Vaping – Friend or Foe? The impact of novel nicotine delivery devices on population health

Stichting Volksbond Rotterdam

November, 13th 2025

Lion Shahab, PhD
University College London
@LionShahab   @lionshahab.bsky.social

Overview

The Good & The Bad

  1) Health effects

  2) Effectiveness

  3) Gateway & Youth appeal

The Ugly

  4) Regulation

The Good

- Principle: nicotine in a solvent is turned into an aerosol by a suction/automatic- or manually-activated battery-powered heating element
- E-liquid typically contains nicotine together with humectants (PG/VG) and flavourings (7000+, most popular are tobacco, menthol, fruit/candy)
- Many different forms now available to aid harm reduction for those <u>unwilling/unable</u> to stop smoking

"Closed Systems" — Pod-Based, Pod Mod | Disposables

"Refillable Open Systems" — Tank Sy...ds, Vape Pens

No combustion !!!

The Good

Outcomes	Vaping vs Smoking (relative risk)
↓ significantly lower, ↑ significantly higher, **=** no significant difference, **–** not enough data	
Biomarkers of exposure	
Carcinogens (e.g., TSNA)	↓ (90%)
Respiratory toxins (e.g., Acrolein)	↓ (70%)
Cardiovascular toxins (e.g., CO)	↓ (75%)
Other toxins (e.g., heavy metals)	**=**
Biomarkers of harm	
Oxidative stress	**=**
Inflammation	↓ (25%)
Endothelial function/Blood pressure	Improved
Health outcomes	
Cancers	– (↓?)
Respiratory diseases	– (↓?)
Cardiovascular diseases	– (↓?)

Nicotine vaping in England: an evidence update including health risks and perceptions, 2022

A report commissioned by the Office for Health Improvement and Disparities

Published 29 September 2022

Authors: Ann McNeill, Erikas Simonavičius, Leonie Brose, Eve Taylor, Katherine East, Elizabeth Zuikova, Robert Calder, Debbie Robson
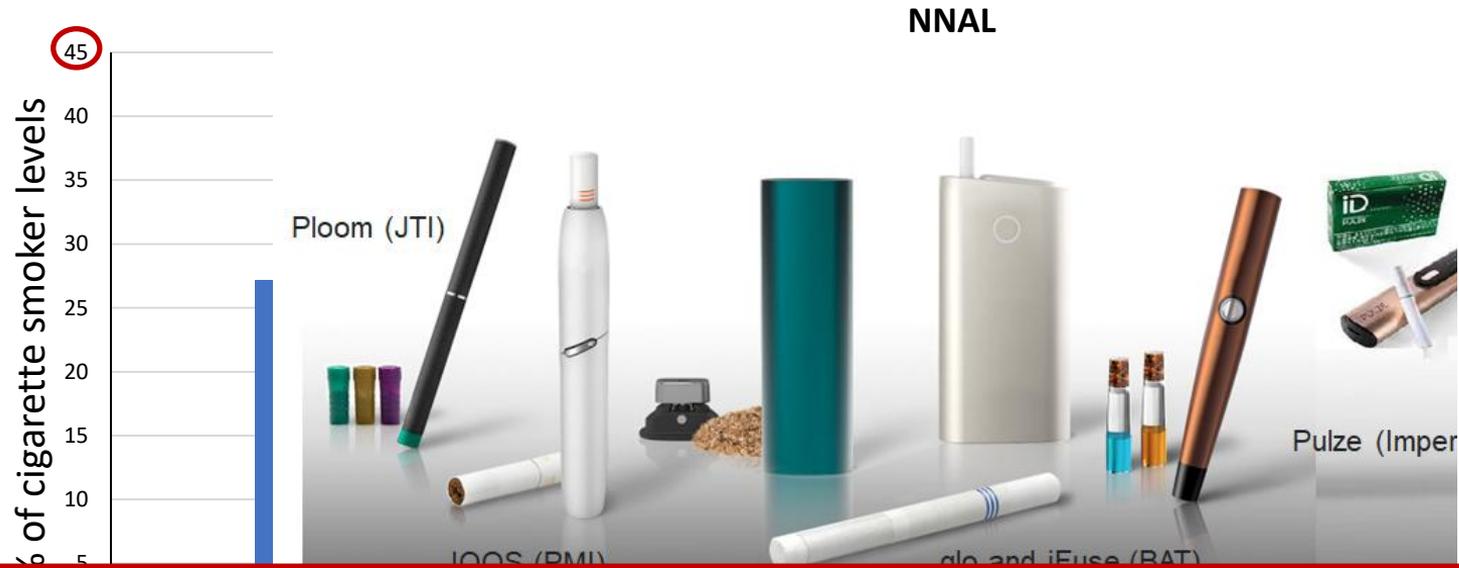
King's College London

The Good

- Compares favourably with other harm reduction methods
  - Lower levels in key smoking-related carcinogens (TSNAs)

NNAL

The Good

- Compares favourably with other harm reduction methods
  - Lower levels in key smoking-related carcinogens (TSNAs)

✓ Across wide range of measures, ECs shown to be less harmful than cigarettes, likely more similar to traditional nicotine replacement therapy in risk

The Bad

Outcomes	Vaping vs Smoking (relative risk)	Vaping vs Non-user (absolute risk)
↓ significantly lower, ↑ significantly higher, = no significant difference, – not enough data		
Biomarkers of exposure		
Carcinogens (e.g., TSNA)		↑ (40%) / =
Respiratory toxins (e.g., Acrolein)		↑ (>10%) / =
Cardiovascular toxins (e.g., CO)		=
Other toxins (e.g., heavy metals)		↑ (>25%)
Biomarkers of harm		
Oxidative stress		↑? / =
Inflammation		↑? / =
Endothelial function/Blood pressure		↑? / –
Health outcomes		
Cancers		–
Respiratory diseases		–
Cardiovascular diseases		– /=

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- Some uncertainty about health effects but some residual risk (vs non-smoking)
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  - Cell studies show effects of aerosol on (epithelial) cells, e.g. by flavours

Noel J Leigh et al. Tob Control doi:10.1136/tobaccocontrol-2016-053205

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Cervelatti, F et al. Toxicol Vitro 2014; 5:999-1005

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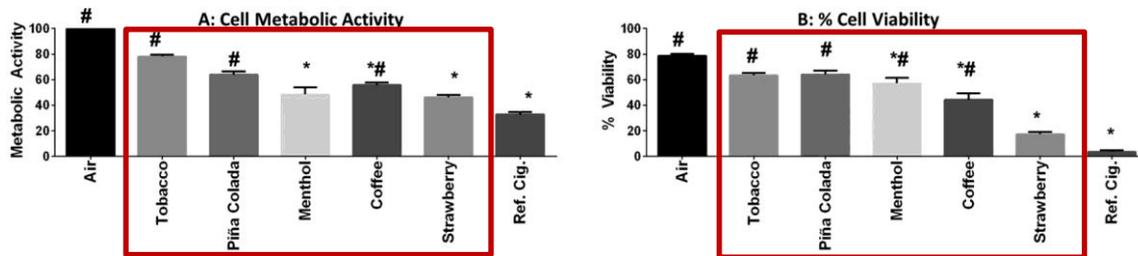 - Limited work in animals suggestive of possible mutagenic effects

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  - Possibly most insightful work is on epigenetic changes in humans
  - Recent Ion   ory system

Herzog, C et al. Canc Res 2024; 23:2597
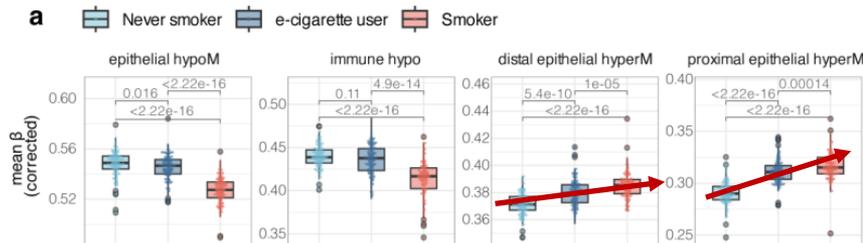
Interlude - COPD

- Various valid critiques made of existing research
- However, some emerging evidence that may signal something is going on in All of US Research Programme (Erharbor et al, 2025)
  - Longitudinal analysis (~4 years) of cardiometabolic conditions
  - Looked at new disease incidence in disease-free individuals at baseline
  - Verified disease occurrence (linked health records)
  - Included never-smoking vapers as well as smokers (positive control)

Table 2. Association Between Tobacco Use Patterns and Incident Cardiometabolic Conditions

