

Vascular health after quitting smoking or switching to e-cigarette use: a systematic review of prospective studies with GRADE assessment

George J, et al. Vascular health after quitting smoking or switching to e-cigarette use: a systematic review of prospective studies with GRADE assessment. *European Journal of Preventive Cardiology* (2026);00:1-18.

Background

Tobacco smoking is a leading cause of **preventable death** and increases cardiovascular disease (CVD) by damaging vascular function.



Smoking cessation is a cornerstone of CVD prevention.



Smoking cessation is strongly recommended by clinical guidelines (2024 evidence) and supported by behavioural and pharmacological **therapies**, including **nicotine replacement therapy** (NRT), varenicline, cytisine, bupropion, and popular **electronic cigarettes** (ECs).



Improvements after cessation can be assessed using **non-invasive vascular biomarkers** such as carotid-femoral pulse wave velocity (PWV), augmentation index (AIx), and brachial flow-mediated dilation (FMD), which detect early vascular changes and predict future risk.

Aim

To evaluate the effects of smoking cessation or switching to exclusive EC use on vascular function in adult smokers, assessed by changes in PWV, AIx, and FMD using prospective clinical evidence.

Methods

A literature search of **PubMed Scopus, Web of Science, and Embase** was conducted on 13 October 2025.

Twenty-three studies (**n = 11,702**) were included from America, Europe and Asia:

04 randomised controlled trials

05 quasi-experimental (non-randomised interventional) studies

14 prospective cohort studies

Risk of bias was assessed using Joanna Briggs Institute (JBI) tools. The Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) approach was applied.

Results

Characteristics

12 studies pharmacotherapy as an intervention/smoking cessation therapy

09 studies NRT (nicotine replacement therapy)

04 studies ECs* (electronic cigarettes)

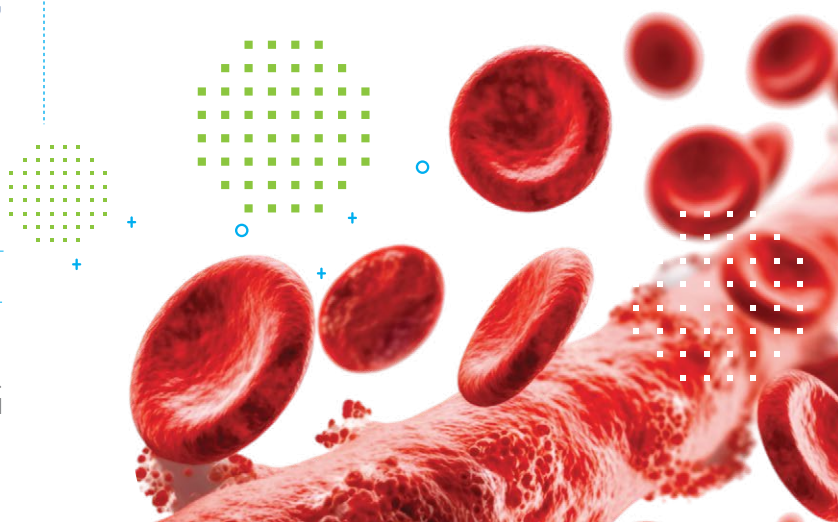
* for EC studies this review did not fully reflect the wide diversity of devices, nicotine concentrations, and flavouring

Vascular Outcomes

Overall, smoking cessation, regardless of method, was associated with early and significant reductions in arterial stiffness.

1 Pulse wave velocity

- **Rapid and Sustained Results:** Benefits are often measurable within **one** month of cessation and have been shown to last for at least **36 months**.
- **Consistent Trend:** Despite variations in study designs, measurement techniques, and follow-up periods, the positive impact on the cardiovascular system remains a stable finding.
- **Method Independence:** Reductions in arterial stiffness occur regardless of the specific cessation method or aid used to quit.
- **Variable Responses:** The degree of improvement (measured via PWV) can vary based on the individual i.e., : **Healthy participants** vs. **those with comorbidities**: Factors like systemic inflammation, renal impairment, concomitant medications can independently affect baseline arterial stiffness and the reliability of measurements.
- **High-risk populations often start with higher baseline arterial stiffness**, affecting their specific physiological response to smoking cessation in other studies.



