

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

Stichting
Volksbond
Rotterdam

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Overview

The Good & The Bad

- 1) Health effects
- 2) Effectiveness
- 3) Gateway & Youth appeal

The Ugly

- 4) Regulation



1) Health Effects

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 unwilling/unable to stop smoking



1) Health Effects

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 Zulkova, Robert Calder, Debbie Robson

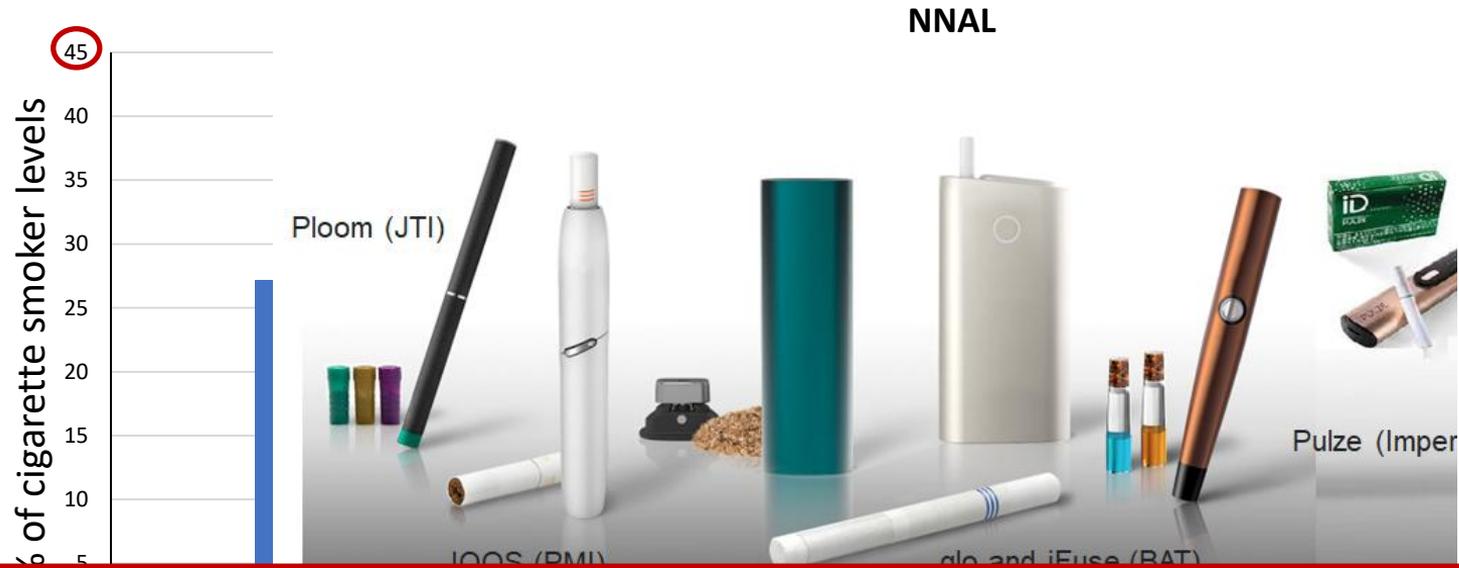
King's College London

1) Health Effects



The Good

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



Annals of Internal Medicine ORIGINAL RESEARCH

Nicotine, Carcinogen, and Toxin Exposure in Long-Term E-Cigarette and Nicotine Replacement Therapy Users

A Cross-sectional Study

Liou Shih-ai, PhD, MScD; Geemickel, PhD; Benjamin C. Blount, PhD; Jamie Brown, PhD; Ann McNeill, PhD; K. Usdul Ahsan, PhD; Jun Feng, PhD; Leiqing Wang, PhD; and Robert West, PhD

Background: Given the rapid increase in the popularity of e-cigarettes and the paucity of associated longitudinal health-related data, the need to assess the potential risks of long-term use is essential.