Cardiometabolic conditions	Nonuse	Exclusive e-cigarette Use	Exclusive combustible cigarette use	Dual use
	aHR (95% CI)	aHR (95% CI)	aHR (95% CI)	aHR (95% CI)
Hypertension	Reference	1.01 (0.83–1.23)	1.20 (1.15–1.26)	1.21 (1.10–1.34)
T2DM	Reference	0.88 (0.66–1.16)	1.18 (1.11–1.26)	1.12 (0.97–1.28)
COPD	Reference	2.29 (1.42–3.71)	6.75 (6.26–7.28)	7.91 (6.91–9.06)
Heart failure	Reference	0.82 (0.47–1.41)	1.50 (1.40–1.62)	1.76 (1.49–2.07)
ASCVD	Reference	1.05 (0.59–1.86)	1.66 (1.51–1.81)	2.18 (1.82–2.62)

- Adjusted for a range of confounders (though not all relevant ones)
- Effect stronger when restricting sample to 30-70 years (aHR 2.94; 95%CI 1.74-4.99)
- **Effect specific to COPD!**

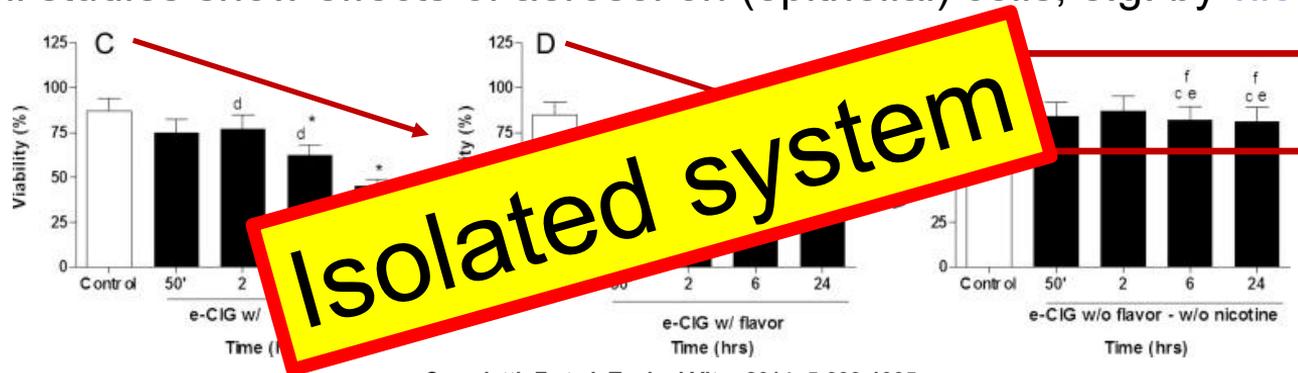Erharbor, J et al. Nic Tob Res; 2025 doi:10.1093/ntr/ntaf067
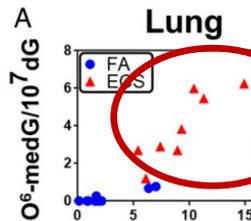
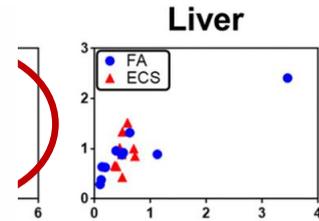## The Bad

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  - Cell studies show effects of aerosol on (epithelial) cells but less than cigarettes
 - Limited work in animals suggestive of possible mutagenic effects
  - Possibly most insightful work is on epigenetic changes in humans
  - Recent longitudinal works suggests effects on respiratory system

✕ Clearly e-cigarettes are not risk-free and may have an impact on physical health that has yet to be quantified accurately

The Good

- Nicotine primary addictive component of cigarettes
  - So to be effective, EC must replace combustible nicotine
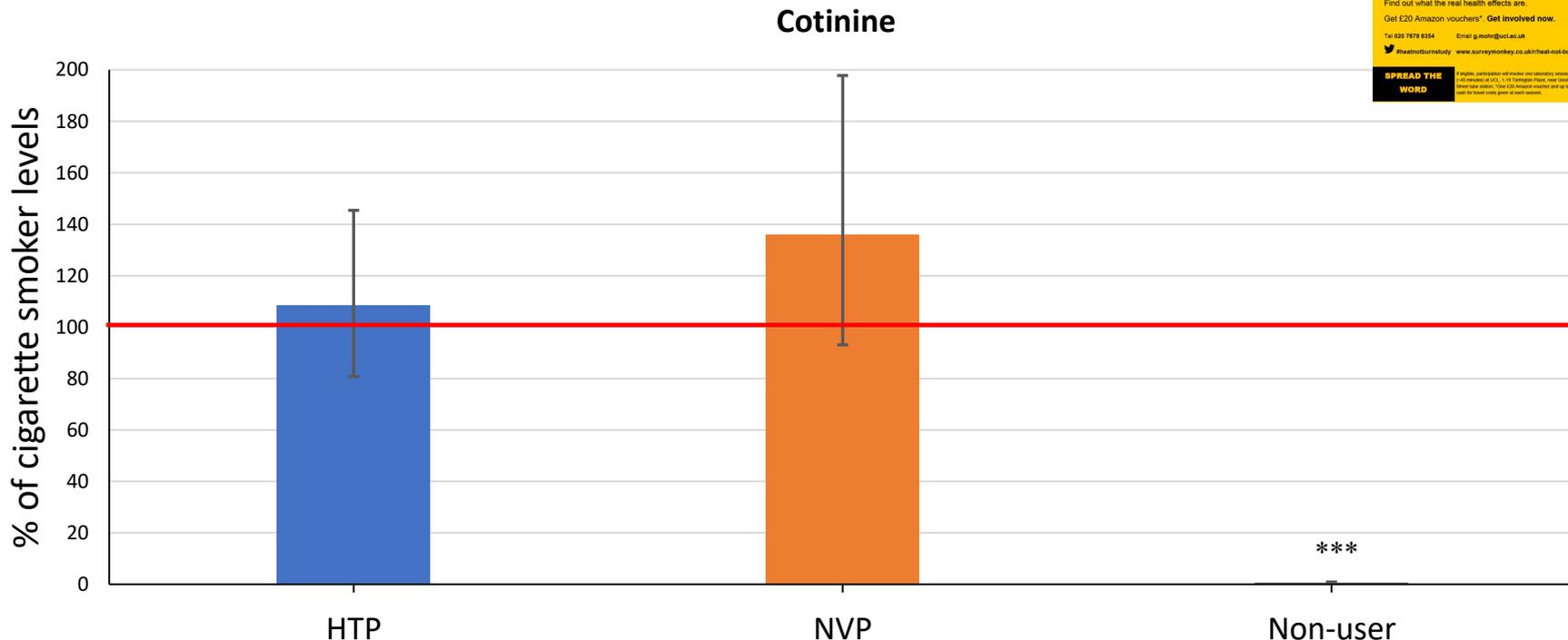
Cotinine

All analyses adjusted for socio-demographics, exposure, physical and mental wellbeing

***p<.001

The Good

- Nicotine primary addictive component of cigarettes
  - EC clearly good nicotine delivery device, similar to cigarettes and HTP
- Cochrane collaboration has undertaken extensive reviews
  - Numerous RCTs confirm effectiveness of EC

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of partici-pants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with behav-ioural support on-ly/no support	Risk with Nicotine EC				
Smoking cessation at 6 to 12 months — Assessed using biochemical validation	Study population		RR 2.66 (1.52 to 4.65)	3126 (7 RCTs)	⊕⊖⊖⊖ VERY LOW[a,b]	-
	1 per 100	3 per 100 (2 to 5)				
Adverse events at 12 weeks to 6 months — Assessed via self-report	Study population		RR 1.22 (1.12 to 1.32)	765 (4 RCTs)	⊕⊕⊖⊖ LOW[a]	-
	66 per 100	80 per 100 (74 to 87)				

The Good

- Nicotine primary addictive component of cigarettes
  - EC clearly good nicotine delivery device, similar to cigarettes and HTP
- Cochrane collaboration has undertaken extensive reviews
  - Numerous RCTs confirm effectiveness of EC
- Analysis of real-world data corroborates RCTs
  - Our group found EC resulted in 144,000 short-term quitters per year, with similar findings reported elsewhere (e.g., USA; Zhu et al, 2017)
  - Comparing countries with low and high levels of EC use shows divergence in declines of smoking rates

✓ Across different methods, EC [...] ctive as existing treatment for smokin[...]

