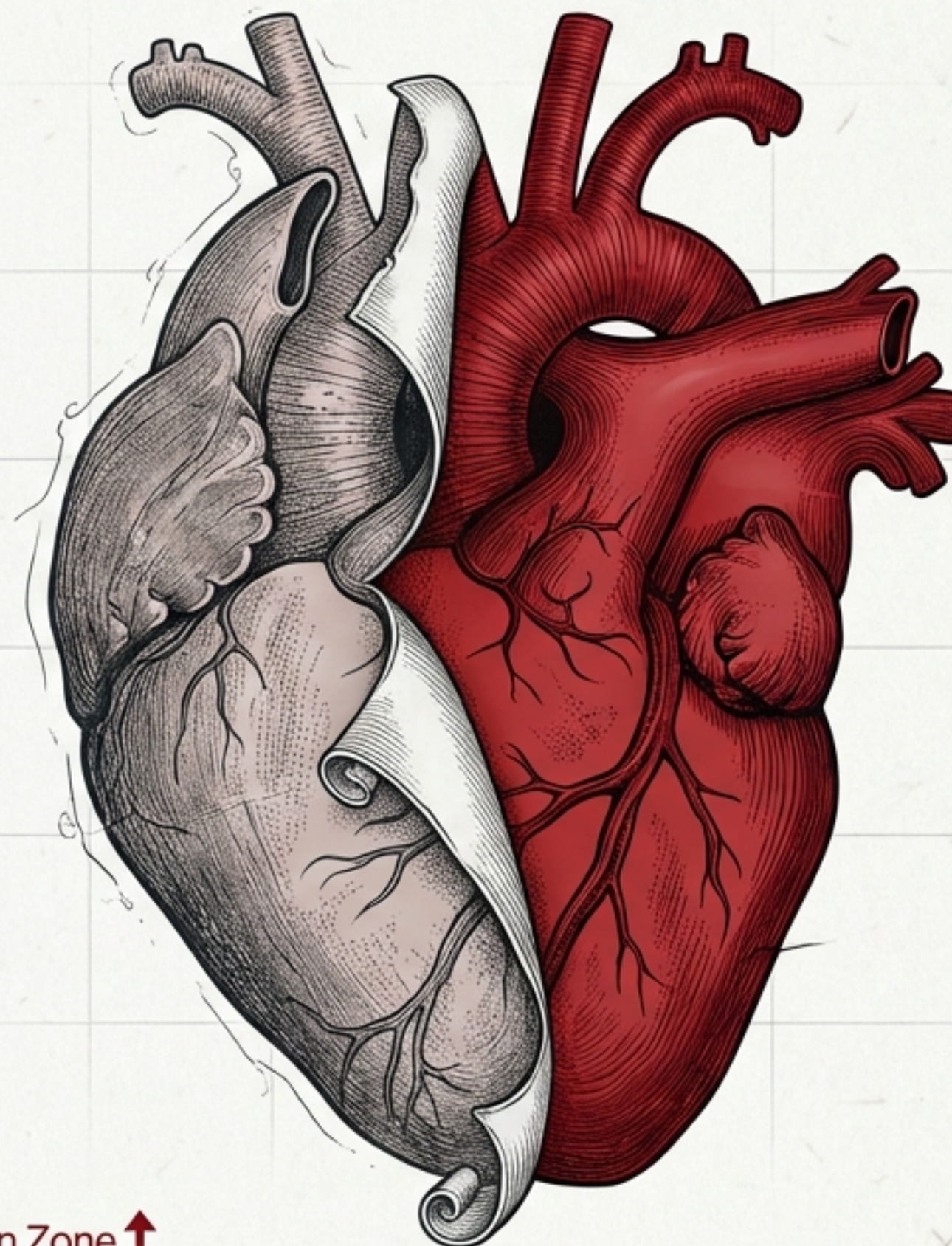


Medical Editorial

Cardiovascular Rejuvenation: The Biological Reversal Blueprint

A user manual for the aging heart based on the Levine Protocol and arterial plasticity.

“The heart retains a ‘sweet spot’ of plasticity in late middle age. Targeted intervention can reverse up to 30 years of stiffness.”



Target Rejuvenation Zone ↑

Age 40

45

50

55

60

65

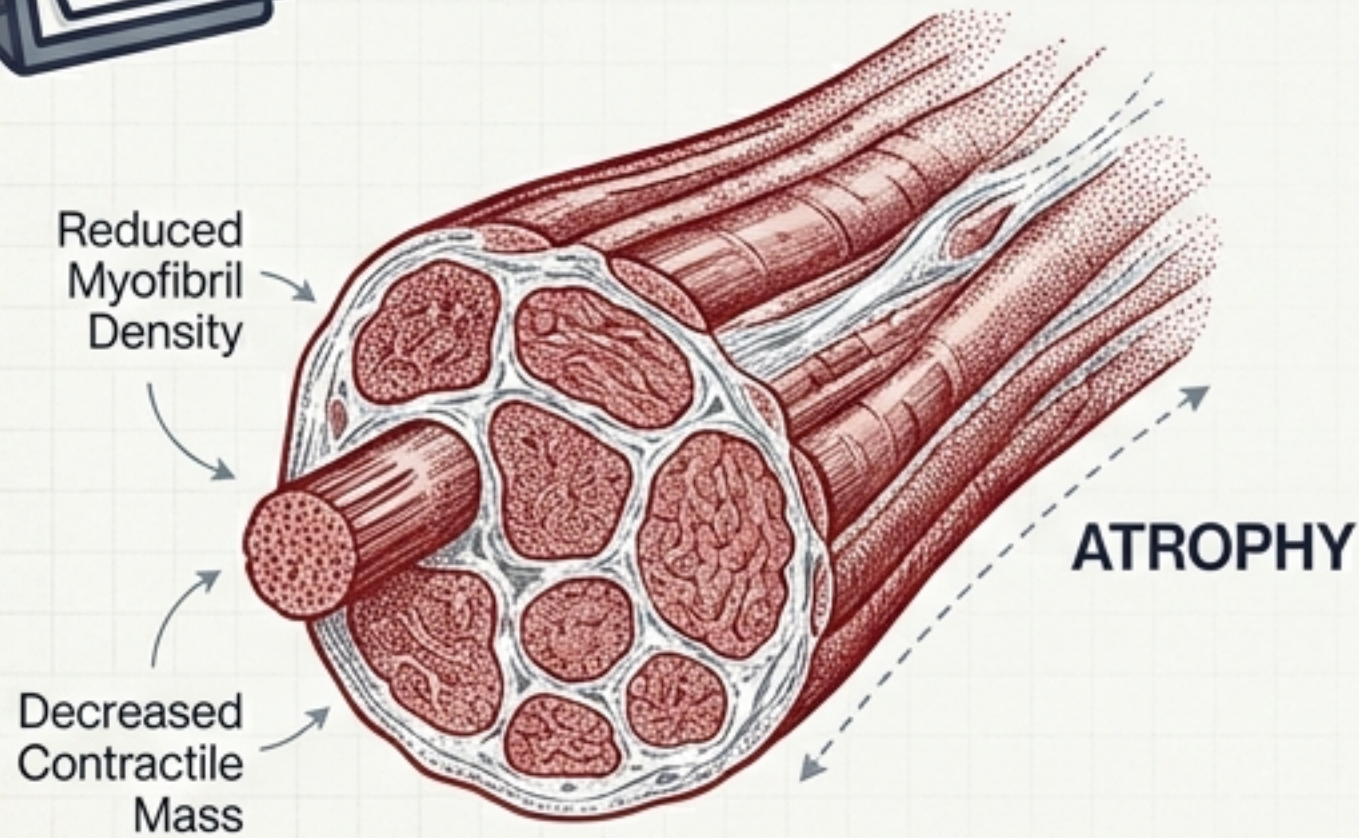
70+

The Sedentary Illusion

Differentiating biological aging from disuse atrophy.