Objective: To compare exposure to nicotine, tobacco-related carcinogens, and toxins among smokers of combustible cigarette only, former smokers with long-term e-cigarette use only, former smokers with long-term nicotine replacement therapy (NRT) use only, long-term dual users of both combustible cigarettes and e-cigarettes, and long-term users of both combustible cigarettes and NRT.

Design: Cross-sectional study.

Setting: United Kingdom.

Participants: The following 5 groups were purposively recruited: combustible cigarette only users, former smokers with long-term (at least 1 wk) e-cigarette-only or NRT only use, and long-term dual combustible cigarette-e-cigarette or combustible cigarette-NRT users ($n = 36$ to 37 per group; total $n = 181$).

Measurements: Sociodemographic and smoking characteristics were assessed. Participants provided urine and saliva samples and were analyzed for biomarkers of nicotine, tobacco-specific nitrosamines (TSNAs), and volatile organic compounds (VOCs).

Results: After confounders were controlled for, no clear between-group differences in salivary or urinary biomarkers of nicotine intake were found. The e-cigarette-only and NRT only users had significantly lower metabolite levels for TSNAs (including the carcinogen metabolite 4-(methylnitrosamino)-1-(3-pyridyl) butane [NNAL] and VOCs (including metabolites of the toxic alcohols acrylonitrile, acrylamide, 1,3-butadiene, and ethylene oxide) than combustible cigarette-only, dual combustible cigarette-e-cigarette, or dual combustible cigarette-NRT users. The e-cigarette-only users had significantly lower NNAL levels than all other groups. Combustible cigarette-only, dual combustible cigarette-NRT, and dual combustible cigarette-e-cigarette users had largely similar levels of TSNAs and VOC metabolites.

Limitations: Cross-sectional design with self-selected sample.

Conclusion: Former smokers with long-term e-cigarette-only or NRT-only use may attain roughly similar levels of nicotine compared with smokers of combustible cigarettes only, but unlike them, long-term NRT-only and e-cigarette-only use, but not dual use of NRT or e-cigarettes with combustible cigarettes, is associated with substantially reduced levels of measured carcinogens and toxins relative to smoking only combustible cigarettes.

Primary Funding Source: Cancer Research UK.

*Ann Intern Med. doi:10.1093/ajcp.1107
For author disclosures, see end of text.
This article was published at Annals.org on 7 February 2015.*

E-cigarettes (1), which produce an aerosol by heating a liquid solvent (usually containing nicotine) through a battery-powered heating element, are becoming increasingly popular. Unlike smoked tobacco, e-cigarettes can deliver nicotine to the respiratory tract without combustion (2). Despite this possible advantage, health concerns for e-cigarettes remain about potential cytotoxicity, delivery of carcinogens (3), including carbonyls (4, 5), tobacco-specific nitrosamines (TSNAs) (6), and heavy metals (4); effects on cardiovascular and respiratory function and inflammatory effects (7); and nicotine delivery (8). Data on the long-term effects of e-cigarettes are needed to accurately assess risk and inform health professionals encountering e-cigarette users (9).

Most studies to date have examined toxic con-

potential health consequences (10). Three studies that have assessed both exposure found lower levels for carcinogens, including TSNAs, in recent former smokers of e-cigarettes than in a historic sample of smokers of combustible cigarettes (11). These studies also found reductions in toxins over a 2- or 4-week period in smokers switching to e-cigarettes with or without concurrent use of combustible cigarettes (12, 13). However, none of the studies involved long-term users, which is important given observed learning effects in e-cigarette use (14, 15) or included real-world controls groups to reduce the risk for confounding when interpreting the results of observational studies.