Smoking prevalence over time: high-vape vs low-vape high-income panels (pop-weighted)

Panel A: UK, Ireland, US, Canada, New Zealand
Panel B: Italy, Spain, France, Germany

e2454962

The Bad

- Effect on population-level smoking rates likely smaller than generally stated
  - ASH states nearly **3 million smokers** in GB have quit with vapes
  - But many of them would have quit anyway – we estimate around **~50,000** additional long-term quitters per year (Beard et al, 2000)
- Use of e-cigarettes may cannibalise use of other effective aids

Methods used during quit attempt

STS Smoking Toolkit Study

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- Unlike for other quit methods, many ex-smokers use e-cigarettes long-term and many smokers remain long-term dual users

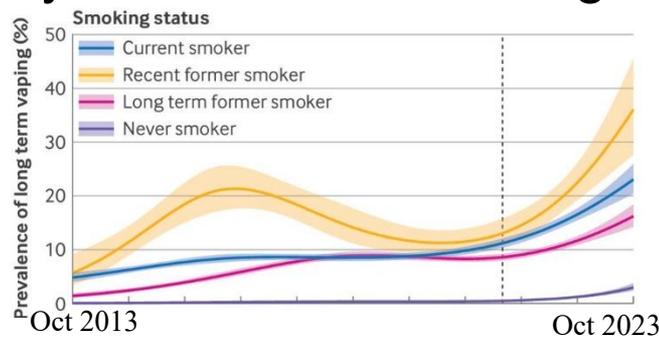Jackson, S.E. et al, BMJ; 2024, 386: e079016

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- Unlike for other quit methods, many ex-smokers use e-cigarettes long-term and many smokers remain long-term dual users

✕ Clearly e-cigarettes are not a simple cessation but more of a transition product that maintains people in a nicotine-dependent state

The Good

- Postulated gateway effects
  - Best way to assess causal claim is via an RCT
  - <u>But</u> impractical and unethical
- Direct observation is not possible
  - Need to infer likely association using different methodological approaches
- Need to triangulate approaches (with different biases) to evaluate likely impact (Shahab et al, 2022)
  - Descriptive epidemiological trends (Netherlands)
  - Individual-level analysis, using real-world and synthetic (PSM) controls (UK/US)
  - Population-level analysis, using time-series analysis (UK/US)
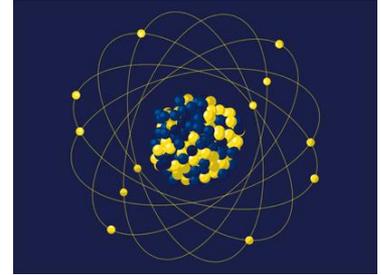
The Good

Product use in 12-16 year olds in the Netherlands
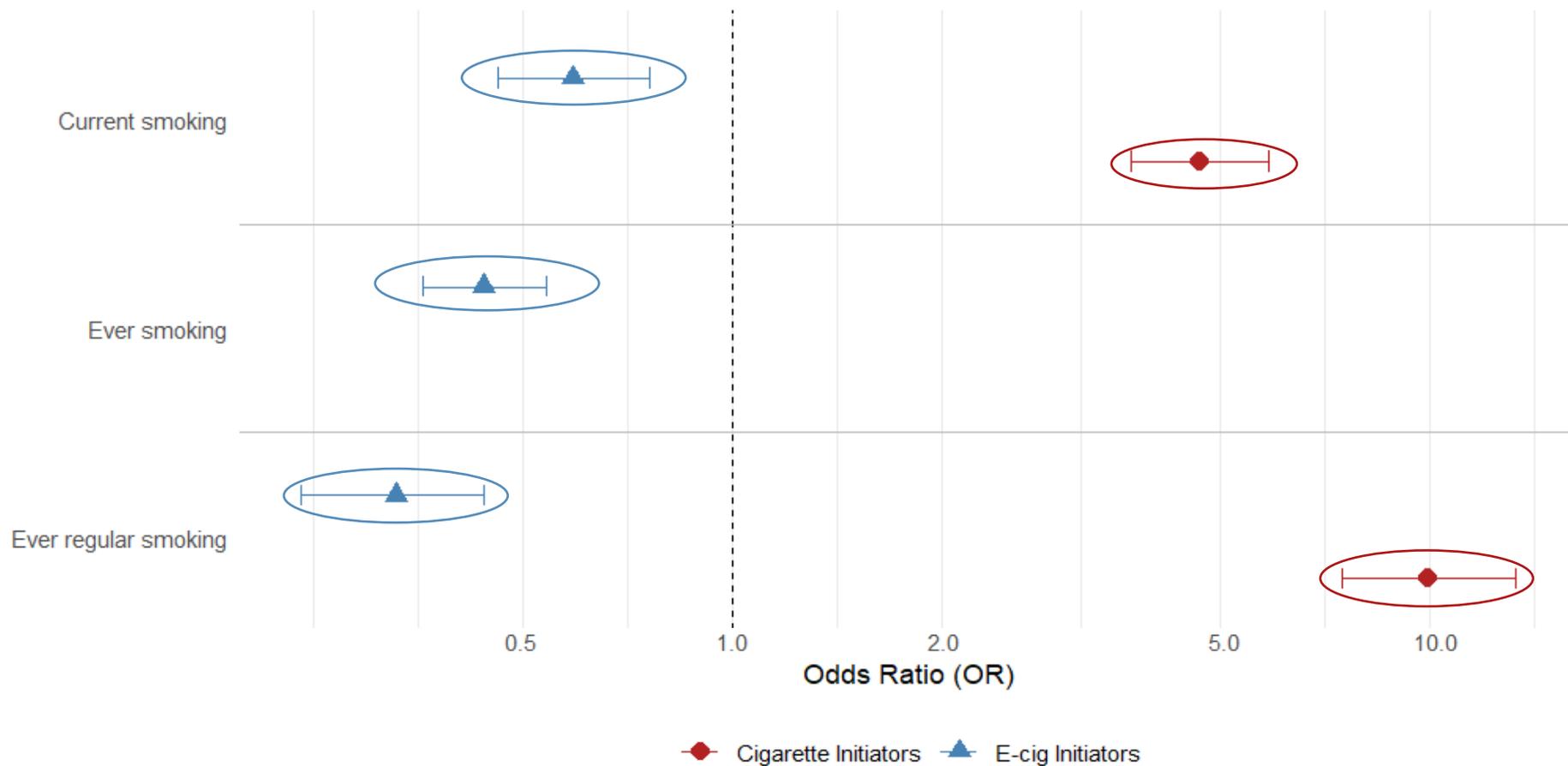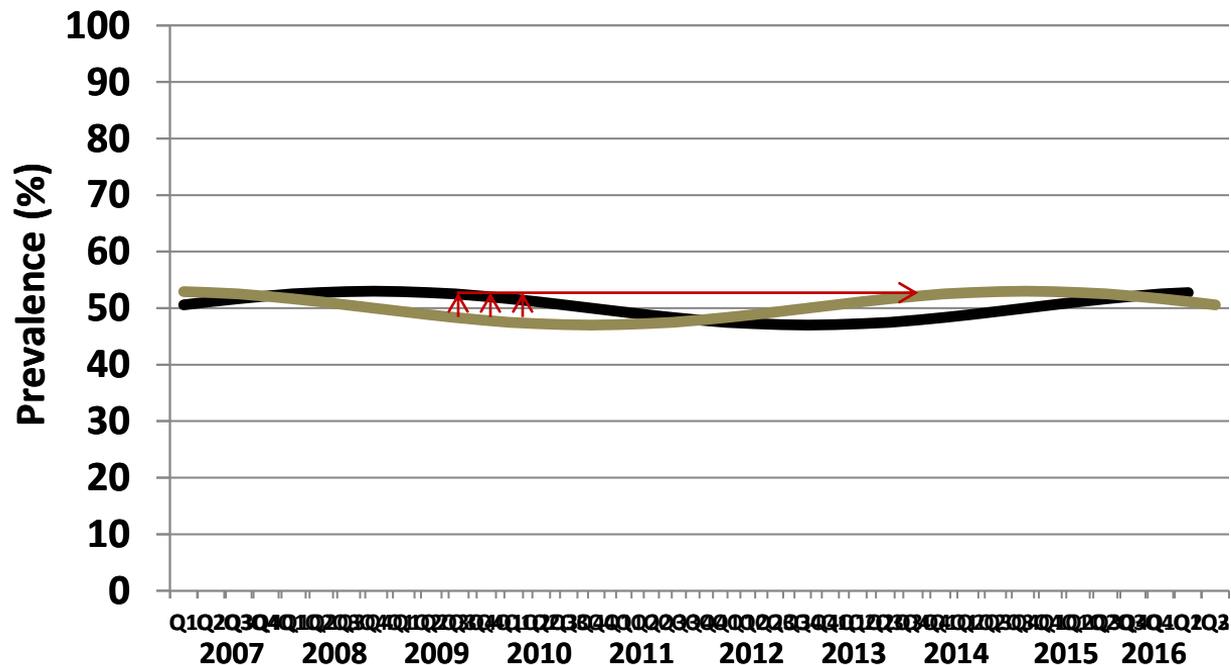
Legend: Daily Smoking — Current vaping