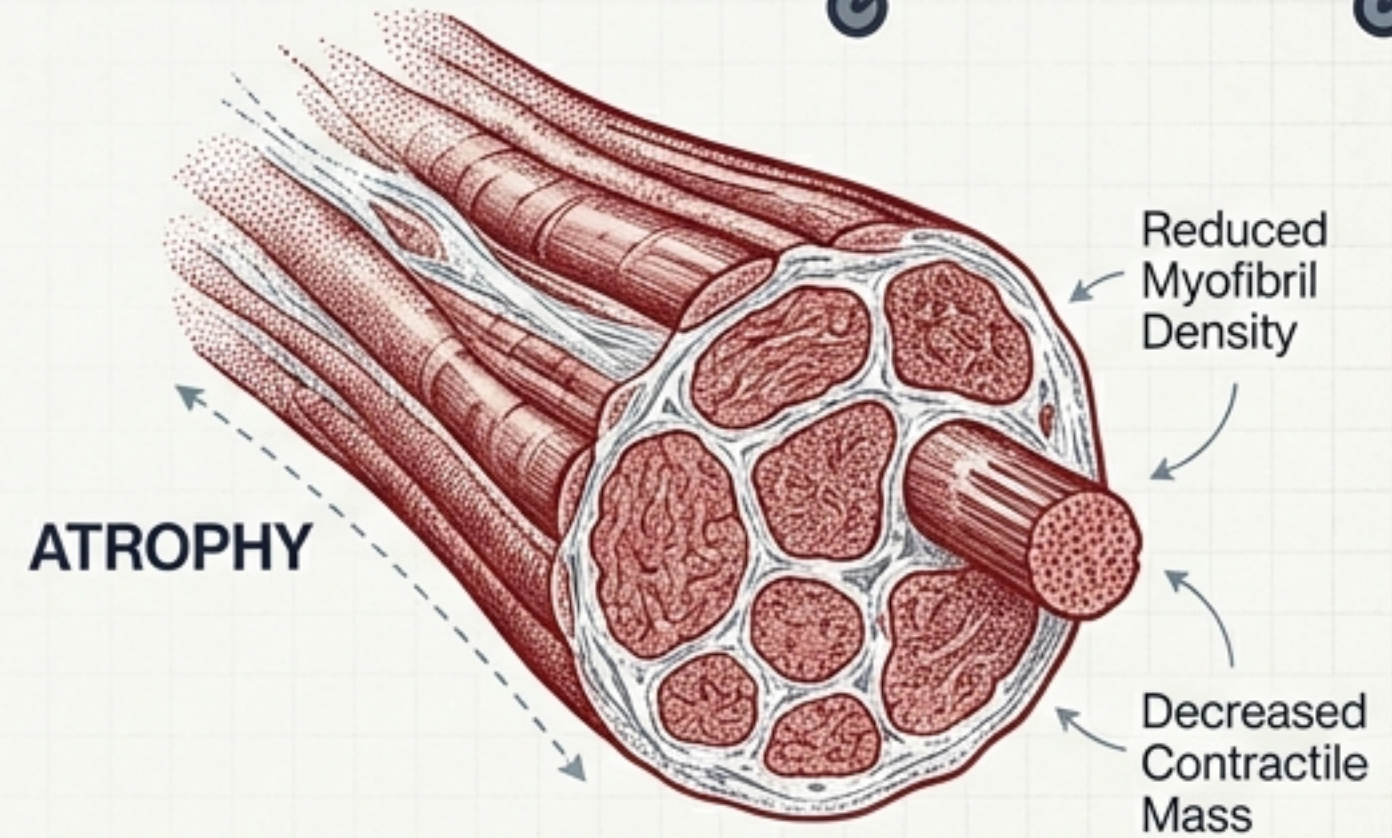


**30 Years of
Natural Aging**



=

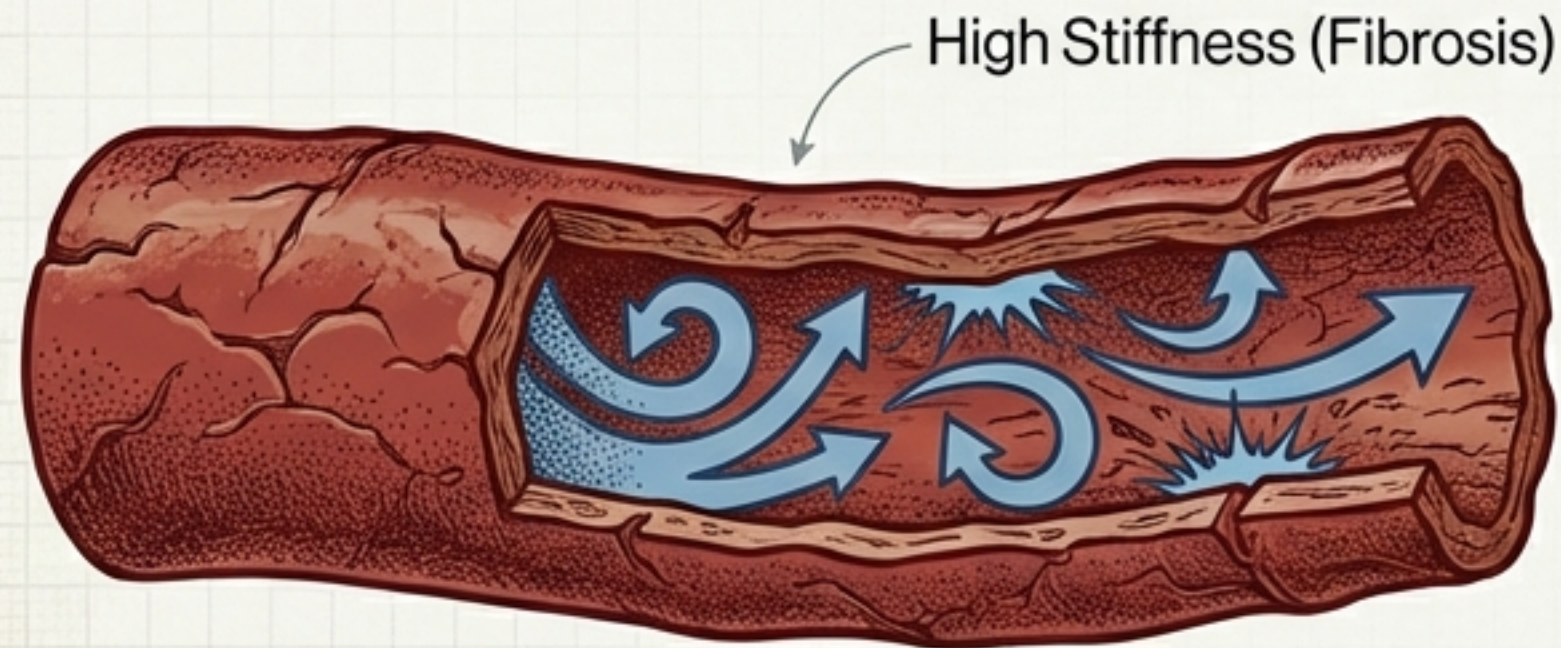
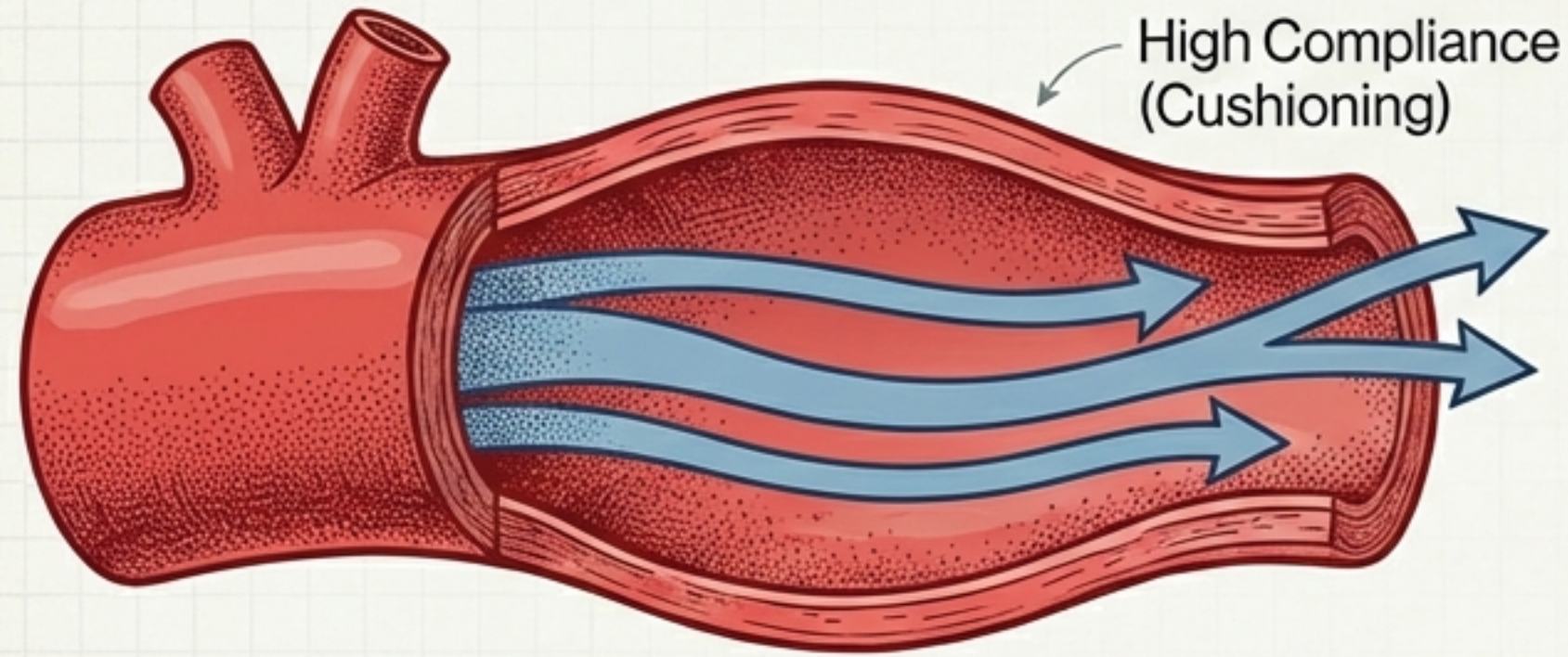
**20 Days
of Bed Rest**



20 days of total bed rest in healthy 20-year-olds resulted in a reduction in cardiovascular capacity more severe than 30 years of natural aging.

Data Source: The Dallas Bed Rest and Training Study (Levine et al.)