Users of nicotine replacement therapy (NRT) (which includes chewing gum and adhesive patches), would be expected to have lower levels of carcinogenic and

Nothing **EC** **NRT** **HTP** **Cigarette**

Low **Health Risk** **High**

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

1) Health Effects

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)

Respiratory toxins (e.g., Acrolein)

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↑ (40%) / =
↑ (>10%) / =
=
↑ (>25%)

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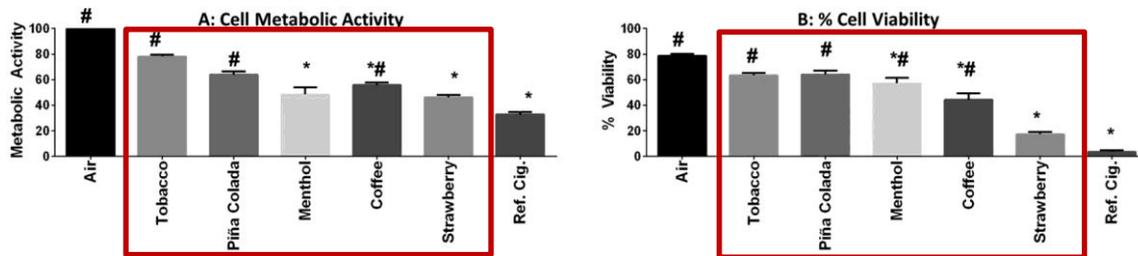
The Bad

- Largest report of health effects recently undertaken (McNeill et al, 2022)
- Some uncertainty about health effects but some residual risk (vs non-smoking)
- Biggest concern is about unknown unknowns
 - Anything inhaled into the lung is likely to have some health effect

1) Health Effects

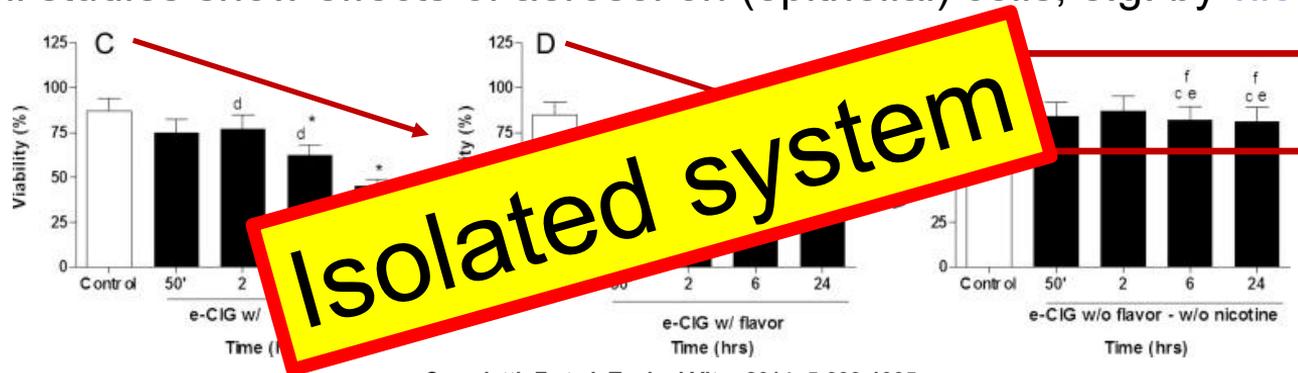
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 - Most research on buccal/dermal not pulmonary administration of EC ingredients
 - Cell studies show effects of aerosol on (epithelial) cells, e.g. by **flavours**



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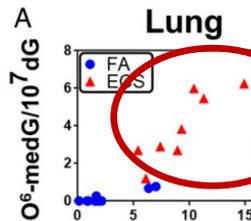
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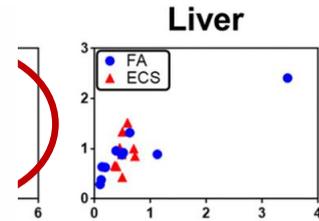
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 - Limited work in animals suggestive of possible mutagenic effects