The Good

The Good

- **ARIMAX**: **A**uto**R**egressive (to model earlier scores, *q*), **I**ntegrated (to capture trends, *d*), **M**oving **A**verage (to model random noise, *p*) with e**X**ogenous input (to model impact of one on another time-series)
  - If seasonality is present, also need to have seasonal *q*, *d*, *p*
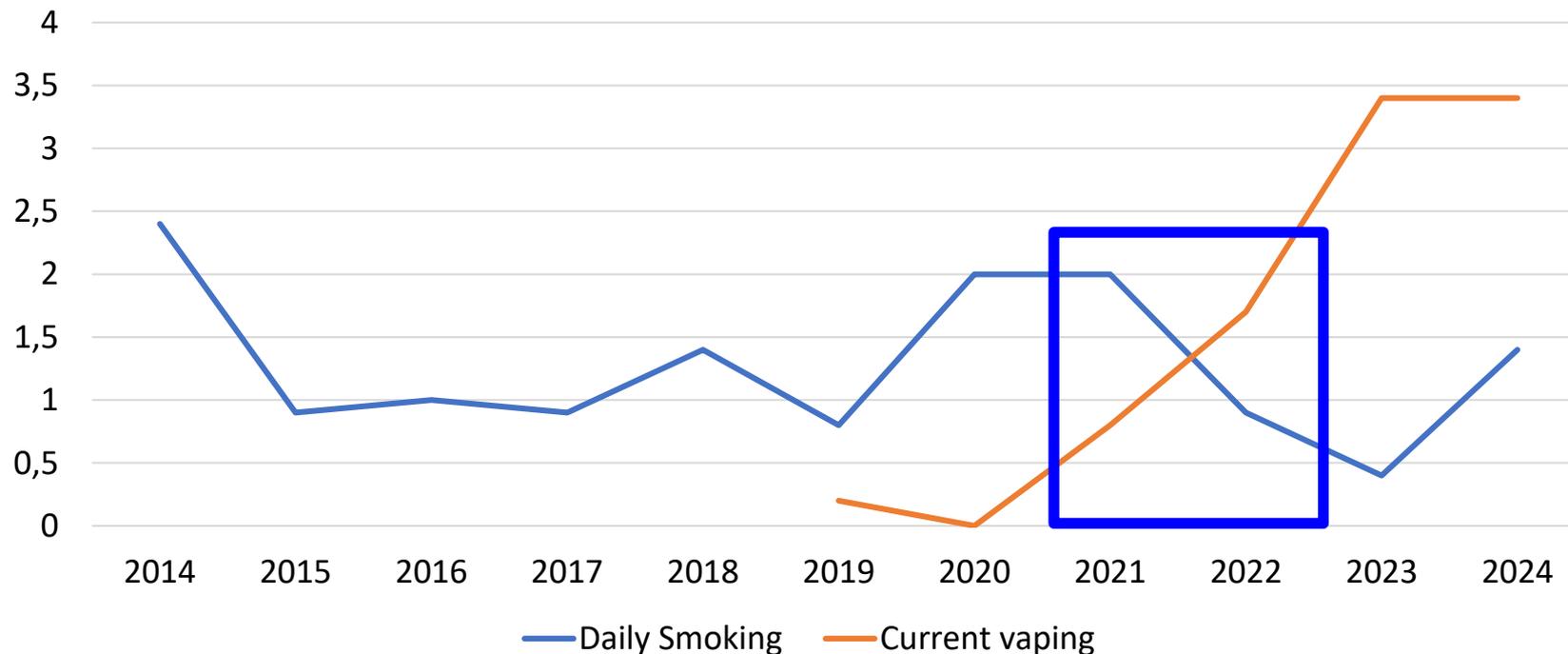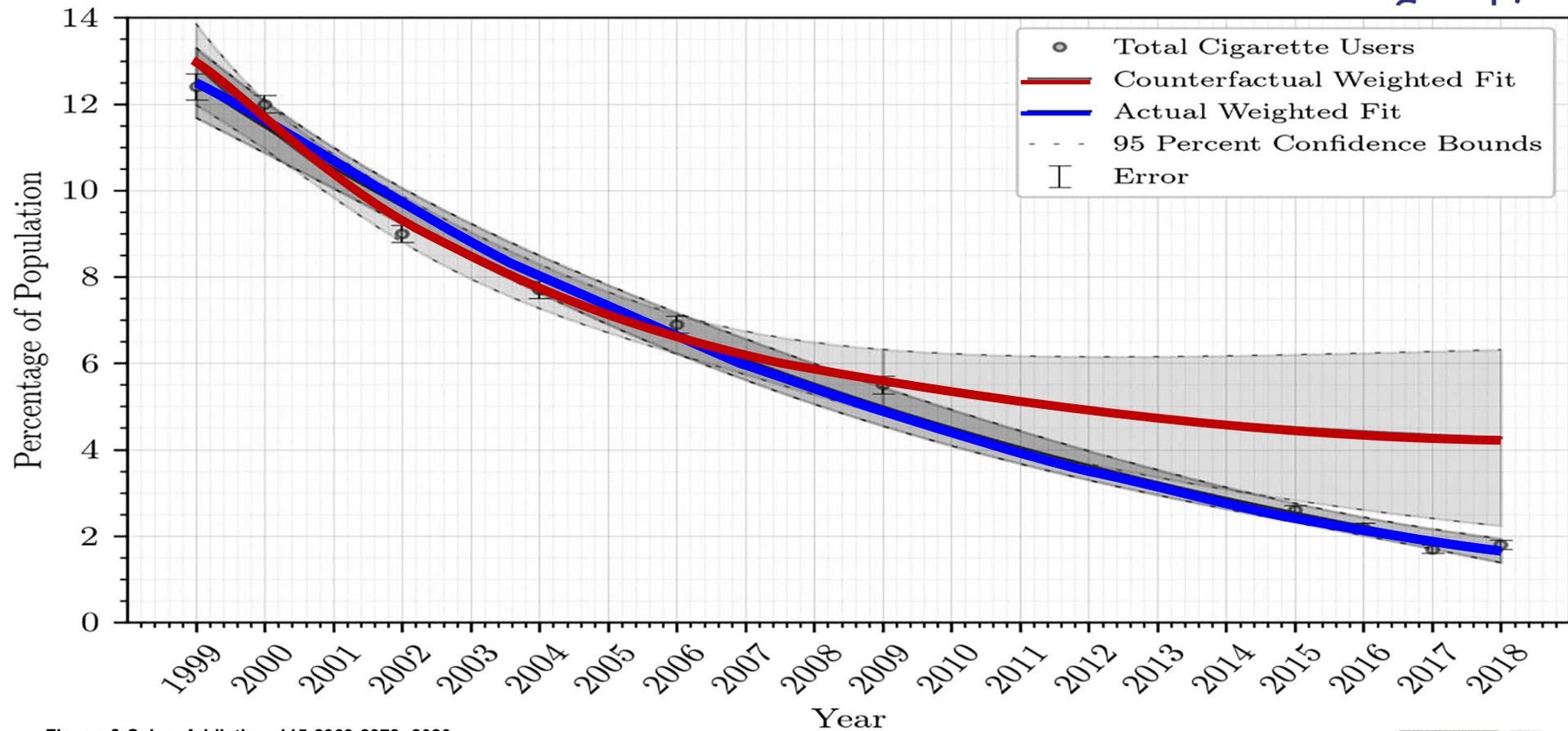
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  - ➢ Individual-level analysis, using real-world and synthetic (PSM) controls (US)
  - ➢ Population-level analysis, using time-series analysis (UK/US)
- ✓ Across different methods, ECs shown not to be strong gateway into smoking and may even divert youth away from cigarettes
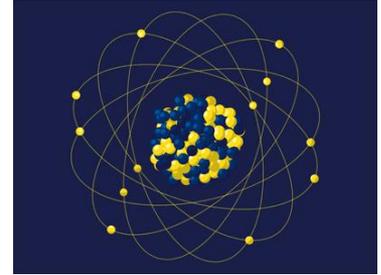
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- There are concerns about a new generation of nicotine-addicted kids