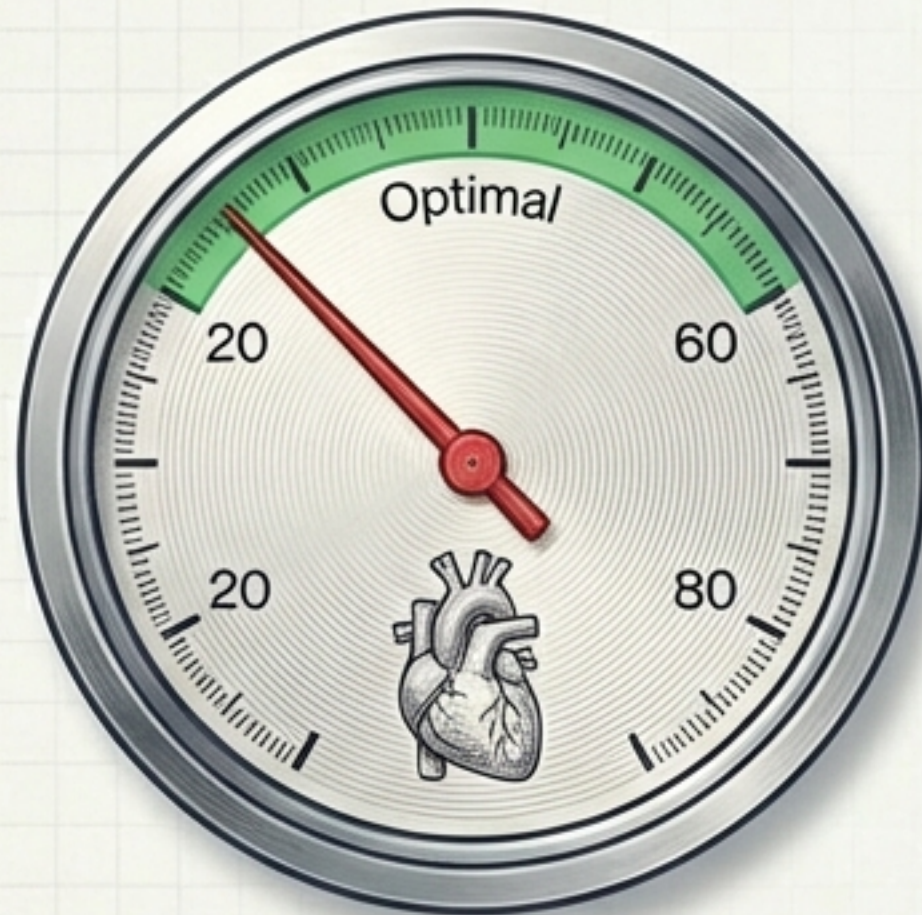
The Physiology of Stiffness.



- **The Mechanism:** Sedentary behavior causes the left ventricle to atrophy and the central arteries to stiffen via collagen cross-linking.
- **The Outcome:** A rise in Effective Arterial Elastance (high afterload).
- **The Risk:** Precursor to HFpEF (Heart Failure with Preserved Ejection Fraction)—a condition largely untreatable once established.

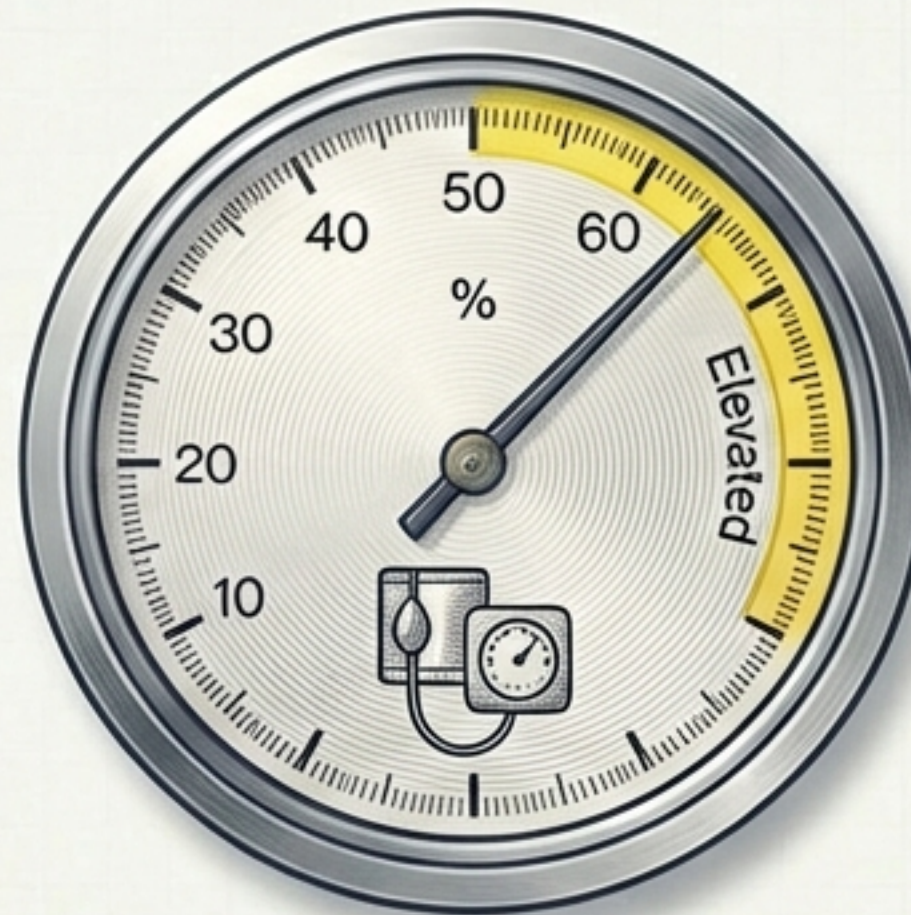
Quantifying the Damage: What is Your Heart Age?

Modelflow Aortic Age



Structural Stiffness
(Gold Standard).

Framingham Risk



Vascular Risk Factors
(BMI, BP).

A-ECG Gap

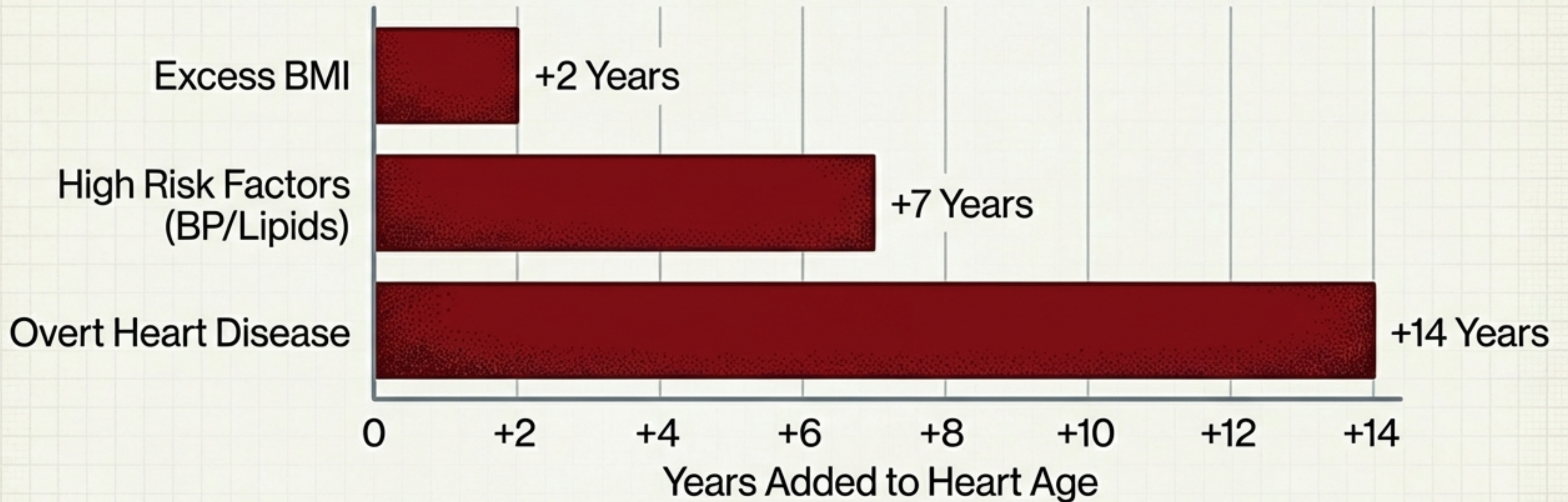


Electrical/Neural
Network Analysis.

The Masters Athlete Benchmark: Competitive endurance athletes (>25 years training) possess aortas biologically 25–30 years younger than their chronological age.

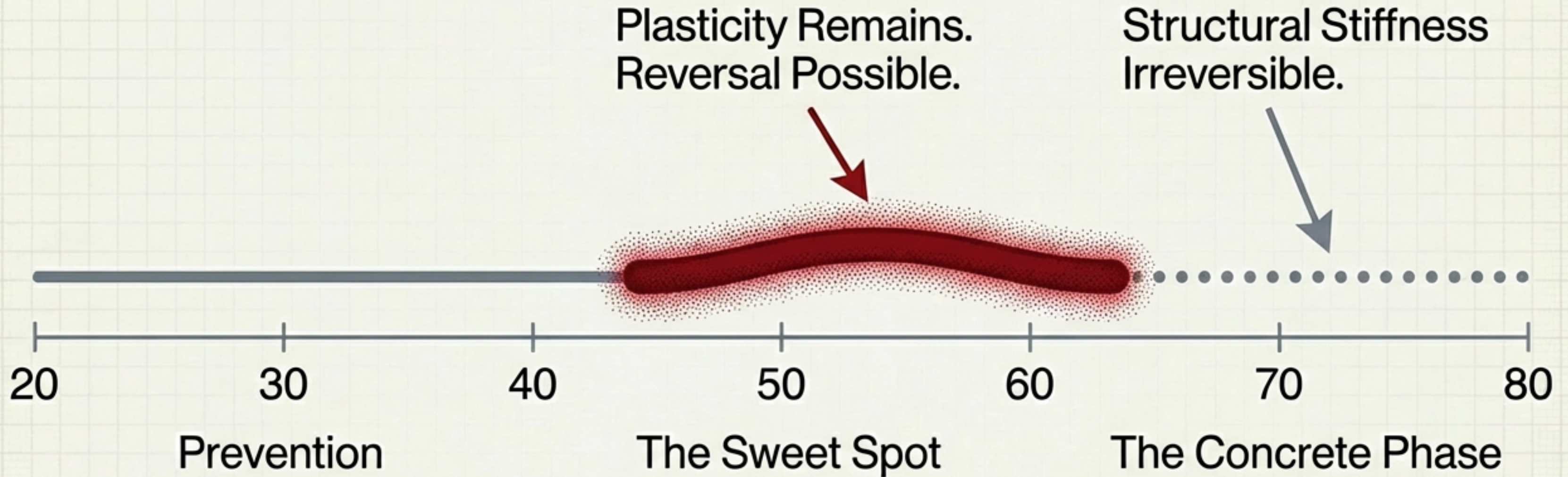
The Diagnostic Gap

Lifestyle factors that accelerate biological heart aging.



