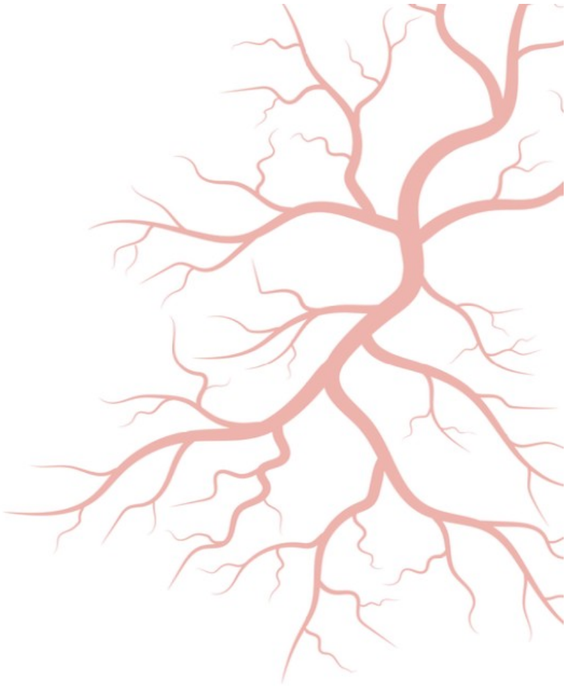

HRVATSKO DRUŠTVO
ZA SUPLEMENTACIJU
U MEDICINI
Hotel Sheraton,
Zagreb
22.-25.10.2026.
JESENSKA AKADEMIJA
SUPLEMENTACIJE
U MEDICINI
MIKRONUTRICIJA U VASKULARNOM STARENJU
ANA JELAKOVIĆ