2 Augmentation index

Smoking cessation was consistently associated with:

- **Reductions in Alx.**
- **Improved arterial stiffness.**
- Longer-term data demonstrated quitting smoking **slowed the worsening of Alx over time**, with modest benefits compared with continued smoking.
- **Shorter follow-up studies** (1–24 months) demonstrated improvements, **results were influenced by factors** such as age, medications, physical fitness, and comorbidities.
- **No significant advantage** was observed **between** the different **pharmacological cessation aids**.
- Smoking **abstinence/quitting** was the **primary therapeutic driver**.
- Overall, despite study heterogeneity, the **evidence** supports a **beneficial effect of smoking cessation** on Alx.

3 Flow-mediated dilation

- **Universal Vascular Gain:** Smoking **cessation** consistently **improves FMD**, regardless of the pharmacological intervention or cessation method utilised.
- **Rapid Physiological Response:** Randomised trials showed that switching from combustible **cigarettes to ECs improved endothelial function** within one to six months, regardless of nicotine content, with similar benefits observed in NRT groups.
- **Nicotine Independence:** Transitions to non-combustible alternatives (NRT or electronic delivery systems) demonstrated **improved endothelial function** within 1–6 months, independent of nicotine concentration.
- **Positive FMD outcomes** are associated with varied therapies, including varenicline, NRT, and cytisinicline, even in patients with pre-existing vascular comorbidities.
 - **NRT studies** reported **improved FMD** within 3 to 4 months.
 - **Long term trials** found that sustained smoking abstinence **improved FMD** regardless of cessation method.
 - A recent **pilot study** using cytisinicline demonstrated particularly large improvements, while rapid gains in **endothelial function** were also observed **within 1 month** of smoking cessation in other studies.

Table 1. Summary of findings

Smoking cessation (with or without cessation aids including exclusive e-cigarette use)
Population: adults (≥18 years) who are regular smokers, with or without cardiovascular risk factors
Interventions: smoking cessation
Comparison: continuous smoking

Outcome	Effect	Number of participants Studies	Certainty in the evidence
Pulse wave velocity (PWV)	Most studies showed a reduction in arterial stiffness (PWV) following smoking cessation	302 2 RCTs	Very low ^{a,b} ●○○○ (Due to serious risk of bias and very serious imprecision)
		2293 10 non-randomised (3 quasi-experimental, 7 cohort)	Very low ^c ●○○○ (Due to study design and serious risk of bias)
Augmentation index (Alx)	All studies reported a reduction in Alx following smoking cessation	188 1 RCT	Very low ^{a,b} ●○○○ (Due to serious risk of bias and very serious imprecision)
		7171 8 non-randomised (2 quasi-experimental, 6 cohort)	Very low ^c ●○○○ (Due to study design and serious risk of bias)
Flow-mediated dilation (FMD)	Smoking cessation was consistently associated with improvements in FMD across the included studies	3 RCTs 1866	Moderate ^d ●●●○ (Due to serious risk of bias)
		520 6 non-randomised (1 quasi-experimental, 5 cohort)	Very low ^c ●○○○ (Due to study design and serious risk of bias)

^aSerious risk of bias across studies because of unclear or inadequate randomisation, blinding, and allocation concealment.

^bVery serious risk of imprecision because of *N* of participants <400 and small or no effect (downgraded two levels).

^cSerious risk of bias across studies because of insufficient strategies to control confounders or address incomplete follow-up in cohort studies.

^dSerious risk of bias across studies because of unclear or inadequate randomisation, blinding, allocation concealment, and incomplete follow-up.

Conclusion

Smoking cessation is associated with early improvements in vascular health markers, including PWV, Alx, and FMD.

Improvements in endothelial function appeared rapidly, while **reductions in arterial stiffness** were also **observed early and sustained over time**. These findings align with the biologically plausible cardiovascular benefits of sustained abstinence. Furthermore large, well-designed, long-term studies are needed to confirm these findings, particularly regarding ECs and harm-reduction strategies.

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