In sedentary seniors, aortic age matches chronological age.
In the “committed” exerciser, the biological clock stops.

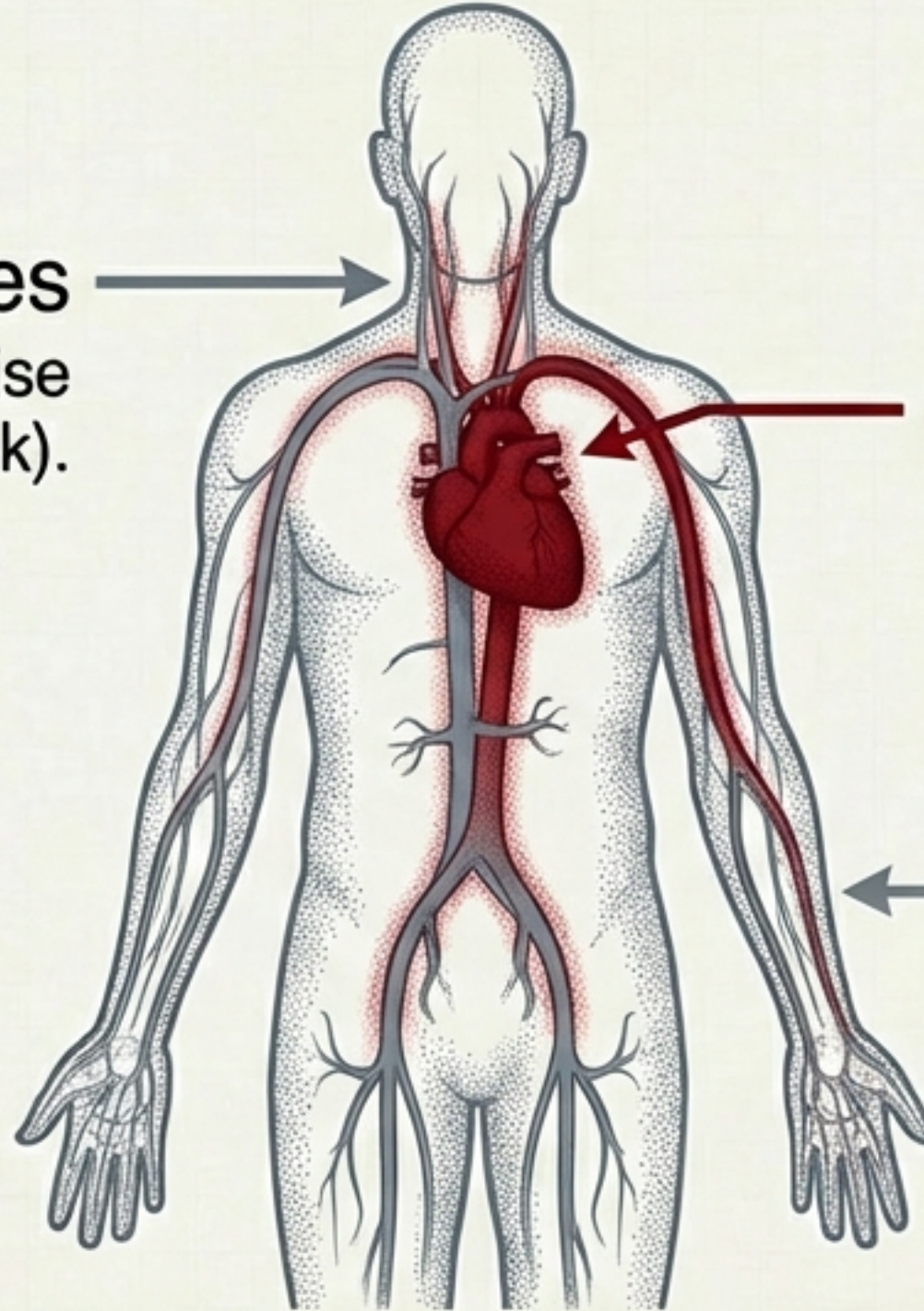
The Window of Opportunity



A two-year committed exercise program started between ages 45–64 can restore youthful elasticity. After age 65, the heart muscle does not not remodel significantly in response to standard training.

Hierarchy of the Arteries

Carotid Arteries
Responds to Casual Exercise
(2-3 days/week).

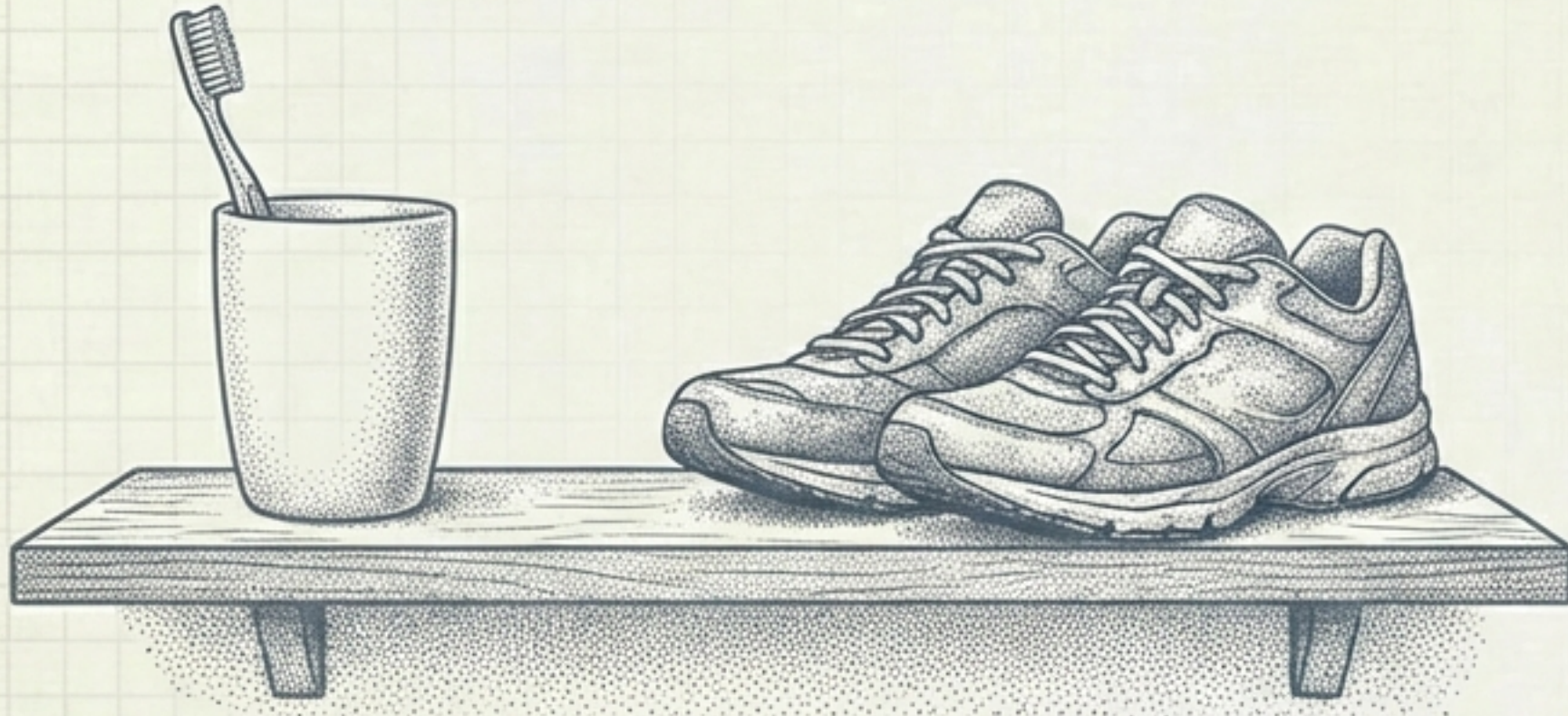


REQUIRES COMMITTED DOSE
(4-5 days/week) to prevent stiffening.

Peripheral Arteries
No structural benefit from
exercise (Genetically set).

You can save your carotids with a jog, but saving your aorta requires a regimen.

The Committed Dose



**4-5 Sessions
Per Week**

(Minimum Lifetime Requirement)

“You brush your teeth every day. Exercise needs to be part of that process.”

— Dr. Benjamin Levine

Sedentary (<2 days):

Maximum stiffness.