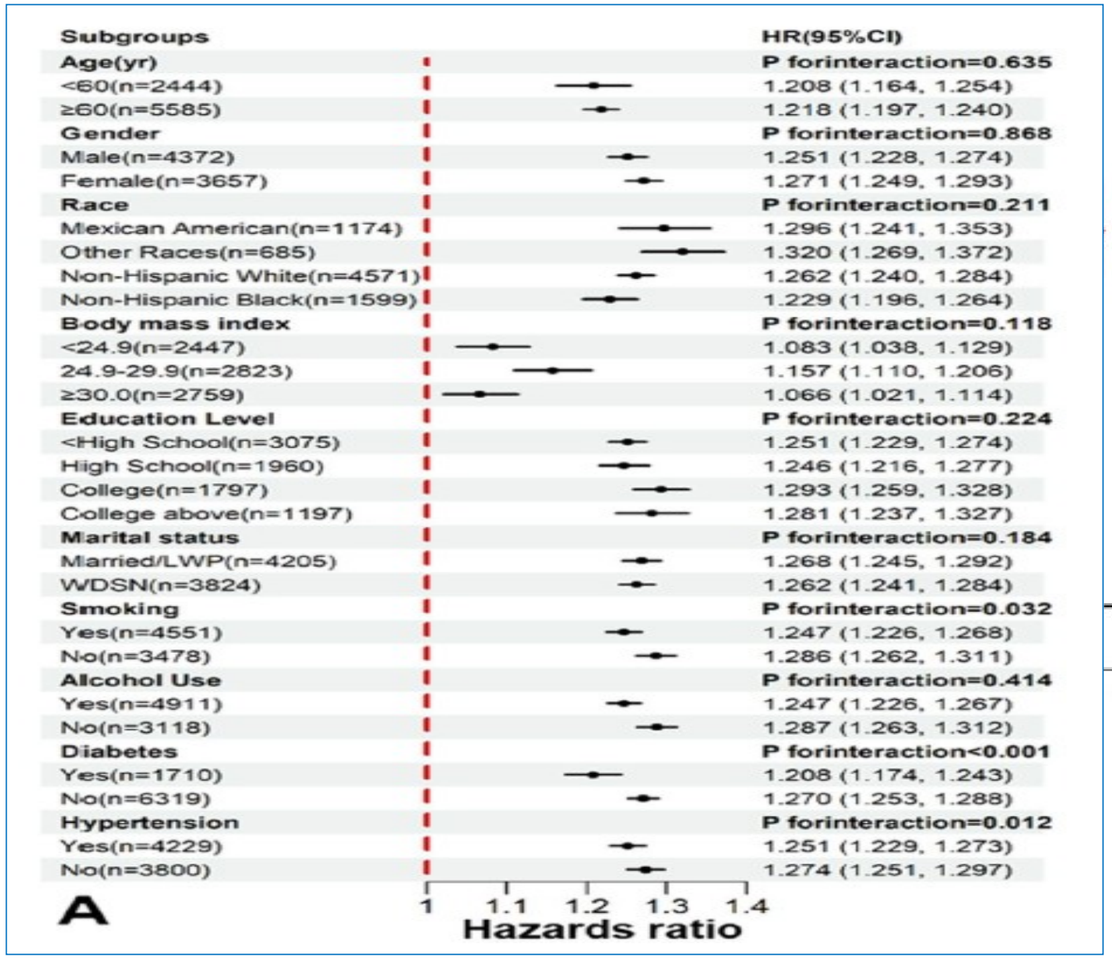
Arterial stiffness



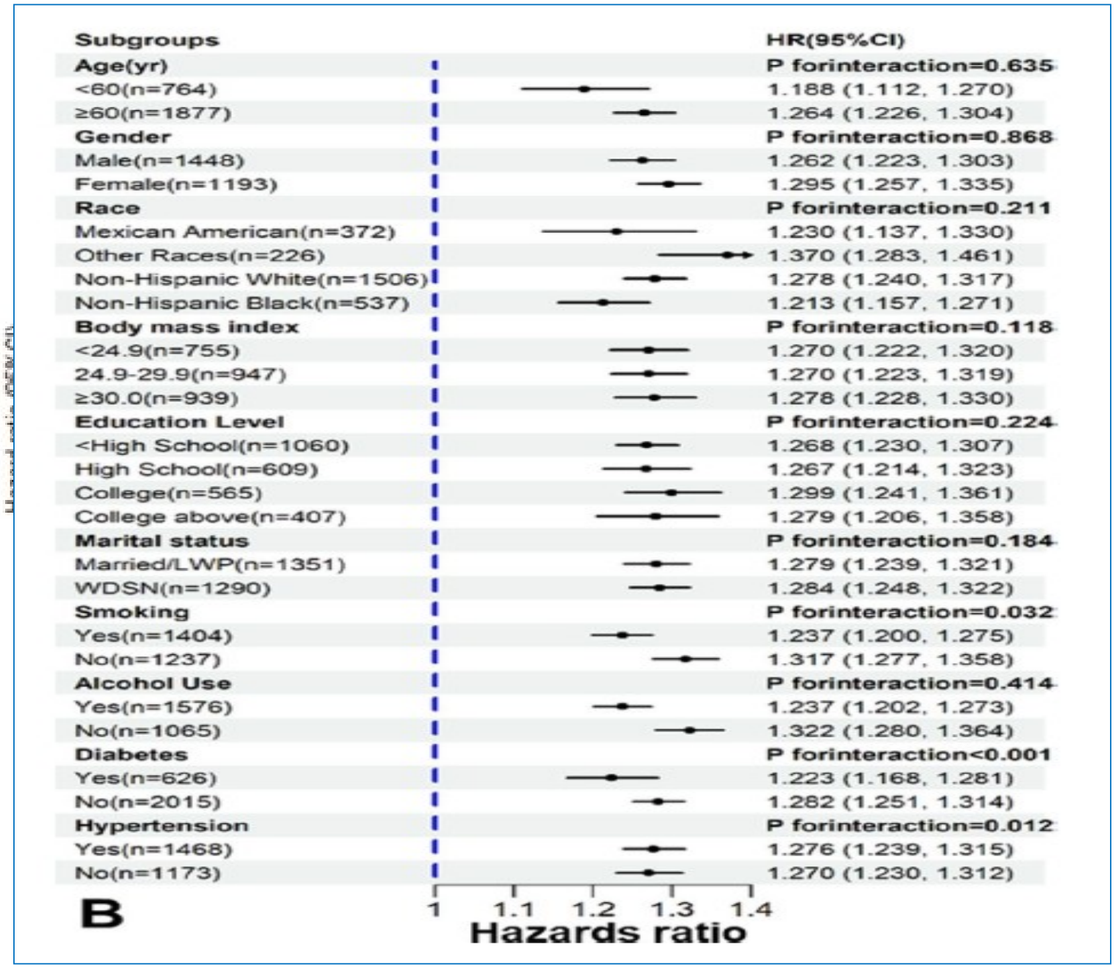
Is an independent risk factor which predicts cardiovascular morbidity and mortality and all-cause mortality better than conventional risk factors combined

Elevated pulse wave velocity as a marker of arterial stiffness and its association with mortality in US adults

All-cause mortality



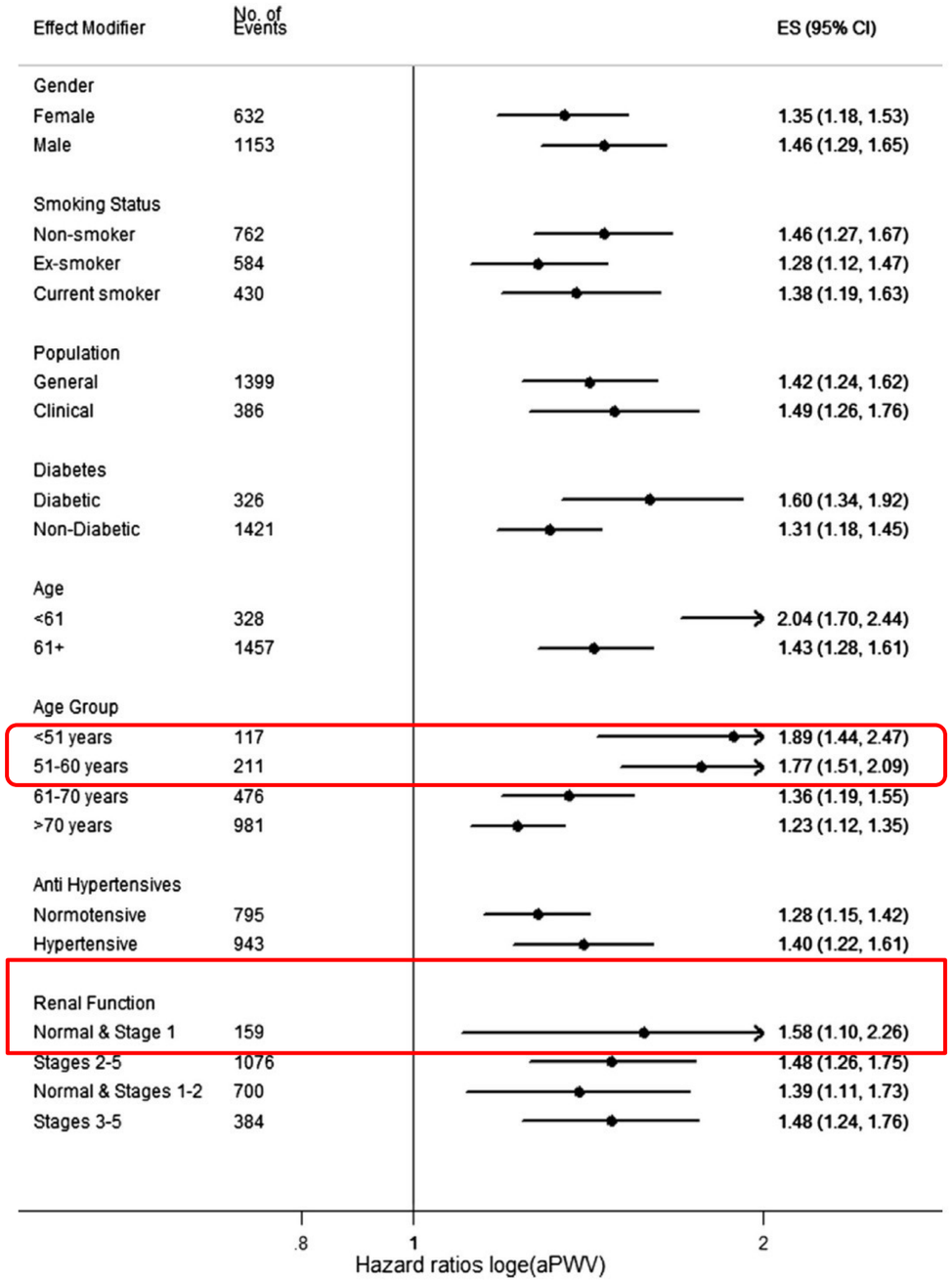
CV mortality



Scientific Reports | 2025;15:23026

Aortic Pulse Wave Velocity Improves Cardiovascular Event Prediction

An Individual Participant Meta-Analysis of Prospective Observational Data From 17,635 Subjects



After full adjustment, a **1 m/s** increase in aPWV was associated with a **7%** increased risk of a cardiovascular events for a 60-year-old man.

→ cfPWV reclassified risk most predominant in younger age and intermediate risk.

J Am Coll Cardiol. 2014; 25;63(7):636-646.