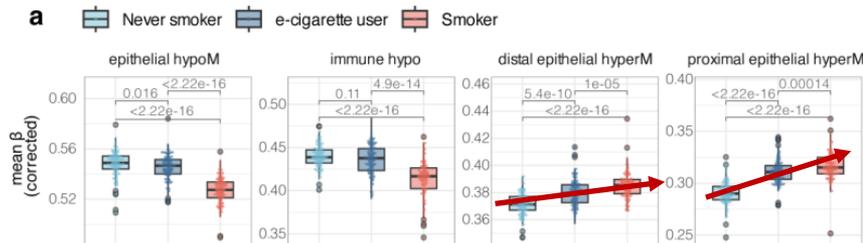
Man's Face or Mouse? What did you see first?



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



dry system

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)

Internal and Emergency Medicine
<https://doi.org/10.1007/s11739-025-03894-7>

IM - REVIEW



Association between electronic cigarette use and respiratory outcomes among people with no established smoking history: a comprehensive review and critical appraisal

Arielle Selya^{1,2}, Giusy Rita Maria La Rosa³, Lucia Spicuzza^{2,3,4}, Jaymin B. Morjaria⁵, Grazia Cacà⁶, Riccardo Polosa^{1,3,7,*}

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

Cardiometabolic conditions	Nonuse aHR (95% CI)	Exclusive e-cigarette Use aHR (95% CI)	Exclusive combustible cigarette use aHR (95% CI)	Dual use 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!**

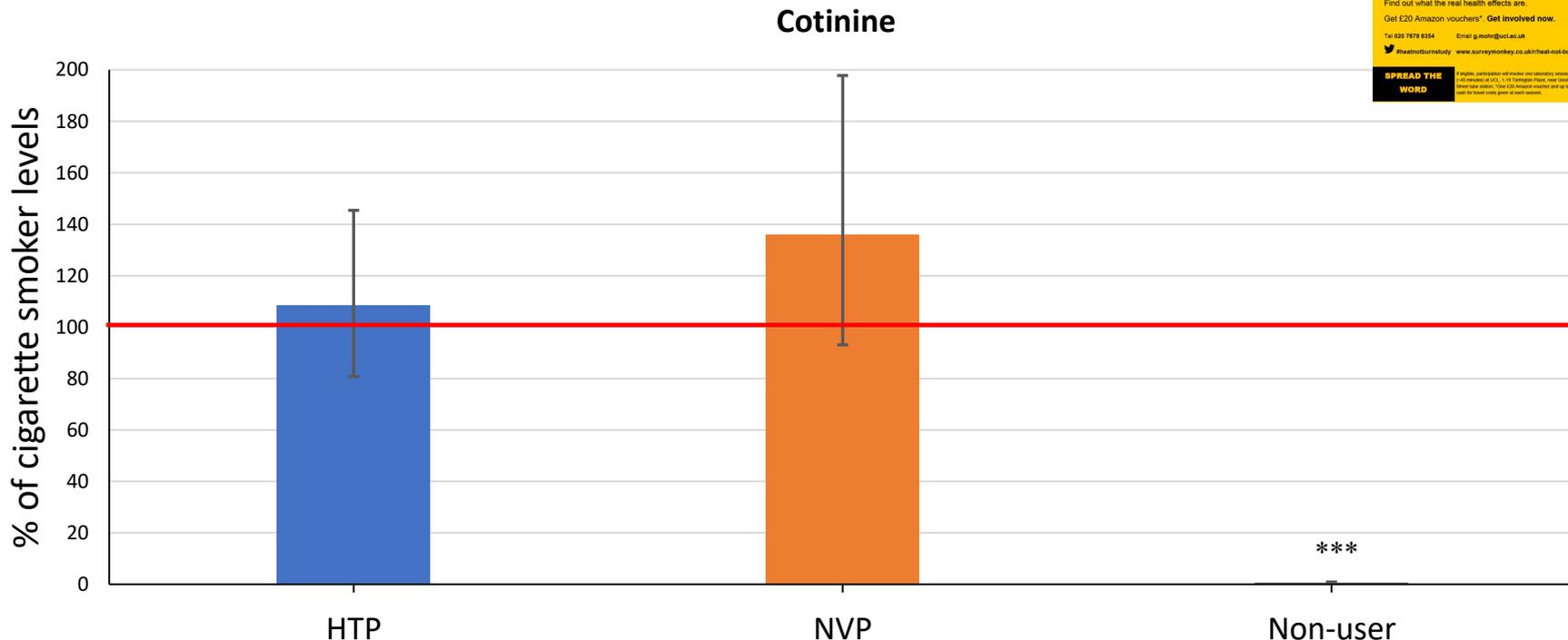
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 - Cell studies show effects of aerosol on (epithelial) cells **but less than cigarettes**
 - Limited work in animals suggestive of possible mutagenic effects
 - Possibly most insightful work is on epigenetic changes in humans
 - Recent longitudinal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