Perceived addiction to **smoking**

Perceived addiction to **vaping**

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- There are concerns about a new generation of nicotine-addicted kids

  – Greater the younger you start

FIGURE 1. Levels of Nicotine Dependence and Craving in Male-Male and Female-Female Monozygotic Twin Pairs Discordant for Age at Onset of Regular Smoking[a]

Kendler, K.S. et al, Am J Psychiatry 2013; 170: 408-413

© 2024 Miler AP et al. *JAMA Network Open.*

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  - Greater the younger you start
  - Possible impacts on mental health
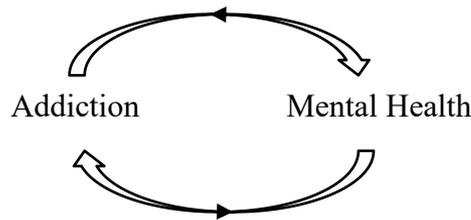
RESEARCH REPORT

ADDICTION SSA

Disentangling the effects of nicotine versus non-nicotine constituents of tobacco smoke on major depressive disorder: A multivariable Mendelian randomisation study

Chloe Burke[1,2,3] | Gemma Taylor[3] | Tom P. Freeman[3] | Hannah Sallis[4] | Robyn E. Wootton[1,2,5,6] | Marcus R. Munafò[1,2,7] | Christina Dardani[2] | Jasmine Khouja[1,2]
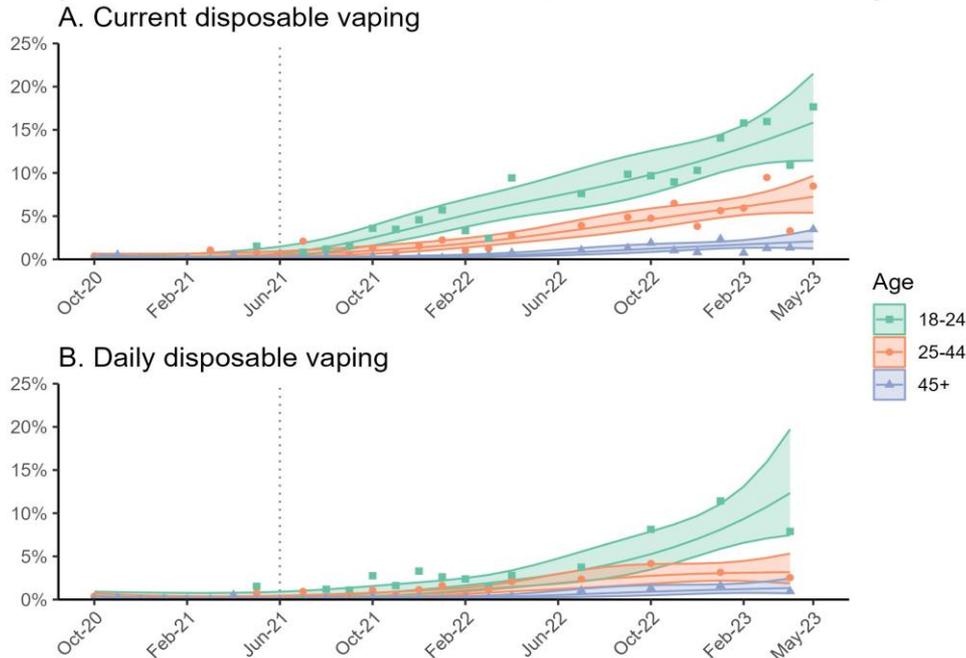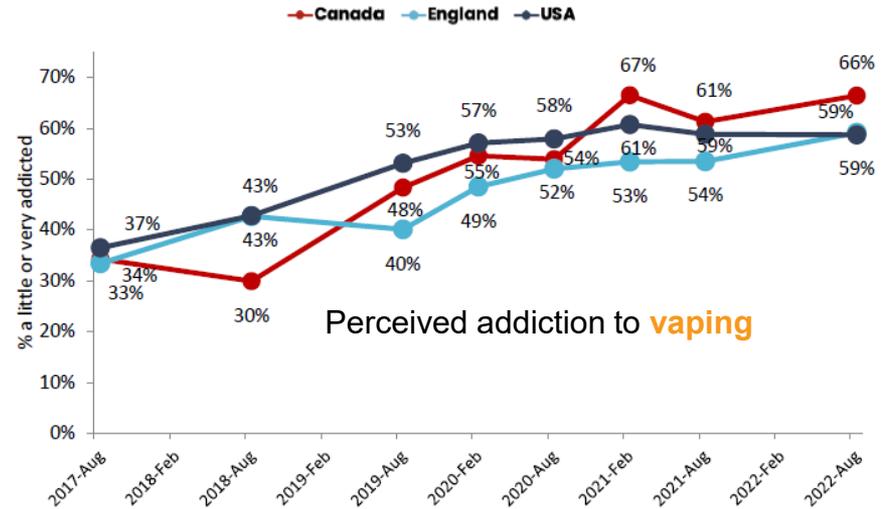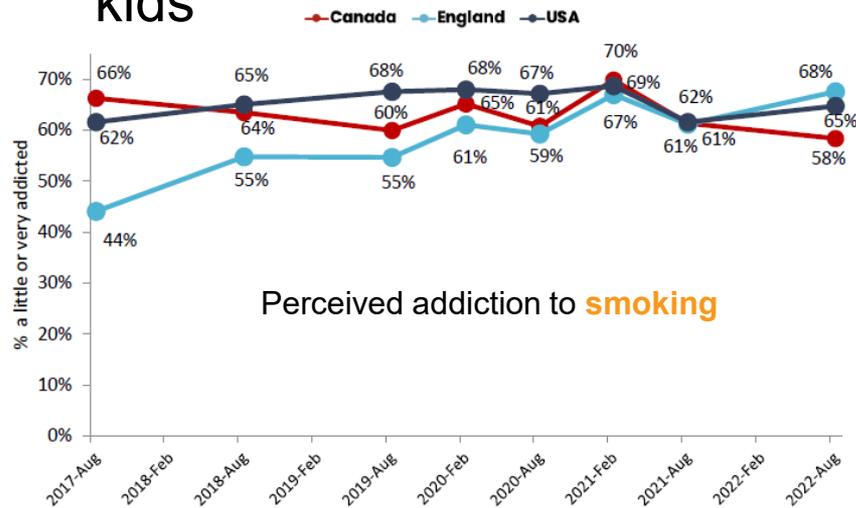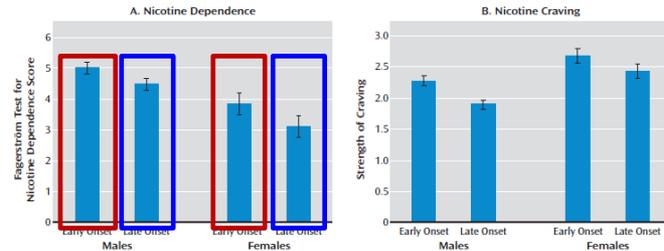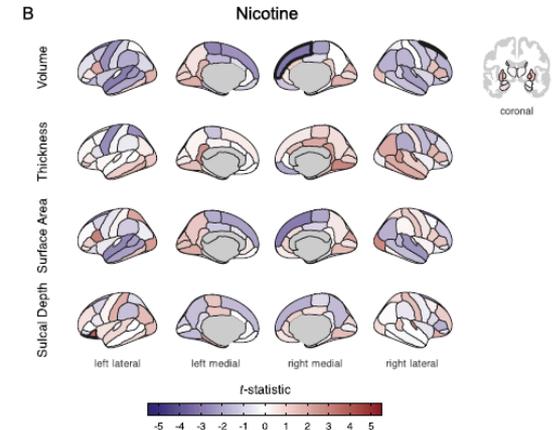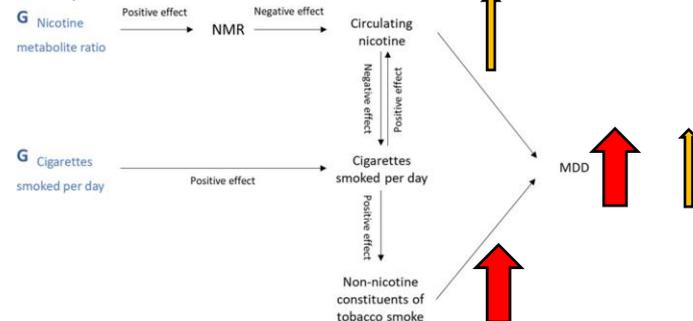
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✕ Increasing numbers of youth are starting to vape and seem dependent on EC

Putting 1) and 2) and 3) together

- Population impact!