What comprise arterial ageing? CKD as a prototype of accelerated vascular aging

Arterial stifness (elastine, colagene), enlargement of puls pressure and puls wave velocity-
MECHANICAL DAMAGE

Glicozilation of proteins in arterys wall, less NO production (endothelial disfunction)-
BIOCHEMICAL CHANGE

Local and perivascular **INFLAMATION**

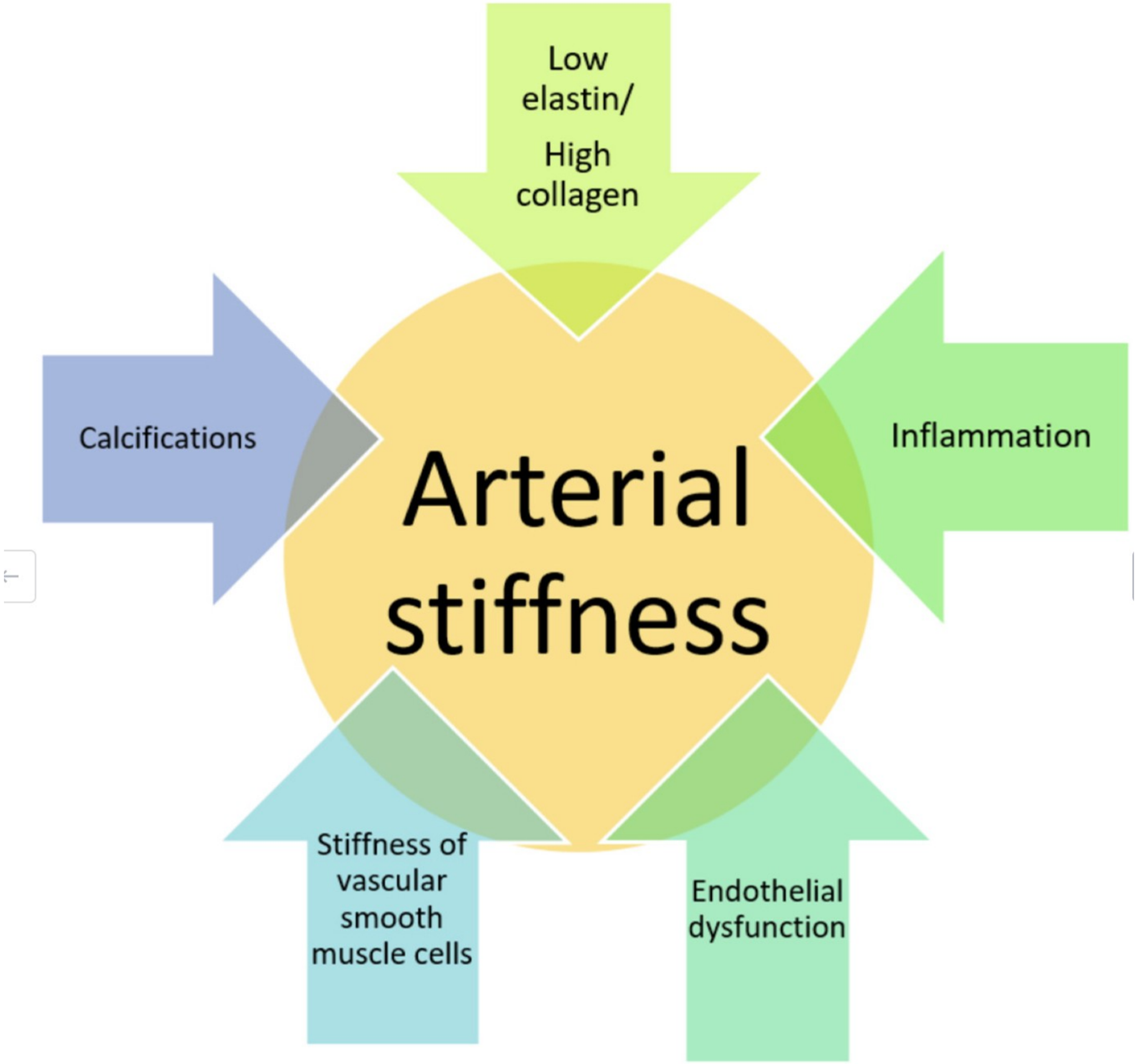
Deposition of calcium products in arterial media-
ARTERIOSCLEROSIS

Rarrefication and disfunction of capillary net-

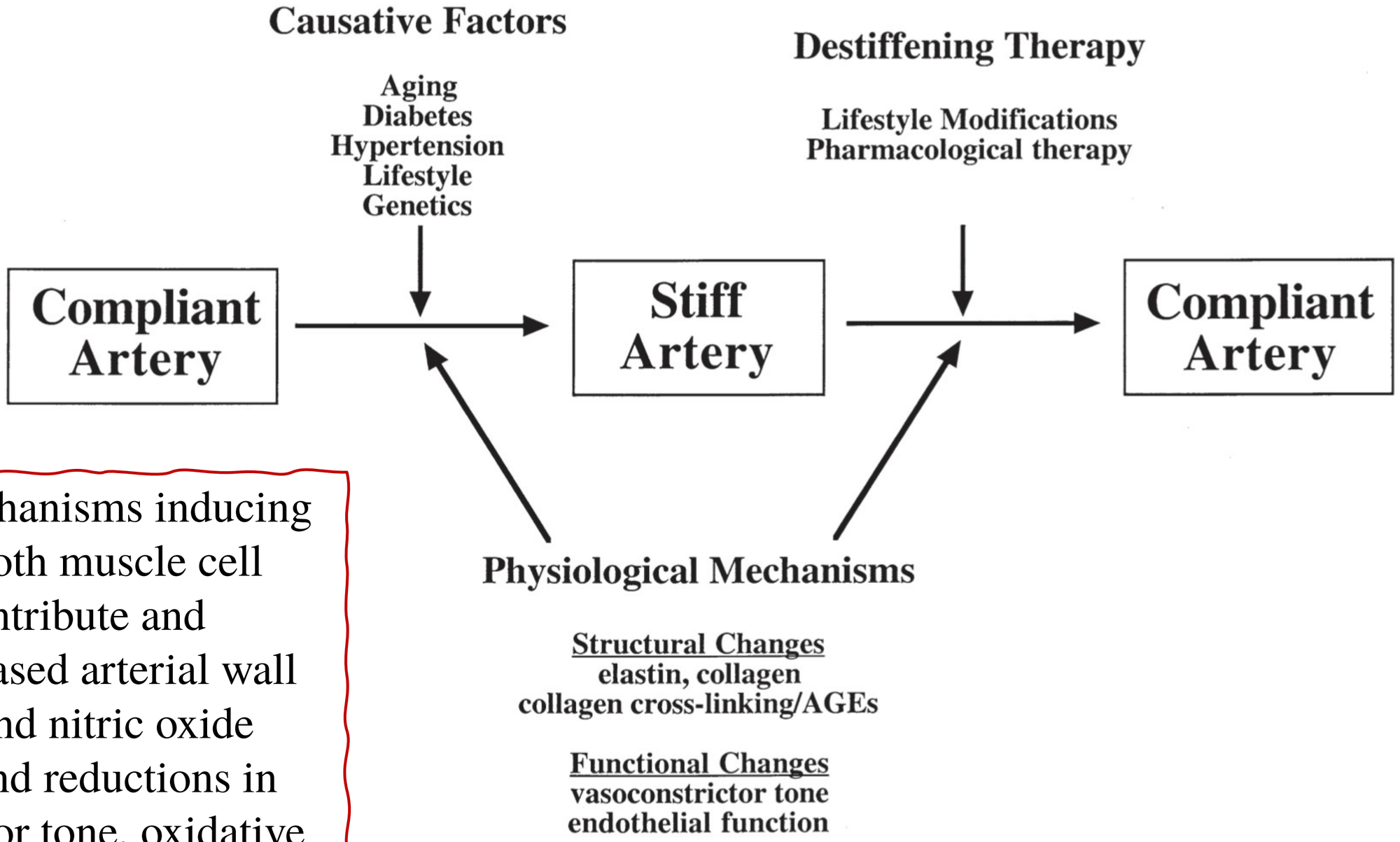
END ORGAN DAMAGE

Atherosclerosis





Baba, . *J. Cardiovasc. Dev. Dis.* **2023**, *10*, 127. https://doi.org/10.3390/jcdd10030127