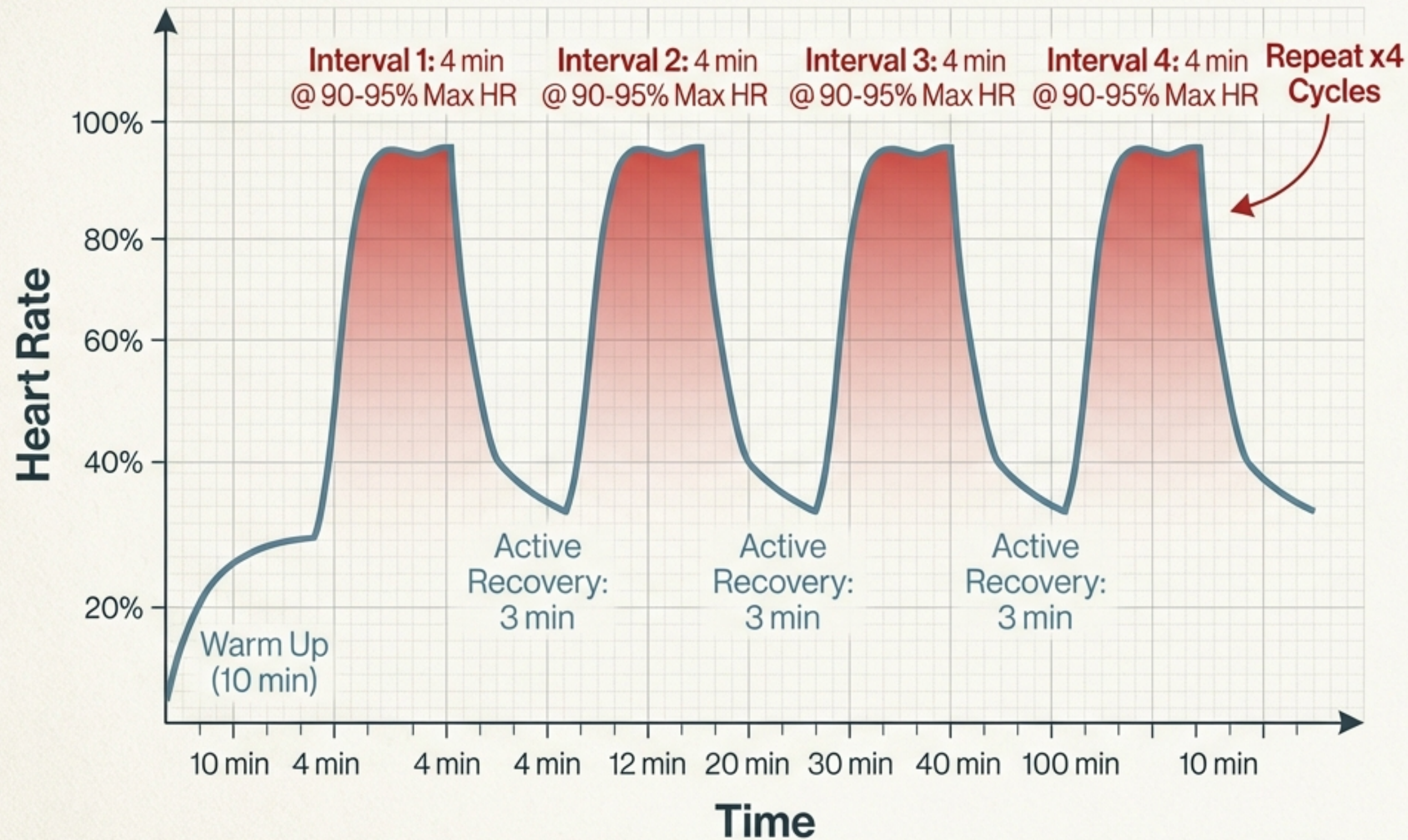
Casual (2-3 days):

Partial benefit (Carotids only).

Committed (4-5 days):

Youthful aortic compliance.

The Magic Bullet: Norwegian 4x4 HIIT



Why this works:
Max stroke volume stretches the myocardium, restoring the mechanical “snap” of the heart.

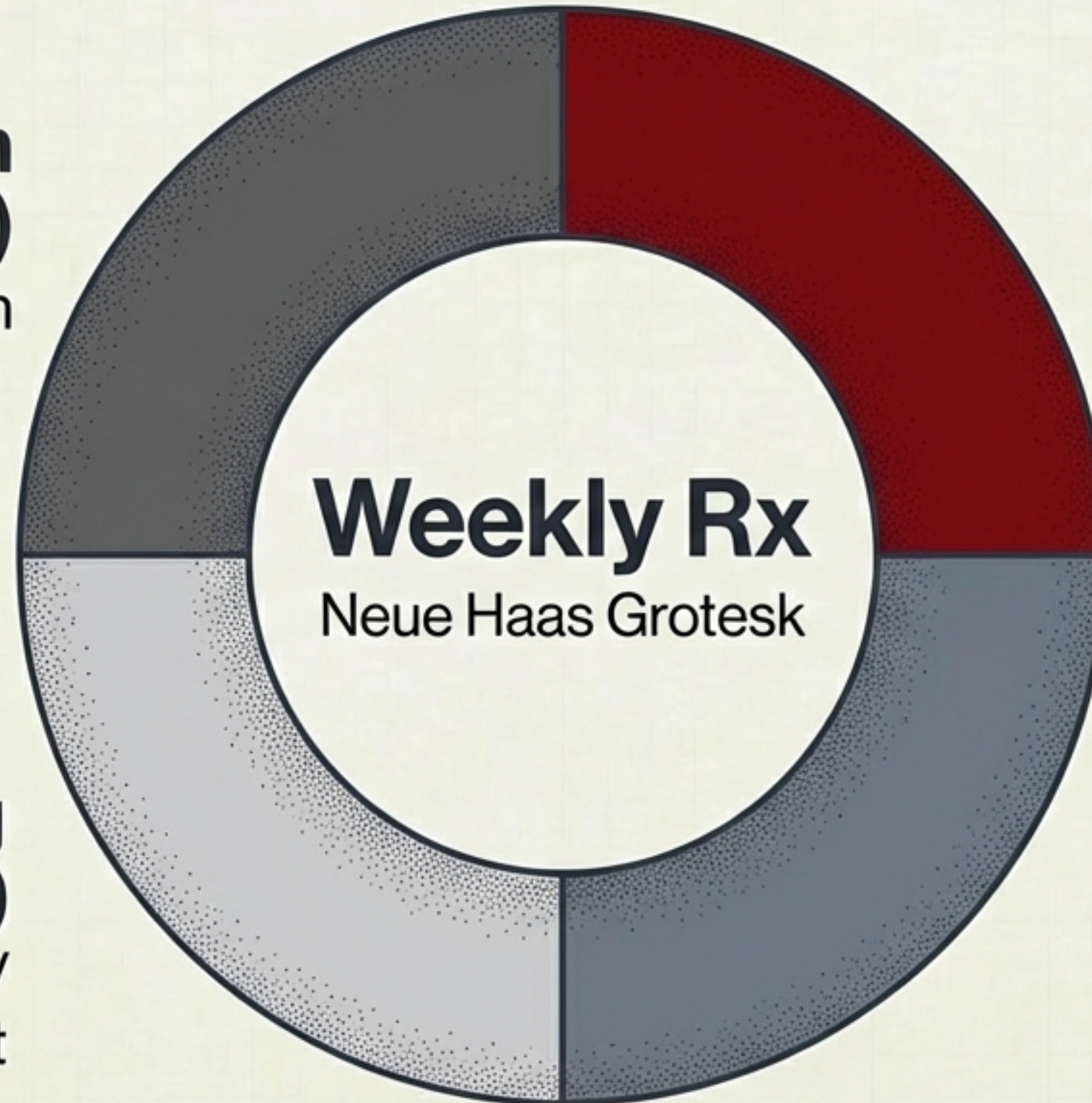
The Supporting Cast in Heldane Display, Deep Slate (#2B2D42)

**Strength
(1-2 Sessions)**
Mitochondrial health

HIIT (1 Session)
Norwegian 4x4

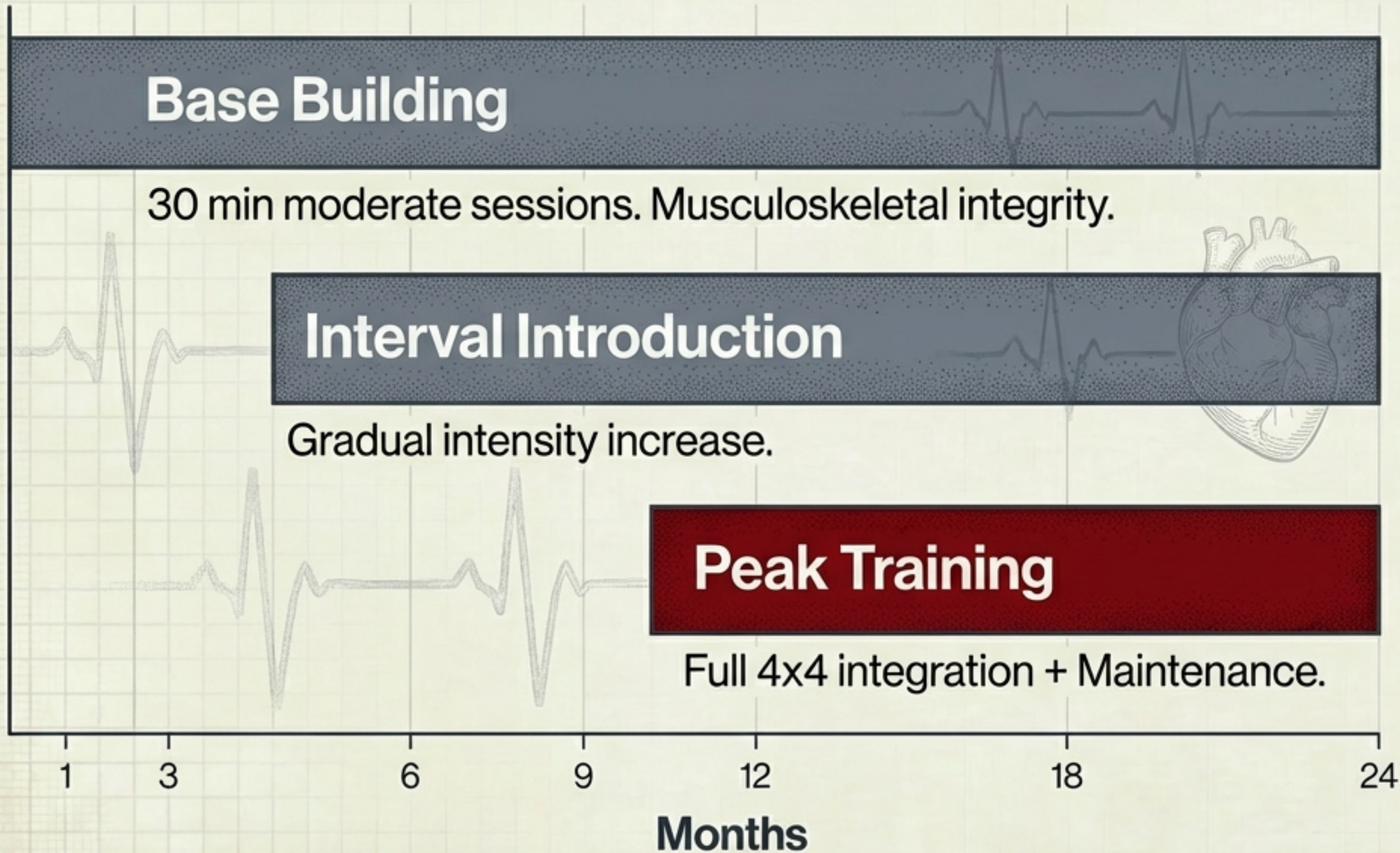
**Base Building
(2-3 Sessions)**
30 min moderate /
Talk Test

