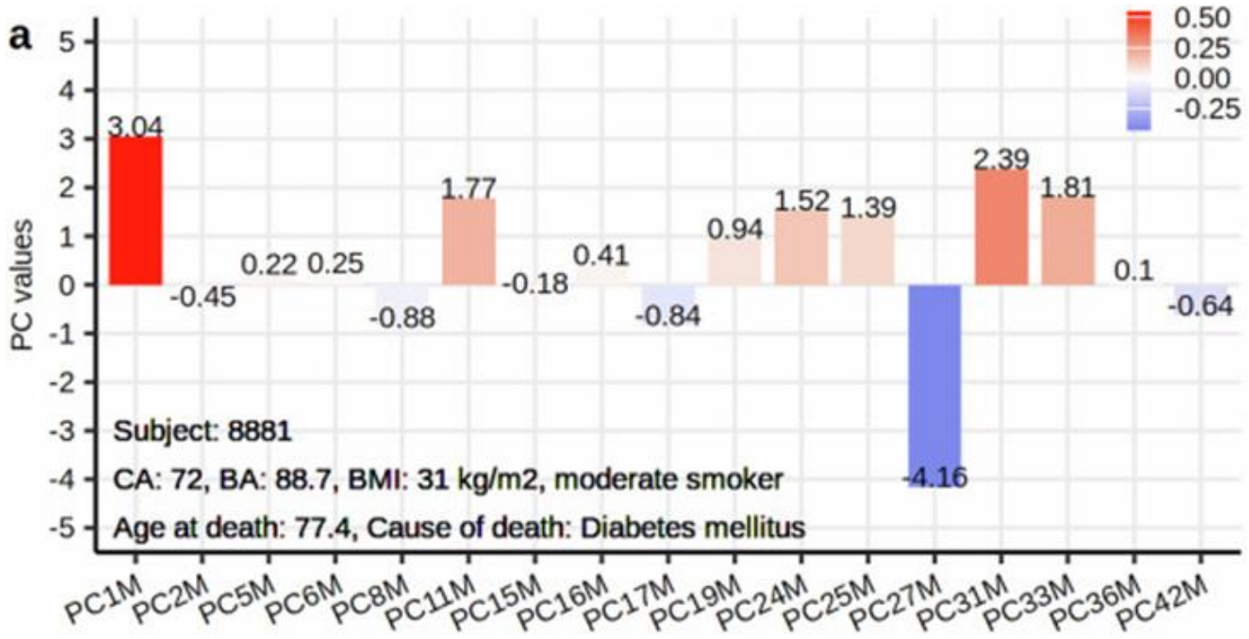
Clock	Type	Biological Age	Delta (vs 72y)	Interpretation
Chronological Age	—	72.0 y	—	Reference
PhenoAge (Levine)	Clinical biomarkers	54.3 y	-17.7 y	Much younger!
HorvathAge	DNAm (353 CpG)	68.3 y	-3.7 y	Slightly younger
HannumAge	DNAm (71 CpG)	68.7 y	-3.3 y	Slightly younger
ZhangAge	DNAm	68.1 y	-3.9 y	Slightly younger
VidalBraloAge	DNAm (8 CpG)	61.3 y	-10.7 y	Younger
SkinBloodAge	DNAm	73.7 y	+1.7 y	≈ chronological
WeidnerAge	DNAm (3 CpG)	41.2 y	-30.8 y	Very young!
LinAge	Mortality-trained	77.6 y	+5.6 y	Older (mortality risk)
LinAge2	Mortality-trained	84.5 y	+12.5 y	Much older (risk!)
DunedinPoAm	Pace of aging	1.17	—	Aging 17% faster

Mortality Accuracy: LinAge2 correctly identifies high-risk individuals

Actionable Transparency: Unlike "Black Box" DNA tests, LinAge2 uses Principal Component Analysis (PCA) to map specific disease trajectory

Case Study 2

Age of death: 77.4
Cause of death: Diabetes mellitus



PC1M	
Subject 8881 Parameters	**Parameter Values**
Urine Albumin (mg/L)	96.9
Urine Albumin-to-Creatinine Ratio (mg/g) (logged)	47.04
Healthcare use index	3
Glycohemoglobin (%)	8
Glucose (mmol/L)	3.9
NT-proBNP (pg/ml) (logged)	1029
Self-health index	0
Systolic Blood Pressure average (mmHg)	111
Red cell distribution width (percent)	13.2
Creatinine (umol/L)	79.6
Blood Urea Nitrogen (mmol/L)	3.9
C-Reactive Protein (mg/dL) (logged)	0.95

LinAge2 picked up the disease and predicted the patient age the most accurately compared to others