Multiple mechanisms inducing vascular smooth muscle cell relaxation contribute and include increased arterial wall shear stress and nitric oxide bioactivity, and reductions in vasoconstrictor tone, oxidative stress, and inflammation.

Tanaka&Safar. AJH 2005; 18:137–

The role of clinitian in 21st century is to assess and modify patients risk and to follow-up his change

Marker of HMOD	Sensitivity to changes	Reproducibility and operator independence	Time to changes	Prognostic value of the change
LVH by ECG	Low	High	Moderate (> 6 months)	Yes
LVH by echocardiogram	Moderate	Moderate	Moderate (> 6 months)	Yes
LVH by CMR	High	High	Moderate (> 6 months)	No data
eGFR	Moderate	High	Very slow (years)	Yes
Urinary albumin excretion	High	Moderate	Fast (weeks to months)	Moderate
Carotid IMT	Very low	Low	Slow (> 12 months)	No
PWV	High	High	Fast (weeks to months)	Limited data
Ankle–brachial index	Low	Moderate	Slow (> 12 months)	Moderate

ESH guidelines 2023

Arterial stiffness as a proxy of vascular aging

Easy to measure CV risk factors

- gender
- blood pressure
- lipids
- smoking
- diabetes …

Difficult to measure CV risk factors

- chronic low grade inflamm
- oxidative stress
- Autonomic ner
- DNA dam
- telom ing
- ight
- cs, epigenetics
- tal programming…...

own CV risk actors

?

Closely correlated with cardiovascular events and death

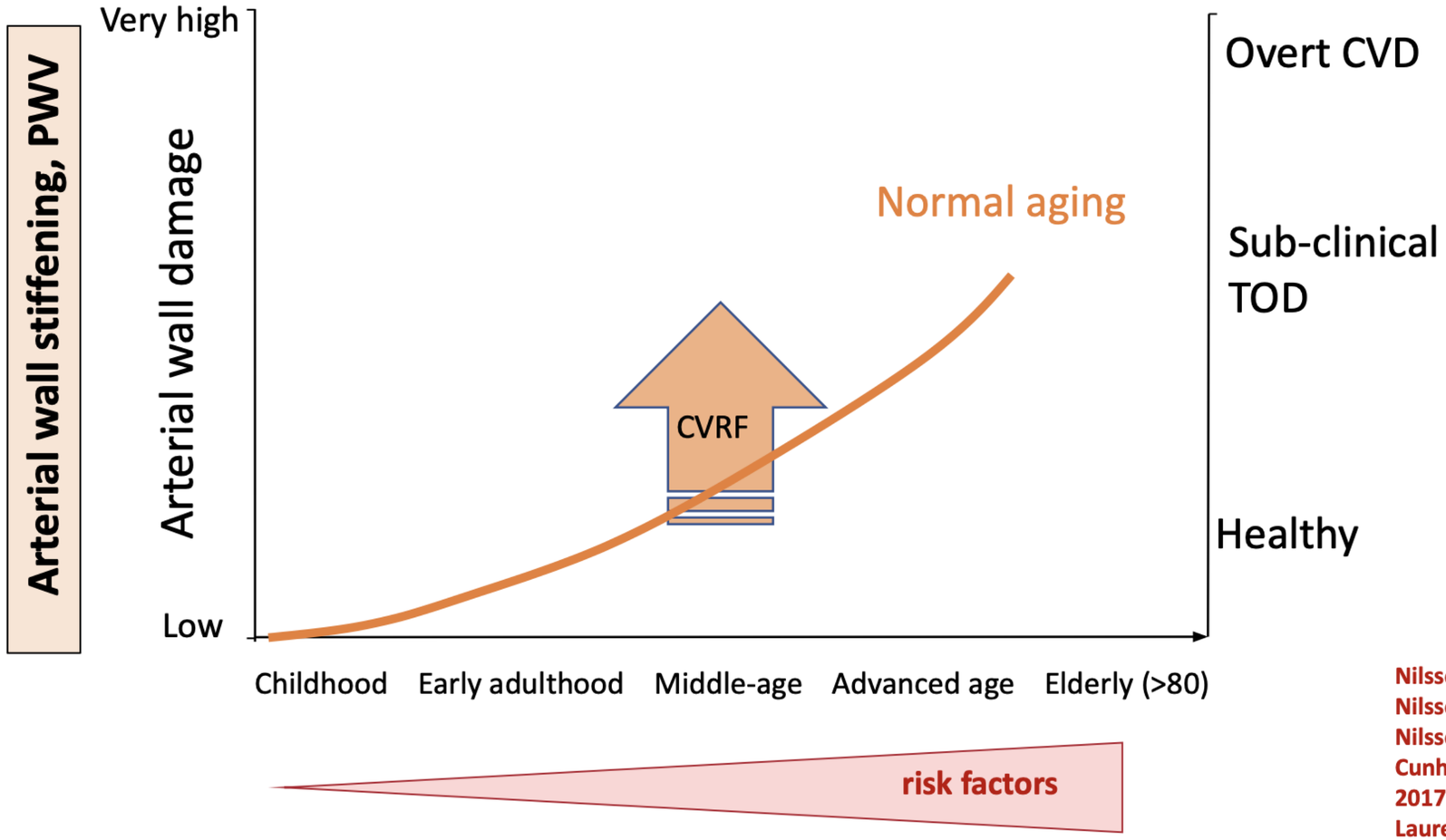
l stiffness (cfPWV) is an lifetime integrator of risk factors

$$Stif = \int_{Birth}^{death} f(RF1, RF2 \ldots FR\infty)$$

Laurent S et al.. ATVB 1994, Hypertension 1994, Hypertension 2005, Hypertension 2012, Circ Res 2015