UCL
WORLD-LEADING RESEARCH NEEDS YOU.
Are you an ex-smoker and now vape?
Or use a heat-not-burn (e.g. IQOS) device?
We need you!
Find out what the real health effects are.
Get £20 Amazon vouchers*. **Get involved now.**
Tel: 020 7879 8354 Email: g.mohr@ucl.ac.uk
@heatnotburnstudy www.surveymonkey.co.uk/heat-not-burn
SPREAD THE WORD

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



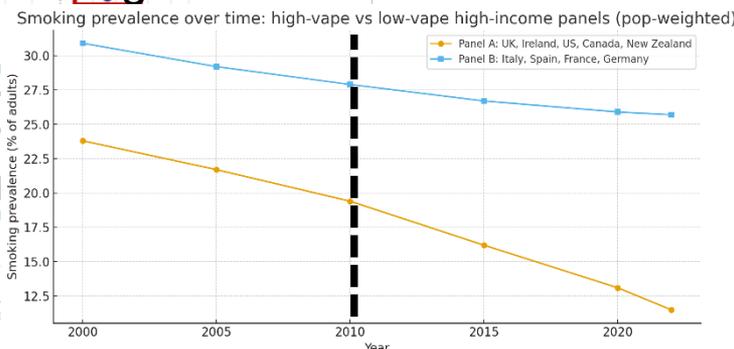
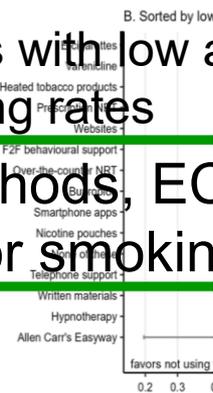
Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Nº of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with behavioural support only/no support	Risk with Nicotine EC				
Smoking cessation at 6 to 12 months Assessed using biochemical validation	Study population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

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



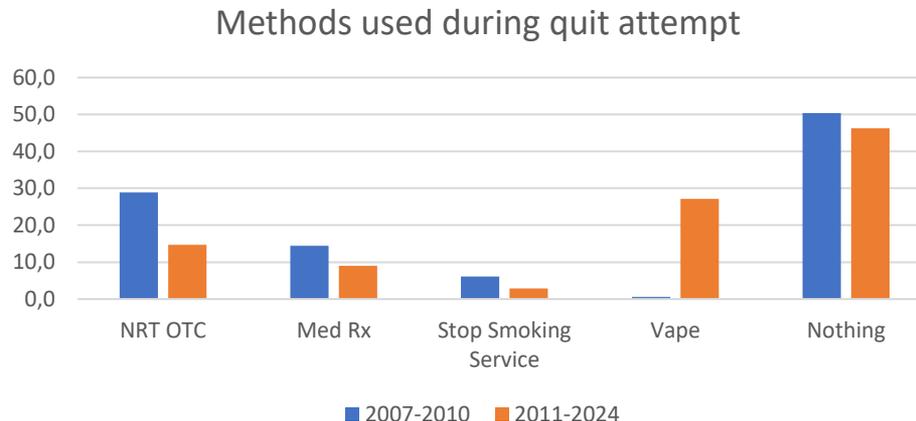
✓ Across different methods, EC existing treatment for smoking