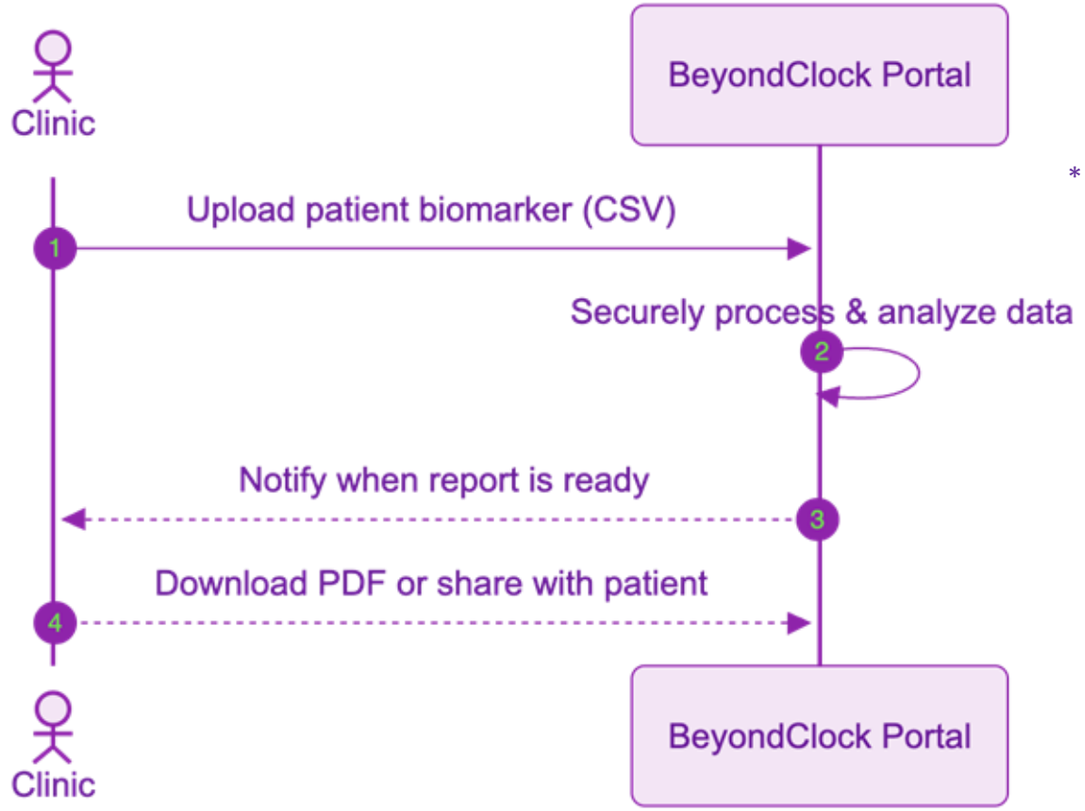
Patterns are more informative than single parameter guidelines

Are you ready to level up your health?

LinAge2 biological aging clock can be used for

- Validating treatment before giving them to patients using objective data
- Identifying the right participants for clinical trials faster and more accurately
- Predict how patients may respond to drugs or treatments
- Validate treatment effectiveness
- Measure aging

Report generation flow



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Scan to see the full 12-page example patient report

Or visit:
https://resources.beyondclock.com/latest/example-report

Beyond Clock

The value for your clinic

1

PATIENT RETENTION

Give patients a reason to re-test every 3-6 months

2

EARLY DETECTION

Catch a disease before they become chronic diseases

3

REVENUE GROWTH

Validate and sell premium longevity interventions with data to back them up

Future-Proof your patient's health!

Beyond Clock

chong.he@livebeyond.ai

avely@beyondclock.com

FAQ

1. What does “mortality” mean in simple terms?

Mortality means the risk of dying over a specific period of time within a population (for example, the chance of dying within one year). It describes how often death occurs in a group of people and how that risk changes with age, health, and biology.

2. How large is the dataset my results are compared against?

The comparison dataset includes a total sample size of n = 4,313 participants. Its racial/ethnic composition is approximately:

Non-Hispanic White: 47.33%
Non-Hispanic Black: 16.64%
Mexican American: 28.09%
Other Hispanic: 5.48%
Other: 2.45%

4. How LinAge uses PCA?

• Integrate many biomarkers simultaneously, rather than relying on a single marker
• Capture system-level aging patterns (metabolism, inflammation, organ function)
• Build a stable, interpretable biological age model

Instead of asking: “Is this one lab abnormal?” LinAge asks: “Which aging-drived disease pattern does this person most resemble?”

5. How is biological age calculated in LinAge? What do PCs tell me beyond a number?

LinAge does more than give you a single number. First, LinAge analyzes 60+ routine biomarkers together and identifies Principal Components (PCs),these are aging patterns showing how different body systems change together over time (metabolism, inflammation, vascular health, lifestyle factors).

Next, these patterns are compared with long-term population data to understand whether your biology aligns with faster or slower aging trajectories. Then, LinAge translates this information into your biological age, a clear snapshot of where you are today. Most importantly, LinAge also shows your personal health trajectory:

- *Which aging patterns are driving your results*
- *Which systems are under the most stress*
- *What subclinical diseases can we intercept before symptoms appear?*