EVA - Early Vascular Ageing

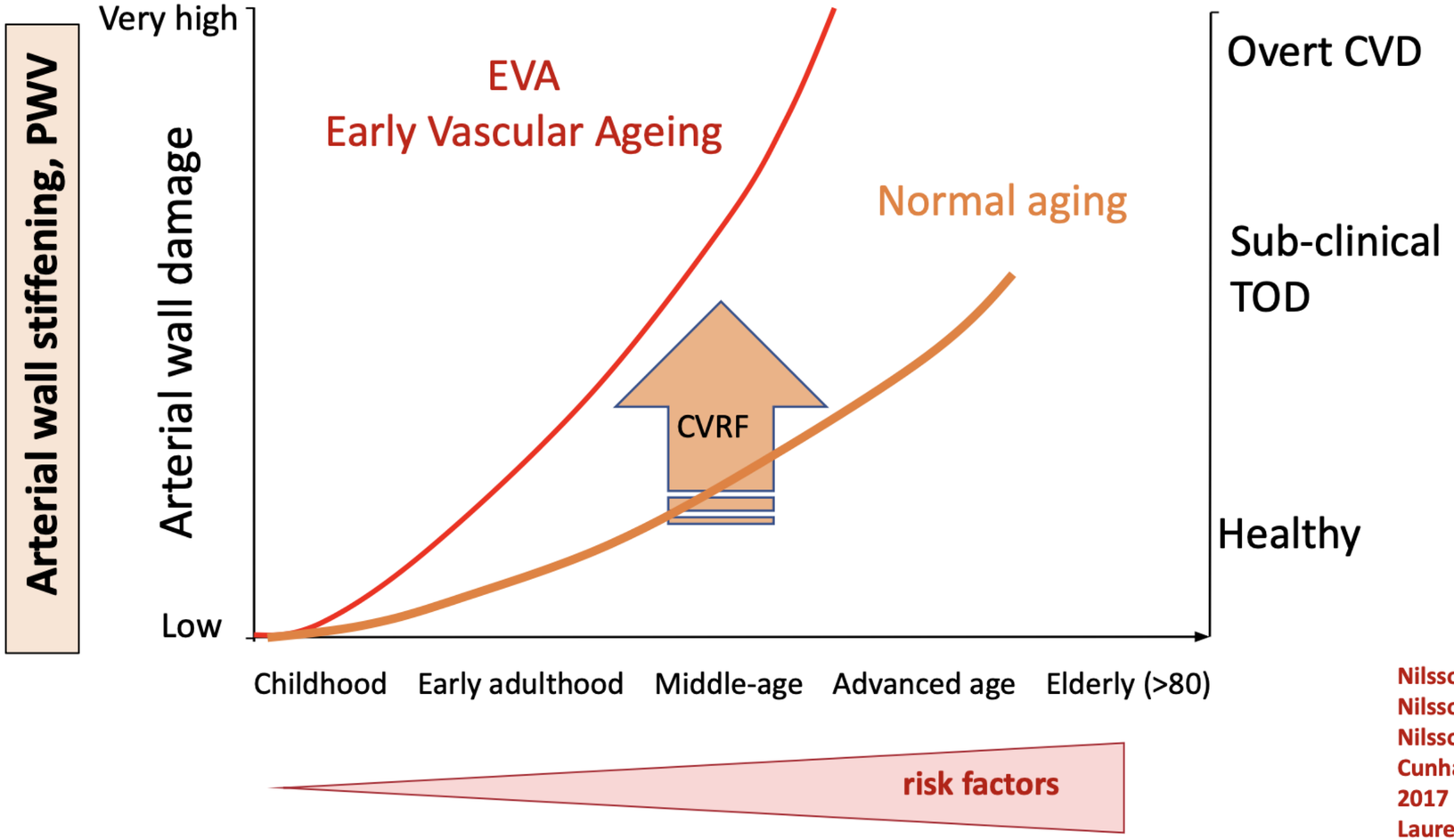
SUPERNOVA-supernormal vascular ageing



Nilsson P et al. J Hypertens 2008
Nilsson P et al. Hypertension 2009
Nilsson P et al. J Hypertens 2013
Cunha P et al. Curr Hypertens Rev 2017
Laurent S et al. Hypertension 2019
Olsen et al, Lancet 2016