**Long Session
(1 Session)**
1 Hour+ Zone 2
(Capillary density)



The Periodization Timeline

in Heldane Display, Deep Slate (#2B2D42)



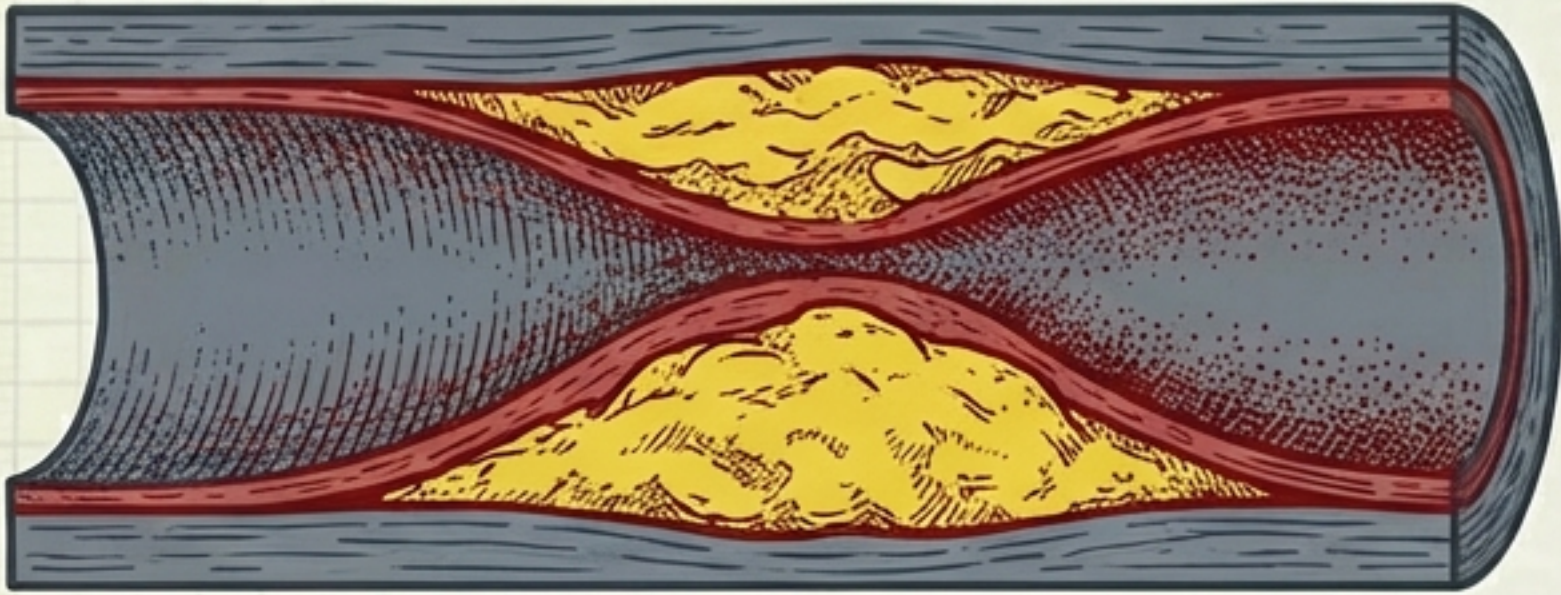
Outcomes:

18% Improvement
in VO2 Max

25% Increase in
Left Ventricular
Compliance

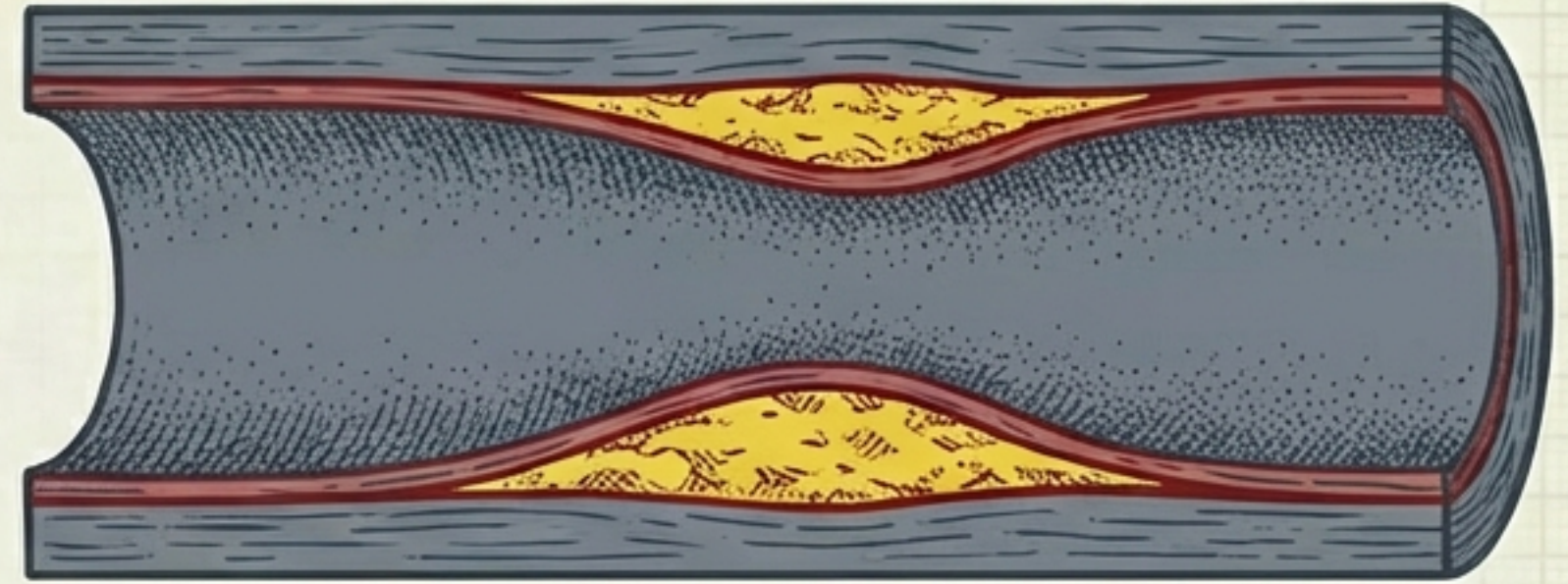
Reversing Plaque Volume in Heldane Display, Deep Slate (#2B2D42)

Plaque Progression



Control Group

Regression (-1% Volume)



HIIT Group

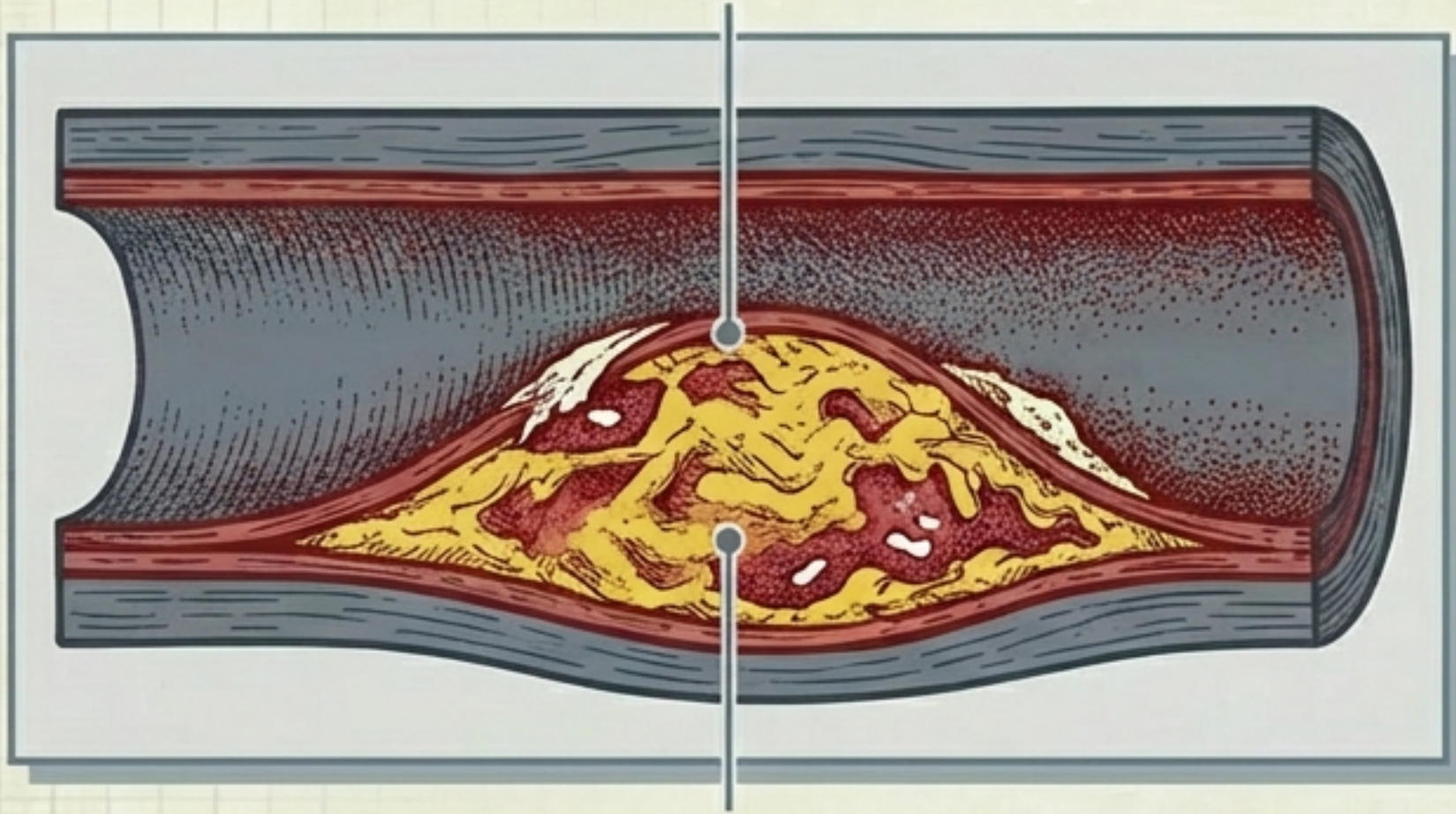
CENIT Trial: HIIT reduced atheroma volume by 1% vs progression in control.