Table 2. Net Effects of Vaping on Mortality and Smoking Cessation by 2100

Vaping risk (% of cigarettes)	Annual cessation rate increase due to vaping (%)	Life-years saved (LYS) (millions)	LYS as % of life-years lost (LYL) due to smoking in ... e-cig...		... in which cigarettes never existed	E-quitters (millions)
5	10	5.7			1.1	4.1
	25			11.0	3.6	9.4
	50			21.7	7.1	16.6
	100		25.7	37.4	12.3	26.9
10		3.9	2.5	0.8	4.1
		9.0	9.2	3.0	9.4
		6.7	15.9	18.5	6.1	16.6
		11.1	25.7	32.1	10.5	26.9
20		1.2	3.9	1.0	0.3	4.1
		8.2	2.7	9.0	5.8	1.9	9.4
		14.6	4.8	15.9	12.4	4.1	16.6
		23.9	7.8	25.7	21.9	7.2	26.9

Best current evidence suggests a population health benefit of e-cigarettes

Data source: Mendez & Warner, Nicotine Tob Res. 2021 Apr; 23(4): 654–661.

The Challenge

- Governments must find the right balance in EC regulation between:
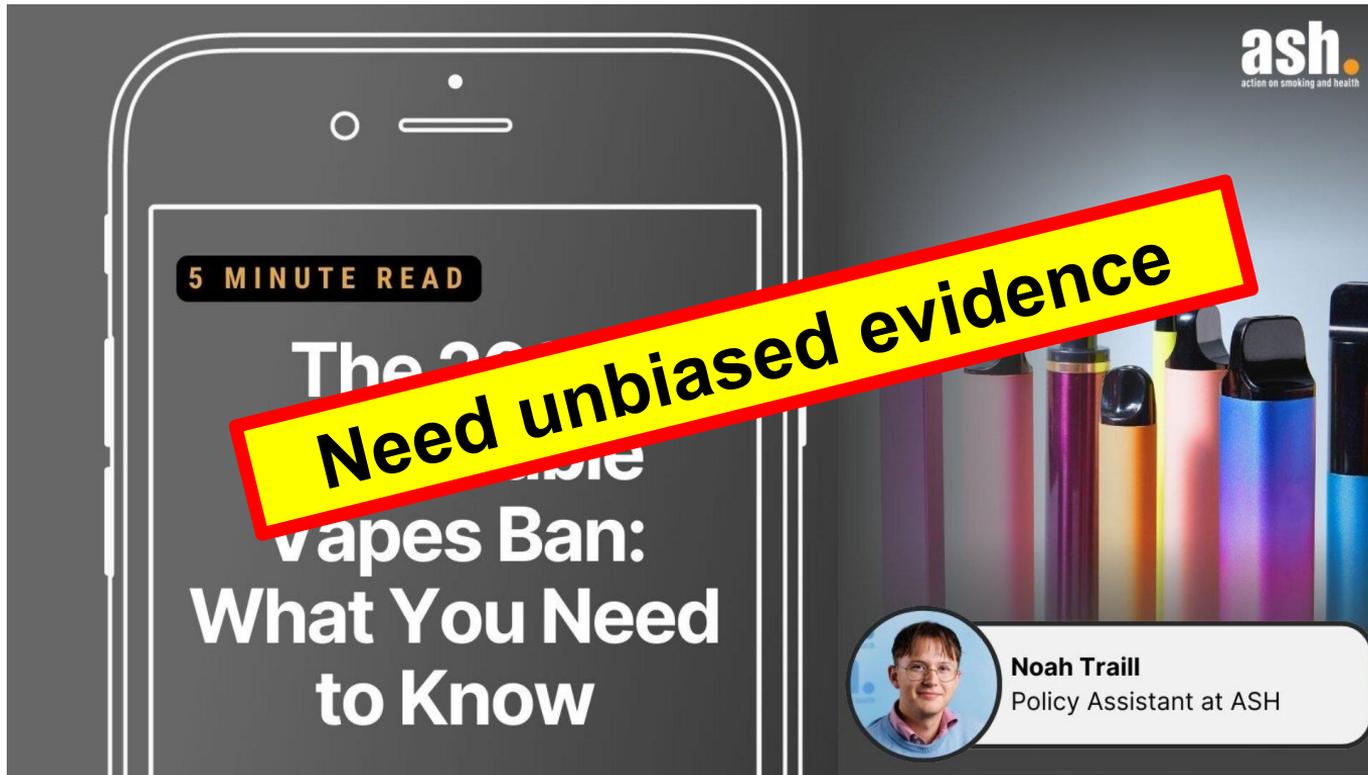
Proposed legislation

- Governments must find the right balance in EC regulation
- Main options currently being discussed/implemented include:
  - Banning disposables
  - Restrict flavours
  - Higher tax
  - POS/Display bans
  - Plain packaging

The Ugly - Unintended consequences

- Some measures make sense, impacting only intended groups (youth)
  - Plain packaging

eFigure 2. No Interest in Trying Vaping Product by Smoking Status, ASH Youth (n=2469)

eFigure 4. No Interest in Trying Vaping Product by Smoking Status, ASH Adult (n=12046)
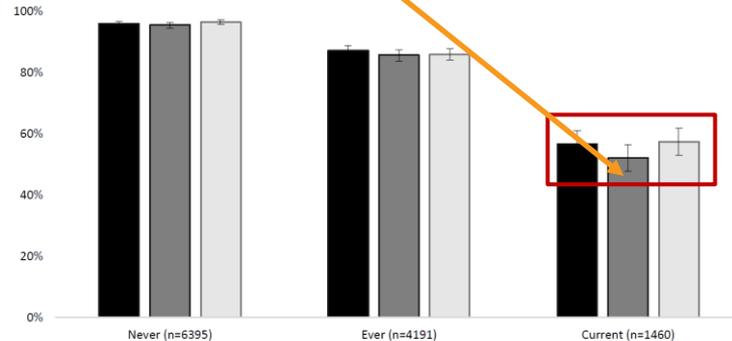
Taylor, E. et al, JAMA Open 2023; 6:e231799

The Ugly - Unintended consequences

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  - Plain packaging
  - Display ban
    - Cigarette PoS bans: ↓ brand awareness & susceptibility to smoke in kids (**Ford, A et al Tob Control 2020; 29:282-288**)
    - Seeing EC displays increases intention to use them (**Best, C et al BMC Pub Health 2016; 16:310**)
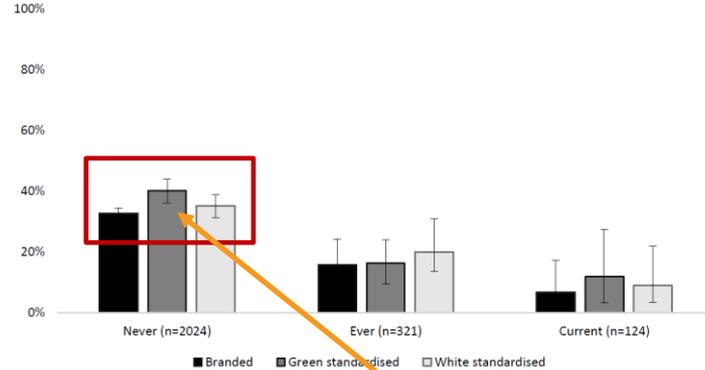
The Ugly - Unintended consequences

- Some measures make sense, impacting only intended groups (youth)
  - Plain packaging
  - Display ban
- Others may not be practical (disposable ban)

Ben King
Business reporter

9 September 2025 · 641 Comments

The ban on disposable vapes is failing to stop millions being thrown away incorrectly, and the devices are still causing chaos for the waste industry, a boss at a leading firm has said.

"We're seeing more vapes in our system, causing more problems, more fires than ever before," said Roger Wright, the strategy and packaging manager at Biffa.

Vape firms have launched cheap reusable devices, so instead of refilling and recycling them, people were binning them and buying more, he said.

A spokesperson for the vape industry said the June ban had been a success, and any rise in devices being thrown away was likely due to sales on the black market.

In April and May, the last two months before the ban, Biffa's recycling facilities in Suffolk, Teesside and London saw around 200,000 vapes on average incorrectly mixed in with general recycling.

For the three months since the ban in June, the average figure has been 3% higher.