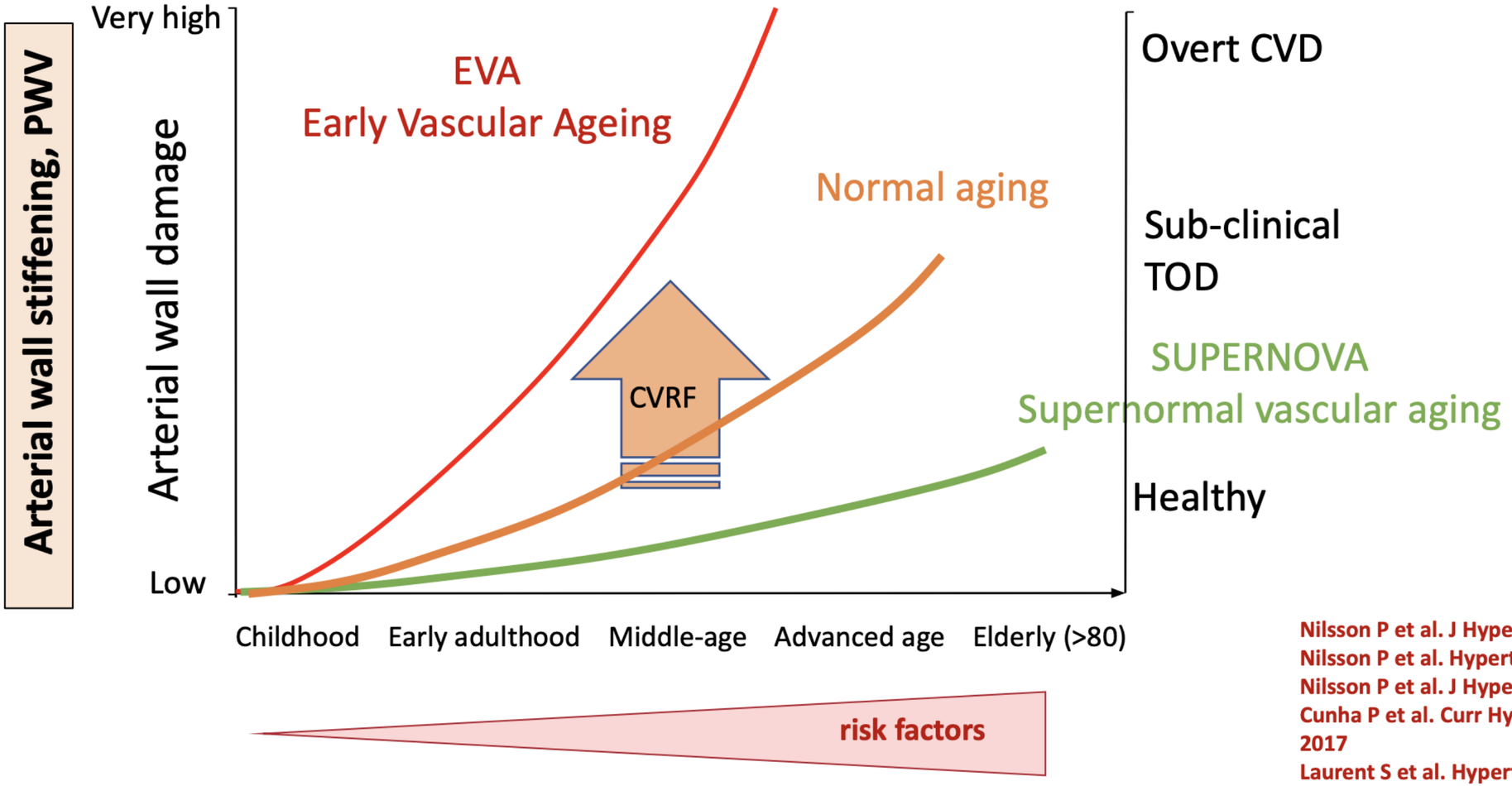
EVA - Early Vascular Ageing

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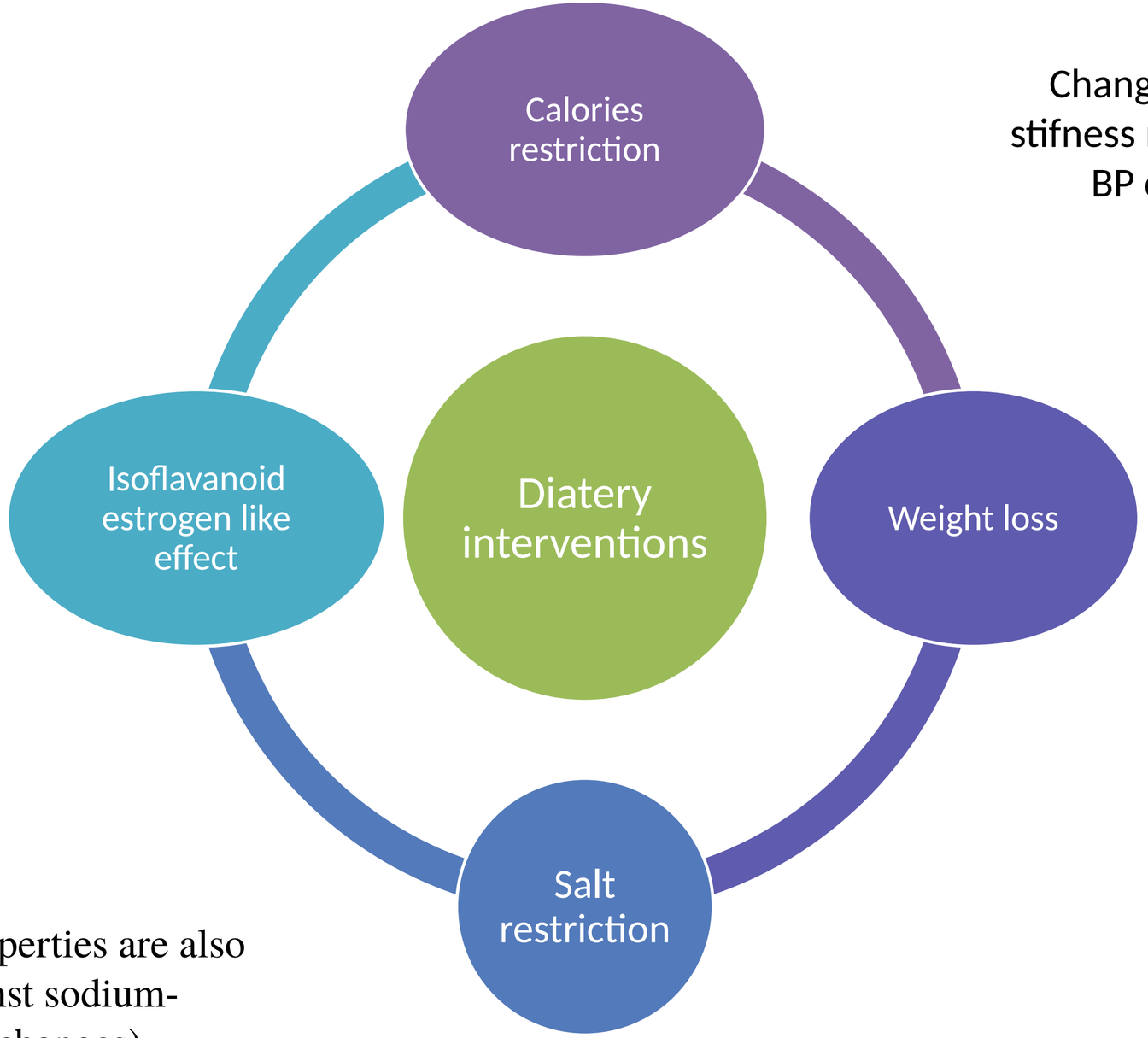
EVA - Early Vascular Ageing
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Cunha P et al. Curr Hypertens Rev 2017
Laurent S et al. Hypertension 2019
Olsen et al, Lancet 2016

Changes in aortic stifness mostly due to BP decrease

improvement of endothelial function and vascular smooth muscle cell relaxation



Changes in intrinsic wall properties are also possible (eg, protection against sodium-induced extracellular matrix changes)

Hypertension. 2014;63:888–893

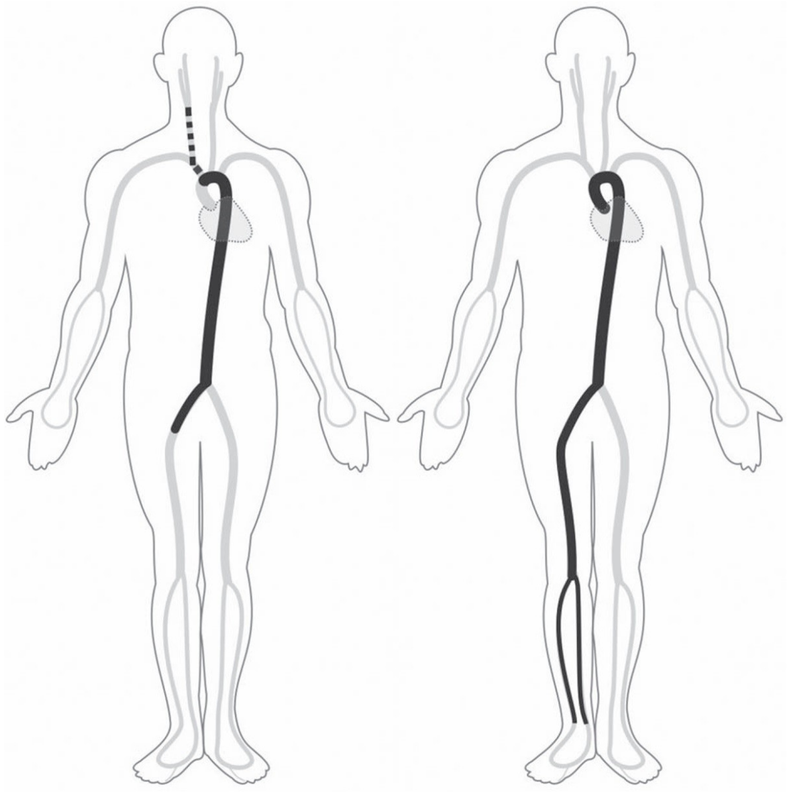
Association Between Increased Central and Peripheral Arterial 2 Stiffness and Vitamin Intake in Healthy Adults: EVA Follow-Up 3 Study