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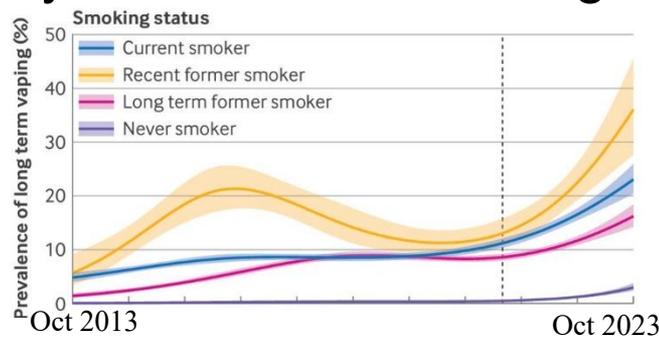
The Bad

- 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



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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



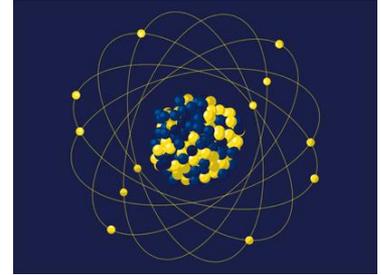
thebmj

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 - Use of e-cigarettes may cannibalise use of other effective aids
 - 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

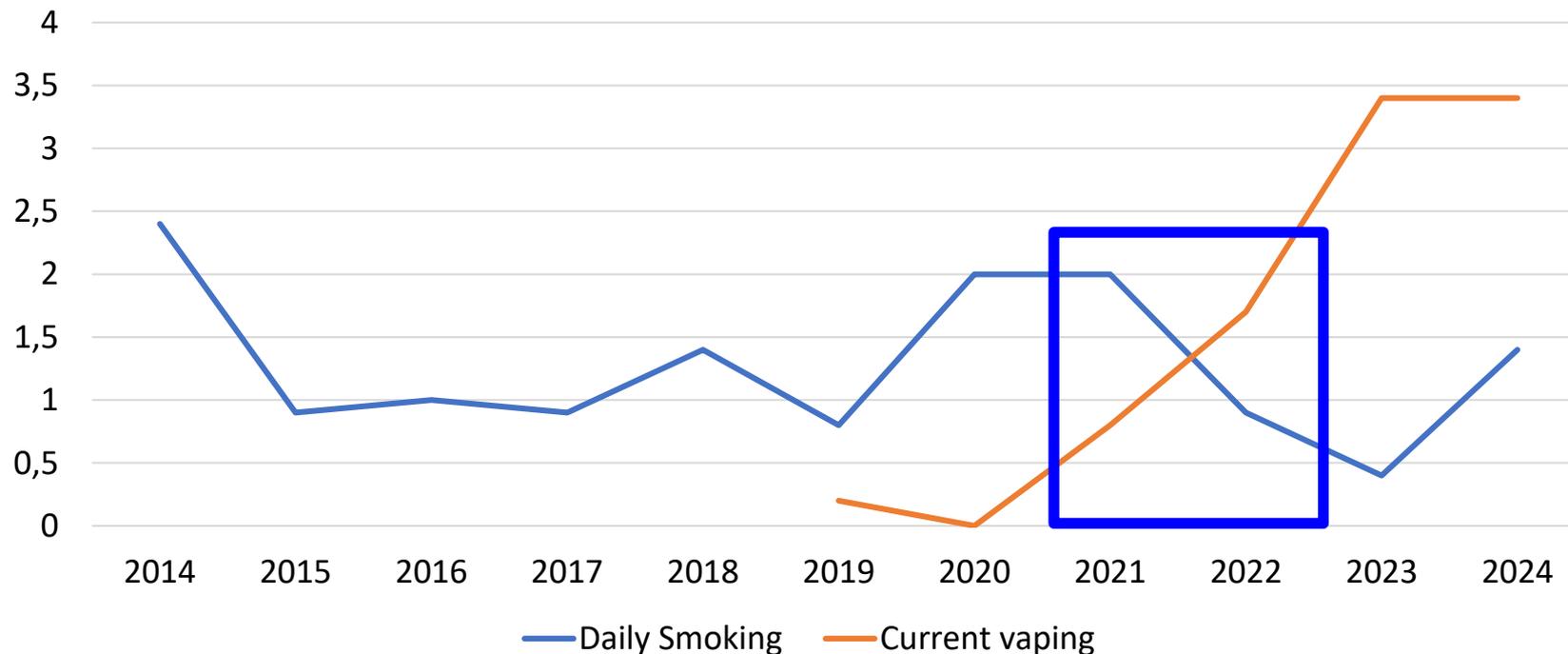
The Good

- Postulated gateway effects
 - Best way to assess causal claim is via an RCT
 - But 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)