The Ugly - Unintended consequences
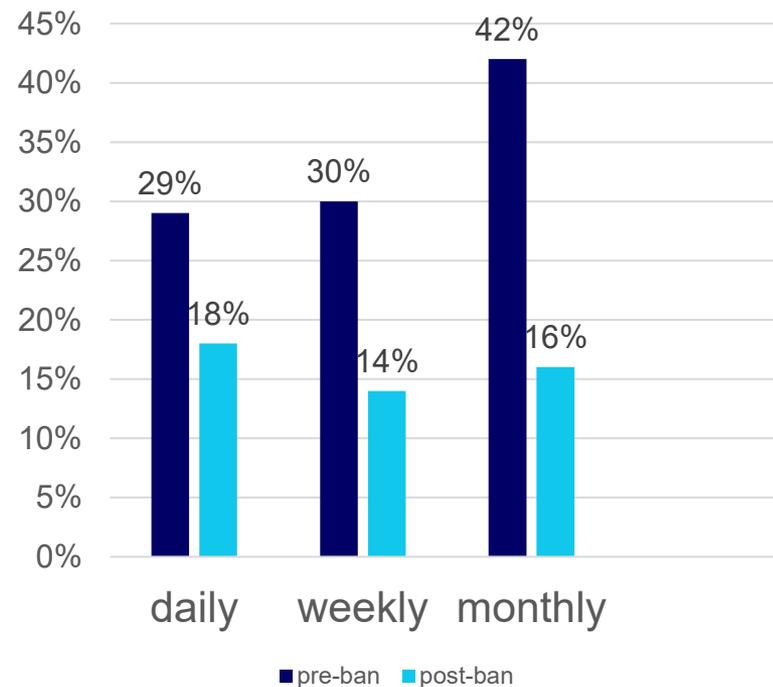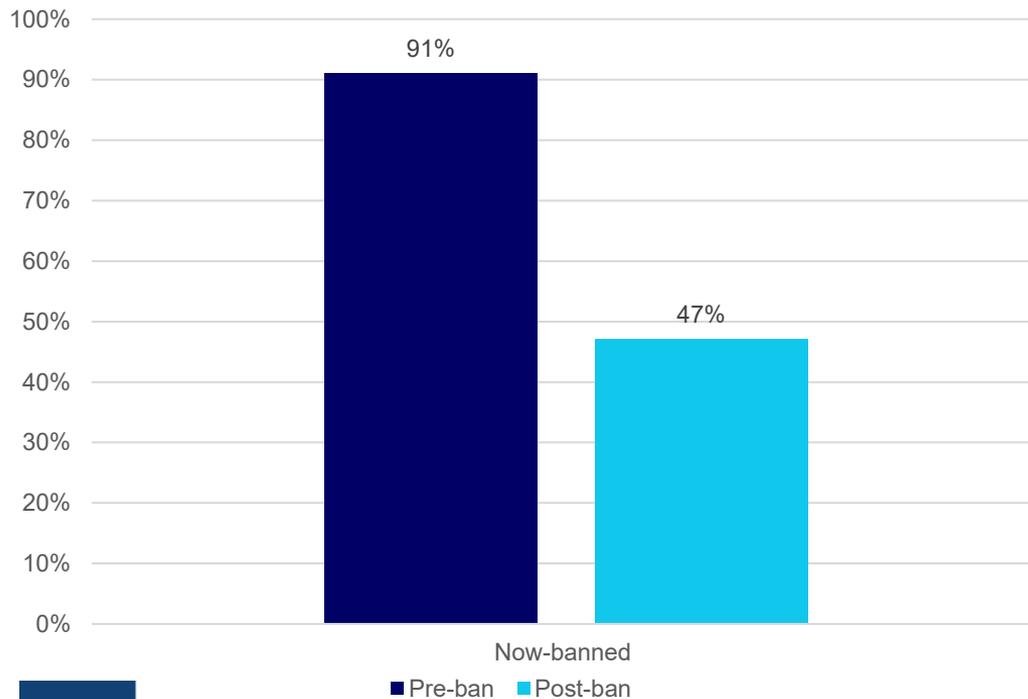
Hellmich et al, SRNT Conference New Orleans, 2025

22% quit vaping
- ➢ 13% smoked more
- ➢ 9% initiated smoking

National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Table 2. Levels of Aerosol and Carbonyl Compound Yields Generated From 6 and 24 mg/mL Nicotine E-liquids, Per One Puff and, for all Puffs as per Human Topography Data

Aerosol yield and selected carbonyl compounds per puff		6 mg/mL (5.04 s puff) — Level per puff (ng unless otherwise specified)	24 mg/mL (3.76 s puff) — Level per puff (ng unless otherwise specified)
Yield (mg)	Mean ± SD	11.1 ± 1.8	7.3 ± 0.5
	Median (Q1–Q3)	11.3 (9.1–12.9)	7.3 (6.9–7.7)
Formaldehyde	Mean ± SD	46.1 ± 12.8	31.7 ± 6.4
	Median (Q1–Q3)	44.8 (35.0–52.4)	33.9 (28.8–35.7)
Acetaldehyde	Mean ± SD	29.3 ± 4.9	22.1 ± 2.7
	Median (Q1–Q3)	29.5 (24.3–31.6)	22.2 (20.8–24.3)
Acetone	Mean ± SD	9.9 ± 2.7	6.0 ± 3.1
	Median (Q1–Q3)	10.5 (7.9–11.6)	5.1 (4.0–6.9)
Acrolein[a]	Mean ± SD	ND	ND

Kosmider, L. et al, Nic Tob Res 2018; 20: 998-1003

- Taxation on units possibly better than on nicotine concentration (effectiveness/titration)

The Ugly - Unintended consequences

- Some measures make sense, impacting only intended groups (youth)
  - Plain packaging
  - Display ban
- Others may not be practical (disposable ban)
- Or it may encourage current vapers to go back to smoking and prevent current smokers from stopping combustibles with EC
  - Flavour ban
  - Increased taxation
- Discussion of tighter regulation has led to misperceptions of relative harms of cigarettes vs e-cigarettes – undermines harm reduction

Harm perceptions of e-cigarettes vs. cigarettes, adult (18+) smokers in England, 2014-2023

Lines represent modelled weighted prevalence

Points represent unmodelled weighted prevalence by quarter

EQUALLY or MORE harmful
June 2023

61% of non-vaping smokers

Legend:
- Less harmful (green)
- Equally harmful (yellow)
- More harmful (red)
- Don't know (black)

Values (left): 44%, 30%, 15%, 11%
Values (right): 34%, 27%, 23%, 16%

PR=0.60, 95%CI 0.55-0.66
PR=1.11, 95%CI 1.01-1.22
PR=2.16, 95%CI 1.84-2.54
PR=1.13, 95%CI 0.96-1.32

Jackson et al. *JAMA Network Open*. 2024; 7(2): e240582.

PR, prevalence ratio. CI, confidence interval.

How to balance harm reduction risks & benefits?