At five-year follow-up, 480 participants complete three-day dietary intake records Mean age was **55.96 ± 14.15 years**, and **51.1% were women**

vitamins **A, B1, B2, B3, B6, B9, B12 and C**; **vitamin D was determined through laboratory analysis**

cf PWV and baPWV

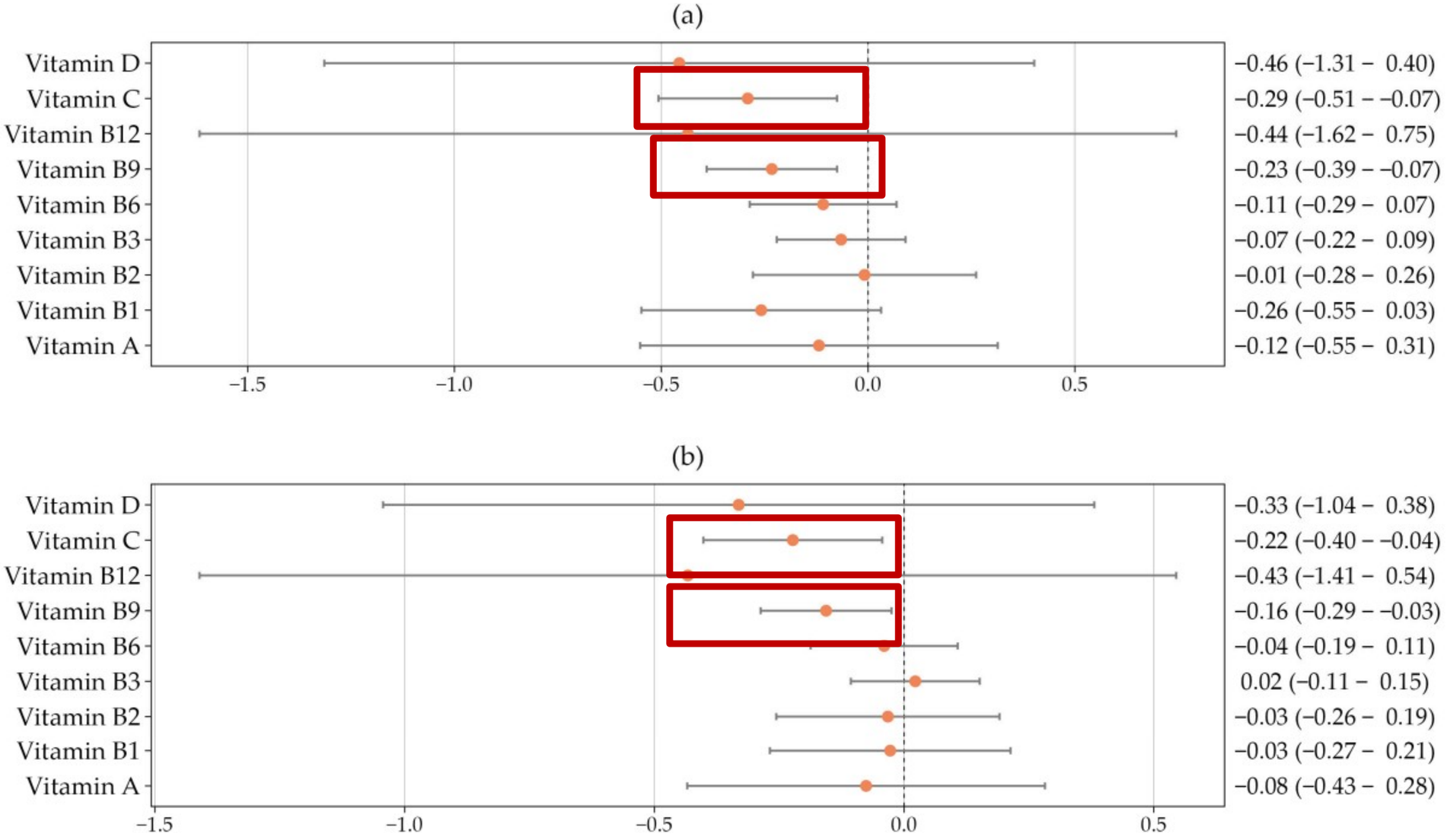
No associations at baseline. After adjustment for age, sex, lifestyle factors and cardiovascular risk factors, **no significant associations were observed between vitamin intake and baseline measures of arterial stiffness**



carotid-femoral PWV **cardio-ankle PWV**

Nutrients 2026, 18, 745; DOI 10.3390/nu18050745;

Associations with five-year progression.



Greater increases in **cfPWV** were inversely associated with **vitamin B9 (folate)** intake (β = −0.233; 95% CI: −0.390 to −0.075) and **vitamin C** intake (β = −0.291; 95% CI: −0.507 to −0.075).

Increases in **baPWV** were likewise inversely associated with **vitamin B9** (β = −0.156; 95% CI: −0.287 to −0.025) and **vitamin C**

Figure 3. Association between dietary vitamin intake and five-year changes in central arterial stiffness (**a**) and peripheral arterial stiffness (**b**), adjusted for age, sex, lifestyle factors, and cardiovascular risk factors.

the higher the dietary intake of folate and vitamin C, the less the arteries stiffened over five years — in both the central and the peripheral circulation — while vitamin D and vitamin A showed no such association

Vitamin B9. Linked to **homocysteine metabolism**; elevated homocysteine has been associated with endothelial dysfunction, vascular inflammation and increased arterial stiffness. Importantly, the authors note that although **B-PROOF** supplementation reduced homocysteine levels, it **did not significantly improve PWV** — indicating a more complex relationship

Vitamin C. Discussed as vascular-protective through reduced oxidative stress, improved endothelial function and preserved **nitric oxide bioavailability**, and by regenerating oxidised vitamin E; trials and meta-analyses report modest but significant reductions in arterial stiffness, particularly in people with higher oxidative stress or cardiovascular risk factors

Vitamin D. In contrast to observational studies reporting inverse associations between circulating 25-hydroxyvitamin D and cfPWV, and a meta-analysis in which correction of deficiency with **at least 2000 IU/day of vitamin D3 for more than four months** produced only modest, non-significant PWV reductions (standardised mean difference = −0.10; 95% CI: −0.24 to 0.04; p = 0.17; **n = 806 across ten studies**), this study found no association

Dietary sources cited include citrus fruit (oranges ≈50–70 mg per medium fruit), kiwifruit (≈70–90 mg per unit), strawberries (≈60 mg per 150 g) and bell peppers (≈80–120 mg per 100 g) for vitamin C, and spinach (≈140 µg per 100 g), lentils (≈180 µg per cooked cup), chickpeas (≈280 µg per cooked cup), whole grains and fortified cereals for folate