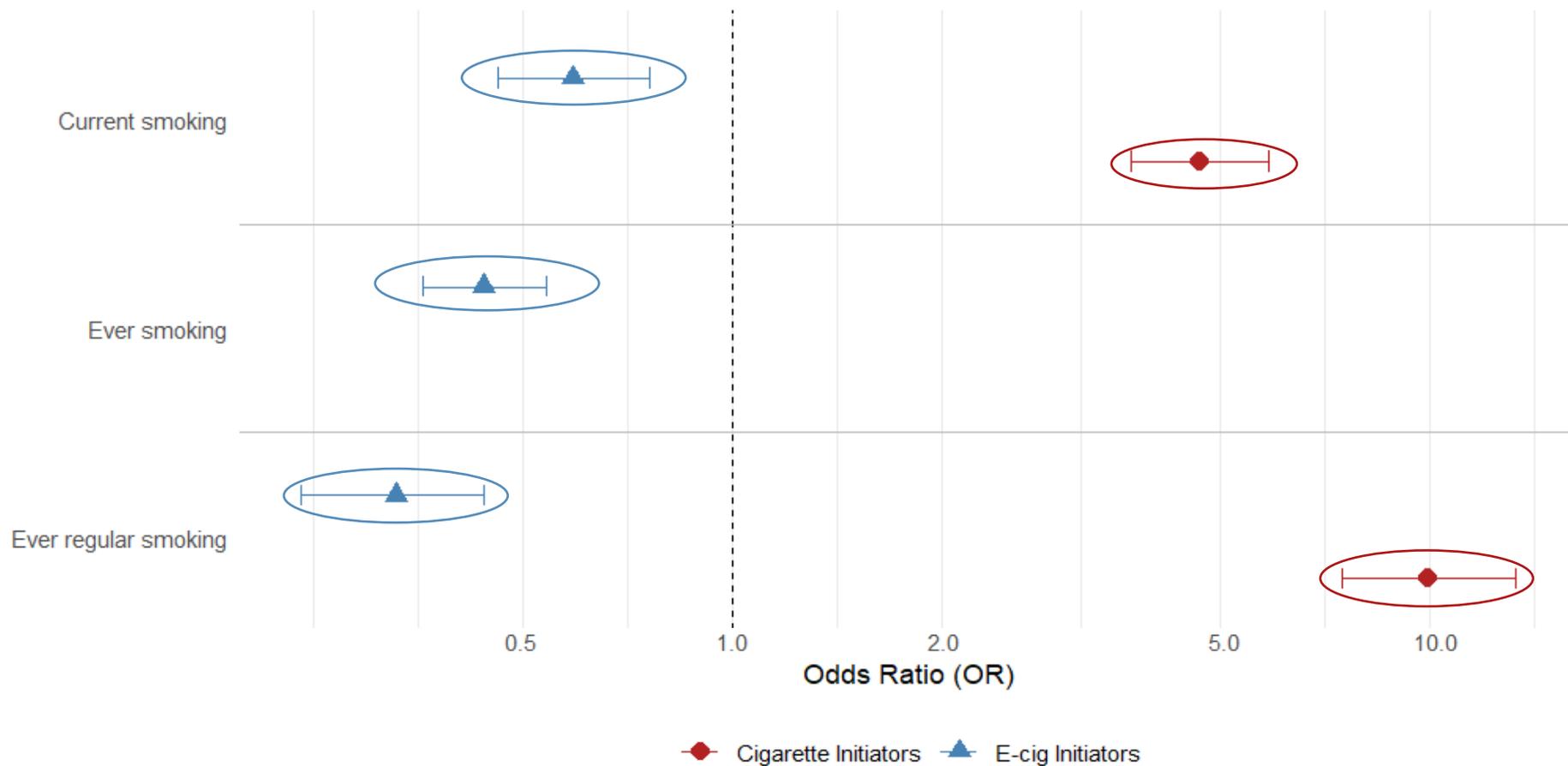
The Good

Product use in 12-16 year olds in the Netherlands