- Clear evidence that e-cigarettes are beneficial for existing smokers, less harmful and with little evidence of gateway effects
- To engage smokers and youth correctly, accurate information/ legislation is key, favouring e-cigarettes over cigarettes
  - Prevent EC use among kids who would have never smoked
    - Reinforce age of sale / regulate online marketplace
    - Tighten advertising rules
    - Emphasise vaping as cessation tool rather than lifestyle tool
    - Consider point-of-sales restrictions / plain packaging
    - Restrict flavours, nicotine content and increase tax
    - Over time, increase age of sale
  - Encourage smokers (*and kids who would smoke anyway*) to use EC
    - Swap to stop / education campaigns / maximise advice during healthcare
- Key thing to remember: risk of uptake of EC less important where cigarettes are still widely available and used
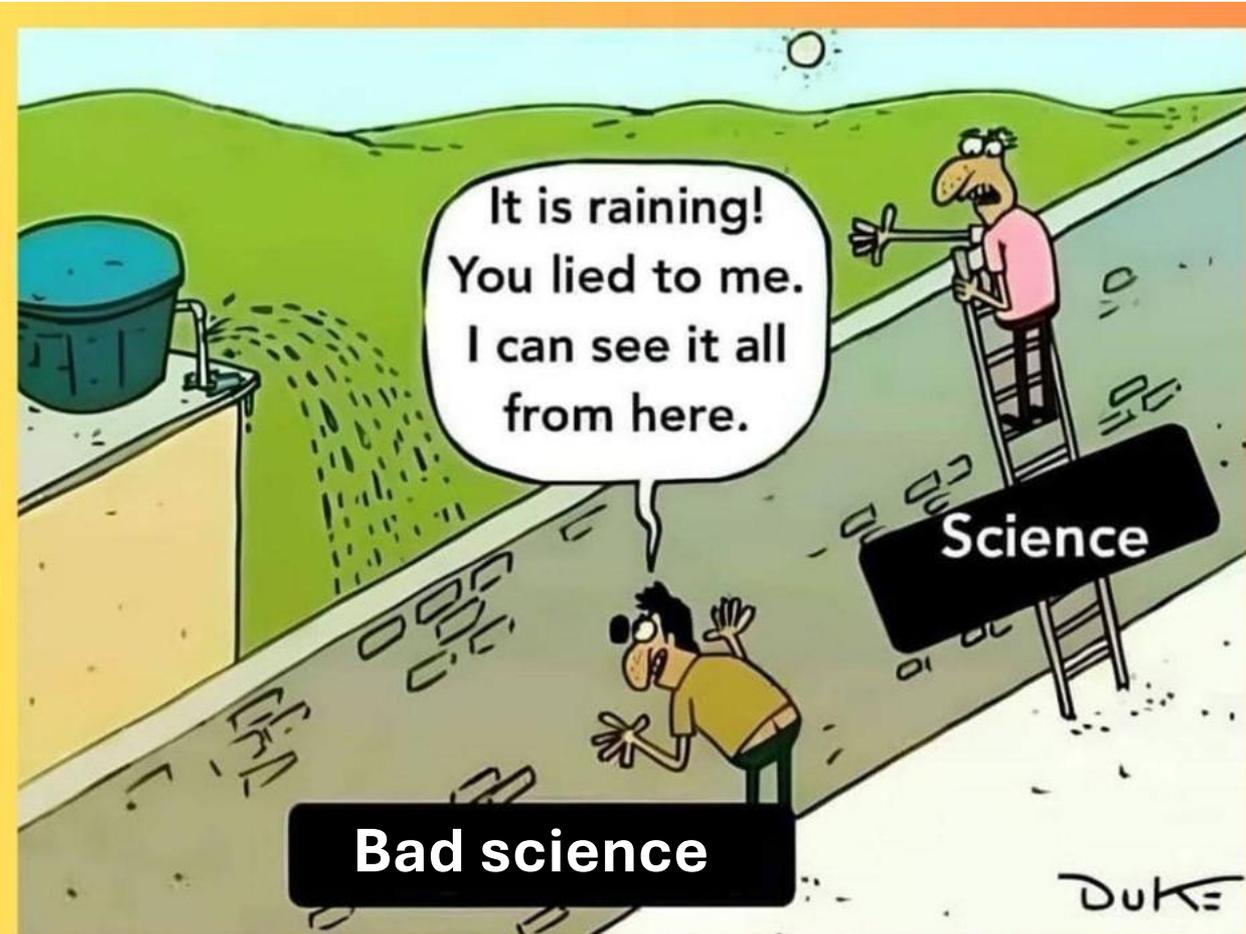

STOP SMOKING WITH AN E-CIGARETTE IN 2018
Search 'Smokefree'.
BECAUSE THERE'S ONLY ONE YOU

Smoking Prevalence (15+/16+)
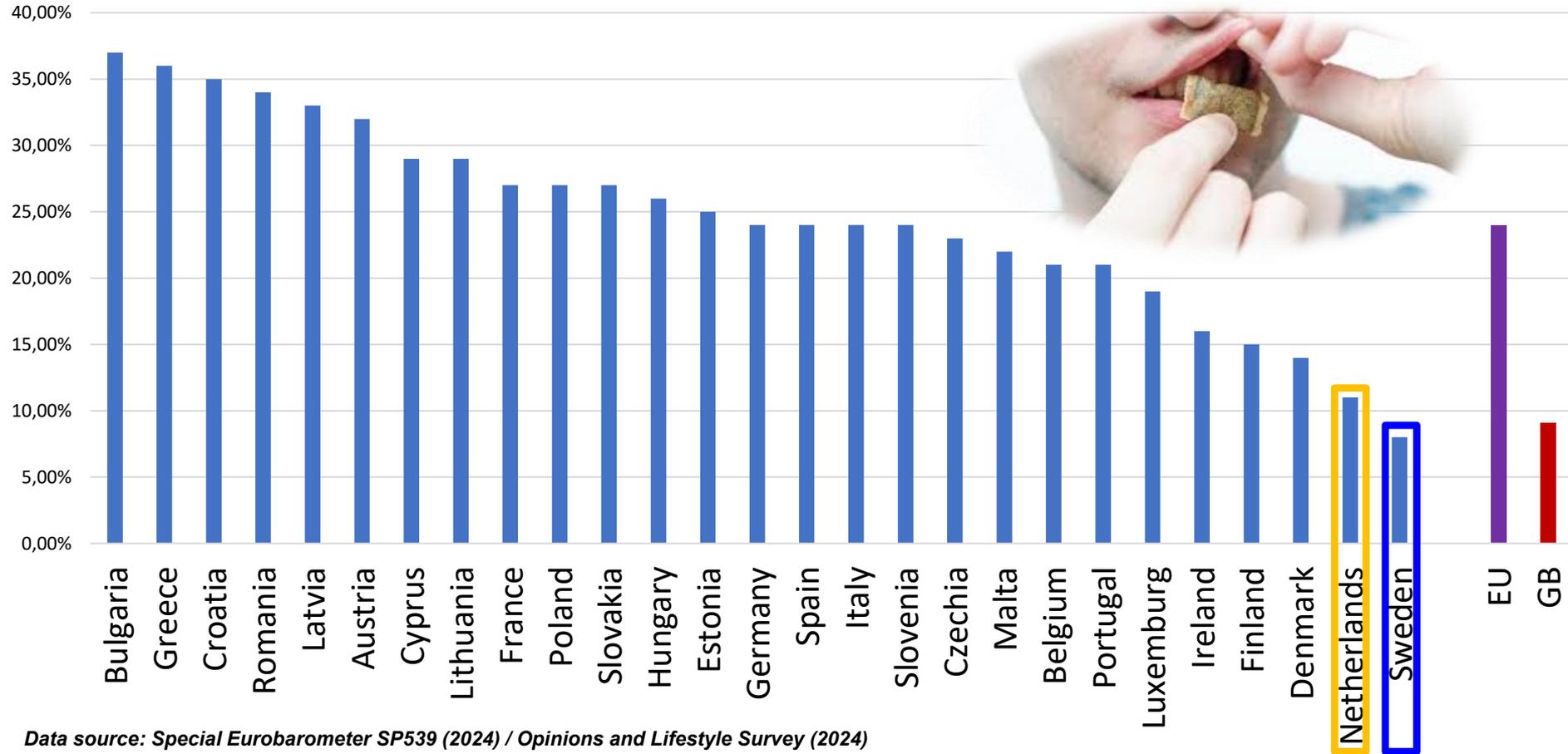
Data source: Special Eurobarometer SP539 (2024) / Opinions and Lifestyle Survey (2024)

How to balance harm reduction risks & benefits?

- Clear evid...   s, less
  harmful ar...

- To engage...   slation is
  key, favou...

  - Prevent...
    - Reinfo...
    - Tighte...
    - Empha...
    - Consid...
    - Restric...
    - Over t...

  - Encoura...
    - Swap   ...ents

- <u>Key thing</u>   ...nate where
  cigarettes

- Once in th...   e applied to
  phase out...

It is raining!
You lied to me.
I can see it all
from here.

Science

Bad science

UCL Tobacco and Alcohol Research Group

Robert West,
Professor Emeritus of
Health Psychology

Jamie Brown,
Director,
Professor of
Behavioural Science

Emma Beard,
Lecturer

Vera Buss,
Research Fellow

Sharon Cox,
Senior Research
Fellow

Claire Garnett,
Senior Research
Fellow

Sahadat Hossain,
PhD Researcher

Sarah Jackson,
Principal
Research Fellow

Martin Jarvis,
Professor Emeritus of
Health Psychology

CANCER RESEARCH UK

Dimitra Kale,
Research Fellow

Corinna Leppin,
PhD Researcher

Masuma Mishu,
Lecturer

Susan Michie,
CBC Director,
Professor of Health
Psychology

Tosan Okpako,
PhD Researcher

Melissa Oldham,
Senior Research
Fellow

Harry Tattan-Birch,
Research Fellow

Loren Kock,
Research
Fellow

Aleksandra Herbec,
Hon. Research
Fellow

Olga Perski,
Hon. Senior
Research Fellow