Nutrients 2026, 18, 745; DOI 10.3390/nu18050745;

sodium intake: low sodium <6 g, medium 6–10 g, and high >10 g sodium daily intake on arterial stiffness.	high sodium intake (>10 g/day) ≥ ↑ arterial stiffness (baPWV ≥1400 cm/s)
high sodium in normotensive subjects	⇧ AIx
↓ sodium intake	↓ blood pressure + ↓ arterial stiffness (independently of antihypertensive effects)
low-salt diet	was proved (meta-analysis) ≥ a reduction of 89.3 mmol/day in sodium intake in different populations is associated with a 2.84% reduction in PWV
two weeks of dietary sodium restriction in older adults	↓ arterial stiffness (rapid improvement of large elastic artery compliance and AIx) ≥ ↓ systolic hypertension
Salt restriction for 6 weeks is untreated in patients with mildly raised blood pressure	↓carotid-femoral PWV ↓ blood pressure ↓urinary albumin and ↓albumin/creatinine ratio
diet with an additional 20 or 40 mmol K(+)/d from fruit and vegetables in a group with early-stage hypertension	no change in arterial stiffness and endothelial function
potassium chloride and potassium bicarbonate supplementation	↑brachial artery flow-mediated dilatation ↓carotid-femoral PWV
low dietary potassium intake in healthy young adults	↑ wave reflection and arterial stiffness ↑ potassium excretion ≥ ↓ aortic AIx + ↓ carotid-femoral PWV
low sodium-to-potassium intake ratio	↓ aortic AIx + ↓ PWV

Stanek.. The Influence of Dietary Interventions on Arterial Stiffness in Overweight and Obese Subjects. *Nutrients* **2023**, *15*, 1440.

Pressure-independent contribution of sodium to large artery structure and function in hypertension

High salt diet → Increased wall thickness
Increased collagen content

Completely independant of intraarterial BP

High salt diet → Alterations in RAAS- bradykinin system → Changes in collagen and elastin content

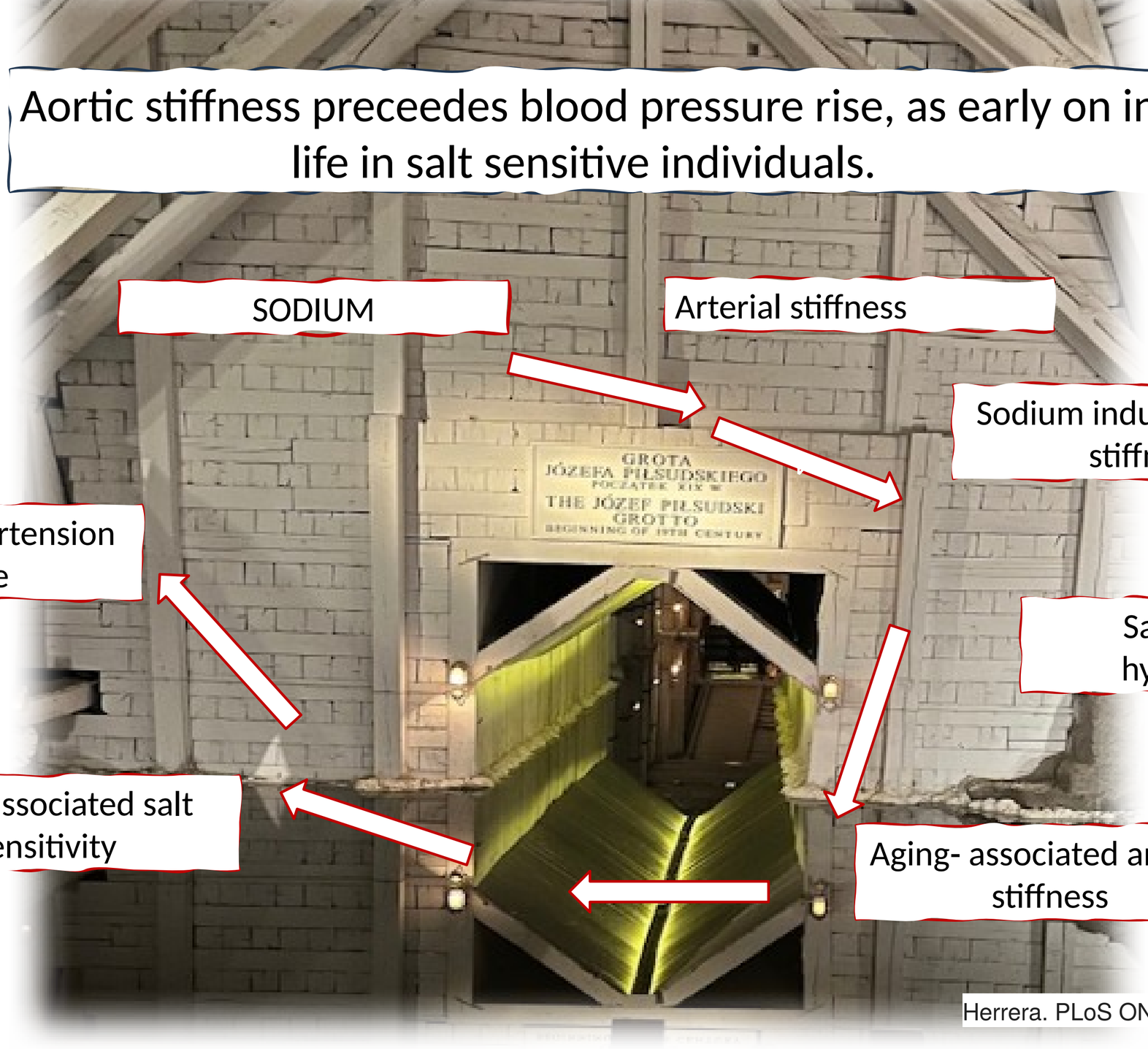
Endothelial disfunction → Shear stress

Sodium sensitivity –more important then salt diet it self.

Sodium induced changes of arterial vessels may affect cardiovascular lesions and hypertension risk independently of blood pressure and atherosclerosis.

Safar ME, Thuilliez C, Richard V, Benetos A. Cardiovasc Res. 2000 May;46(2):269-76.

Aortic stiffness preceedes blood pressure rise, as early on in life in salt sensitive individuals.



SODIUM

Arterial stiffness

Sodium induced arterial stiffness

Salt sensitive hypertension

Aging- associated arterial stiffness

Aging associated salt sensitivity

Increased hypertension with age

Herrera. PLoS ONE; 2014. 9(9): e107888.

After certain age no dietery interventions can destiff stiff aorta.
Whole life activity and whole food diet will result in less stiff arteries.

Low salt diet is the least expensive, essential and effective nutritional intervention for destiffening.

High salt diet and arterial stiffening is primordial event preceding hypertension evolution in most individuals.