Lifestyle Heart Trial (Ornish): 7.9% relative improvement in stenosis over 5 years.

Plaque is not static stone; it is biologically active tissue that can regress.

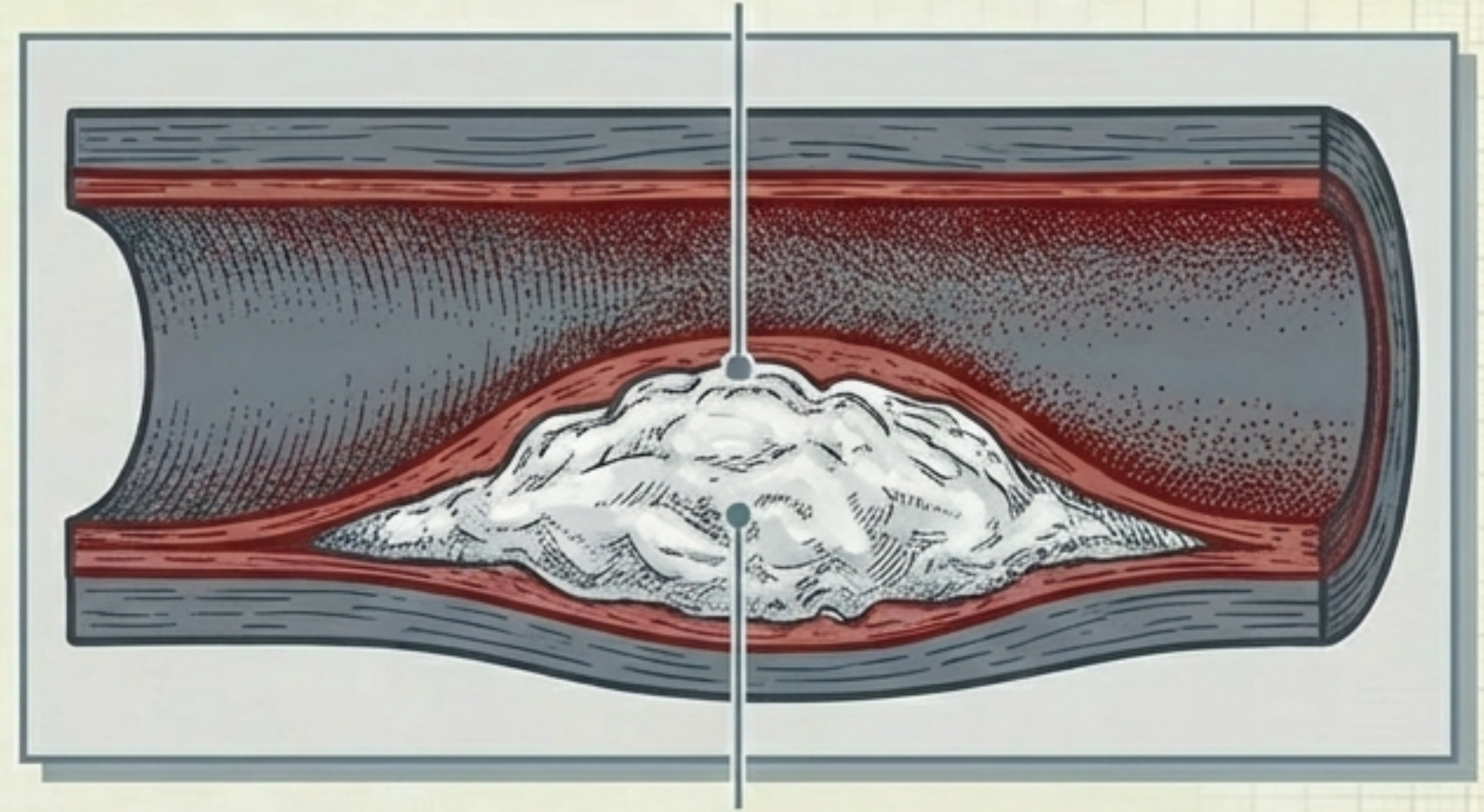
The Calcification Paradox in Heldane Display, Deep Slate (#2B2D42)

Sedentary Artery



Low Calcium / High Rupture Risk

Athlete's Artery



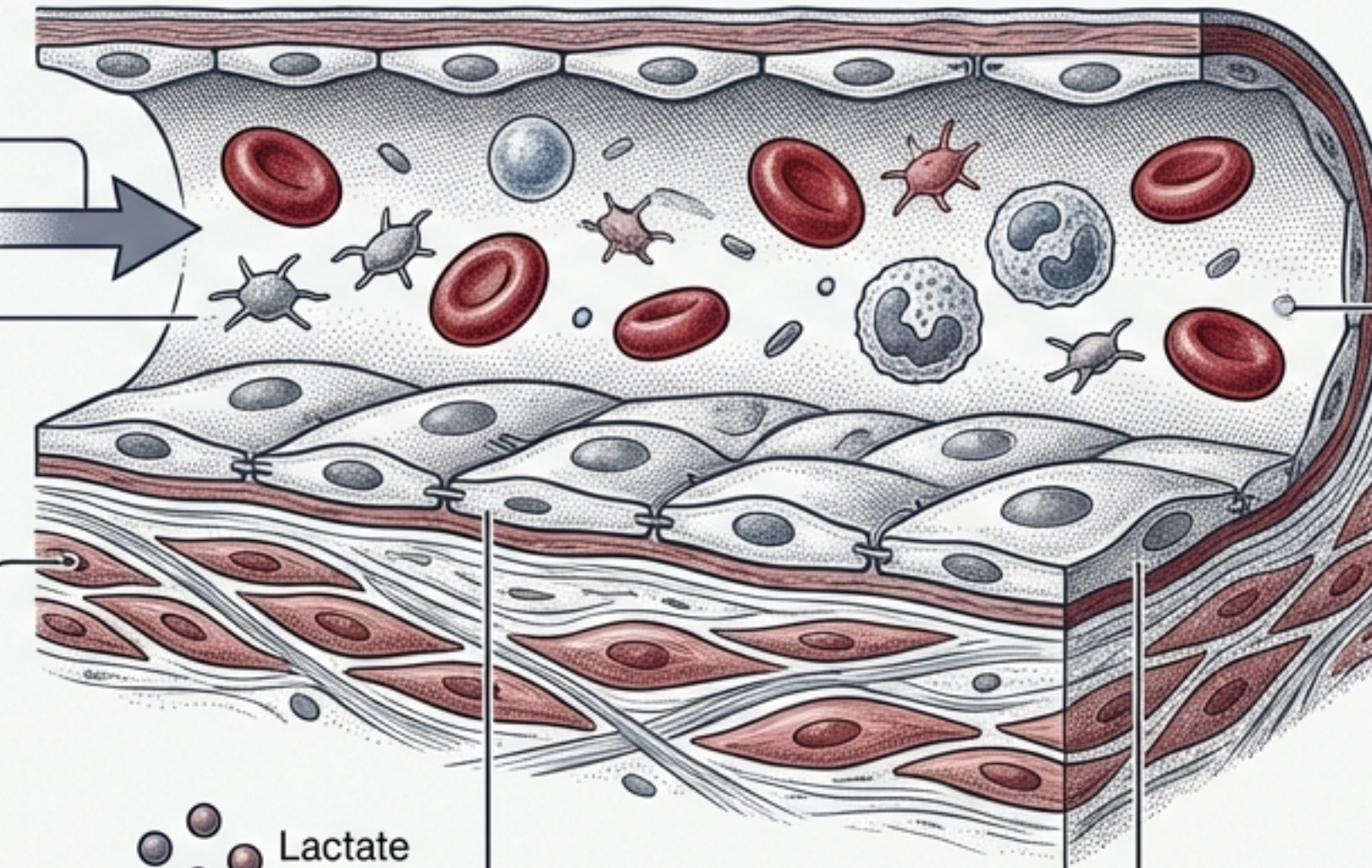
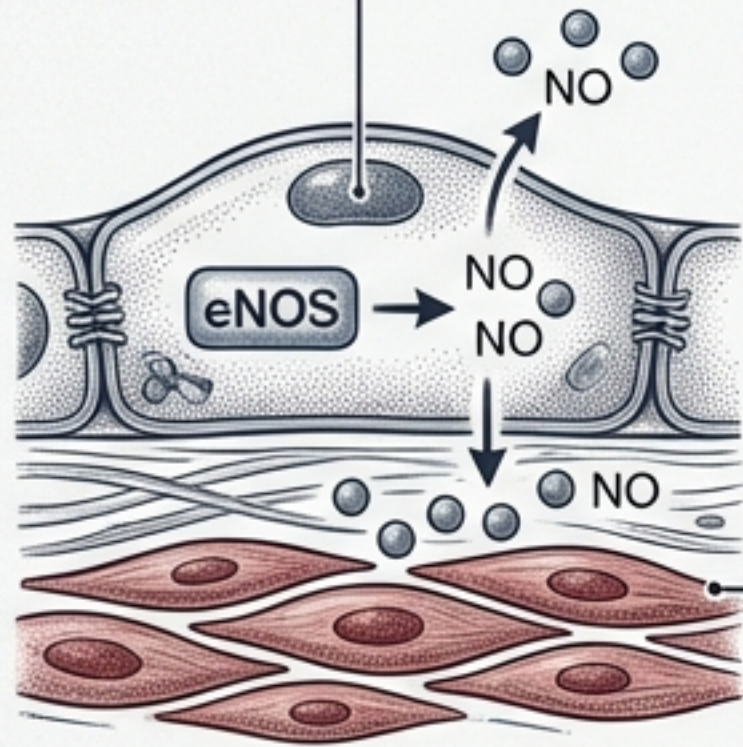
High Calcium / Stable / 'Capped'

Mechanism: High-intensity exercise accelerates calcification, which acts as a protective biological 'scab,' stabilizing the plaque and preventing heart attacks.

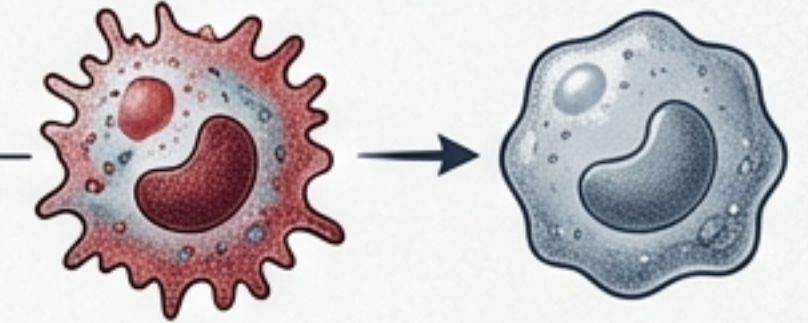
Molecular Mechanisms of Repair

1. Shear Stress

Blood flow → Upregulates eNOS
→ Nitric Oxide (Vasodilation)



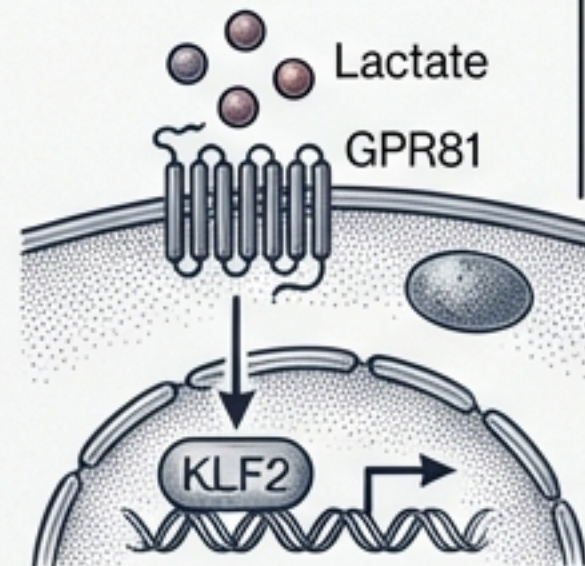
3. Macrophage Polarization



Shifts to M2 State
(Healing/Stabilization)

2. Lactate Signaling

Increases KLF2 →
Anti-inflammatory effect
KLF2 transcription factor and
upregulate anti-inflammatory genes,
suppressing inflammation in vessel wall

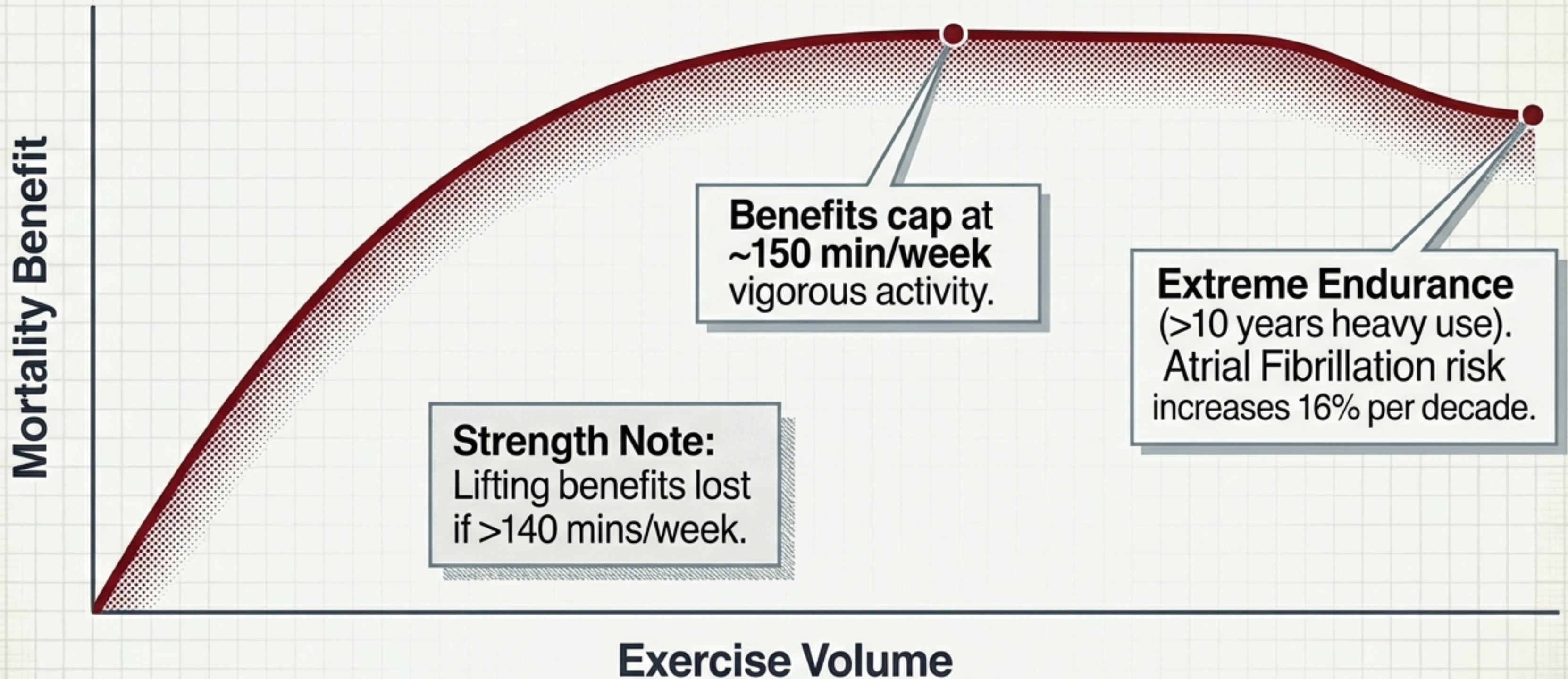


4. Genomic Integrity

Upregulates OGG1 →
DNA damage repair



The Upper Limit: More is Not Always Better



Neue Haas Grotesk (Surgical Steel #717C89)

The Rejuvenation Prescription

R_x



The Window: Act before **age 65** (The Plasticity Deadline).



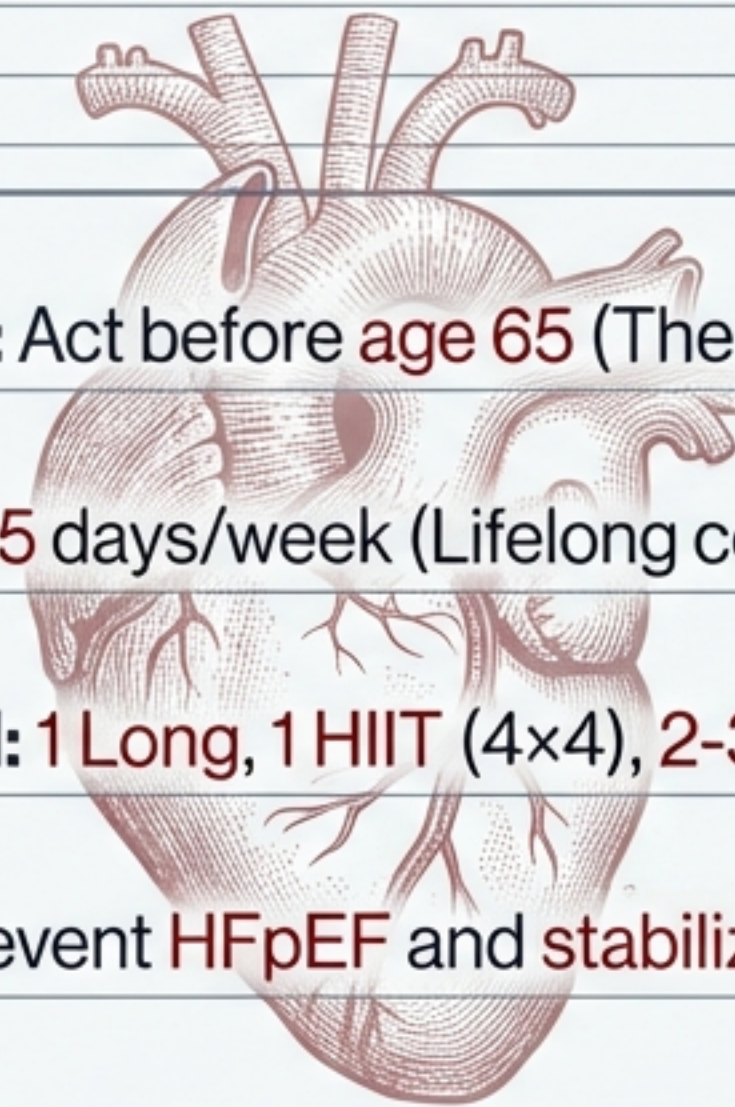
The Dose: **4-5** days/week (Lifelong commitment).



The Protocol: **1 Long, 1 HIIT (4x4), 2-3 Base, 1 Strength.**



The Goal: Prevent **HFpEF** and **stabilize coronary plaque.**



Prevention requires shifting from casual activity to committed hygiene.