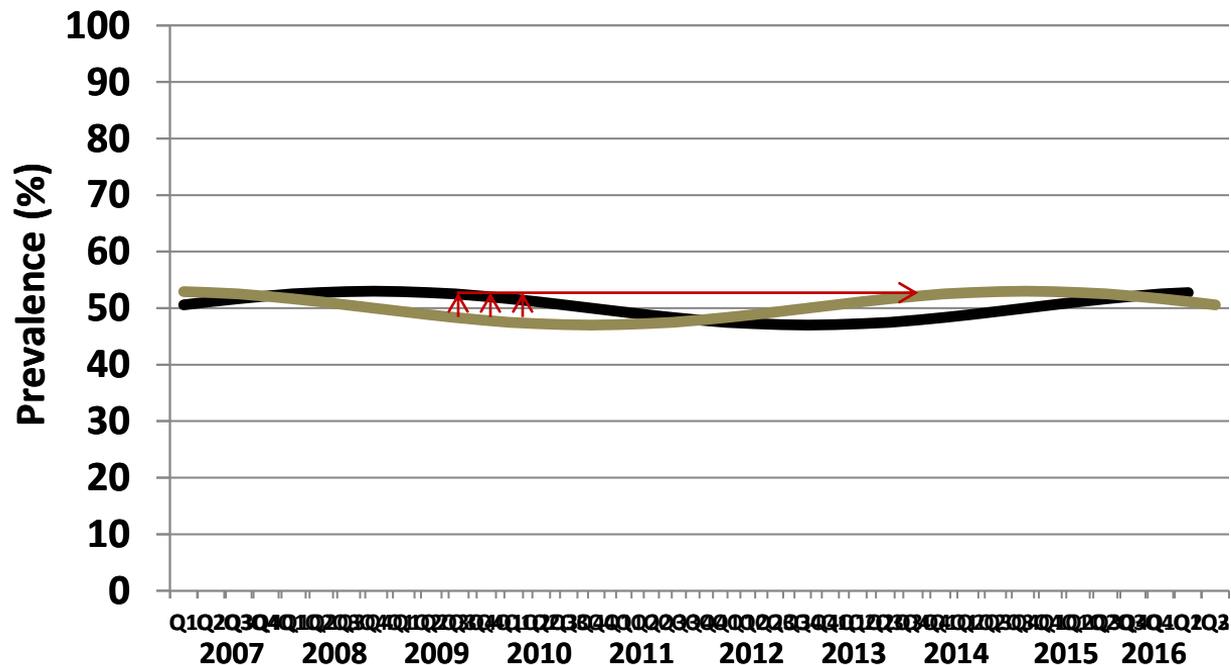


3) Gateway and Youth Appeal

The Good



The Good

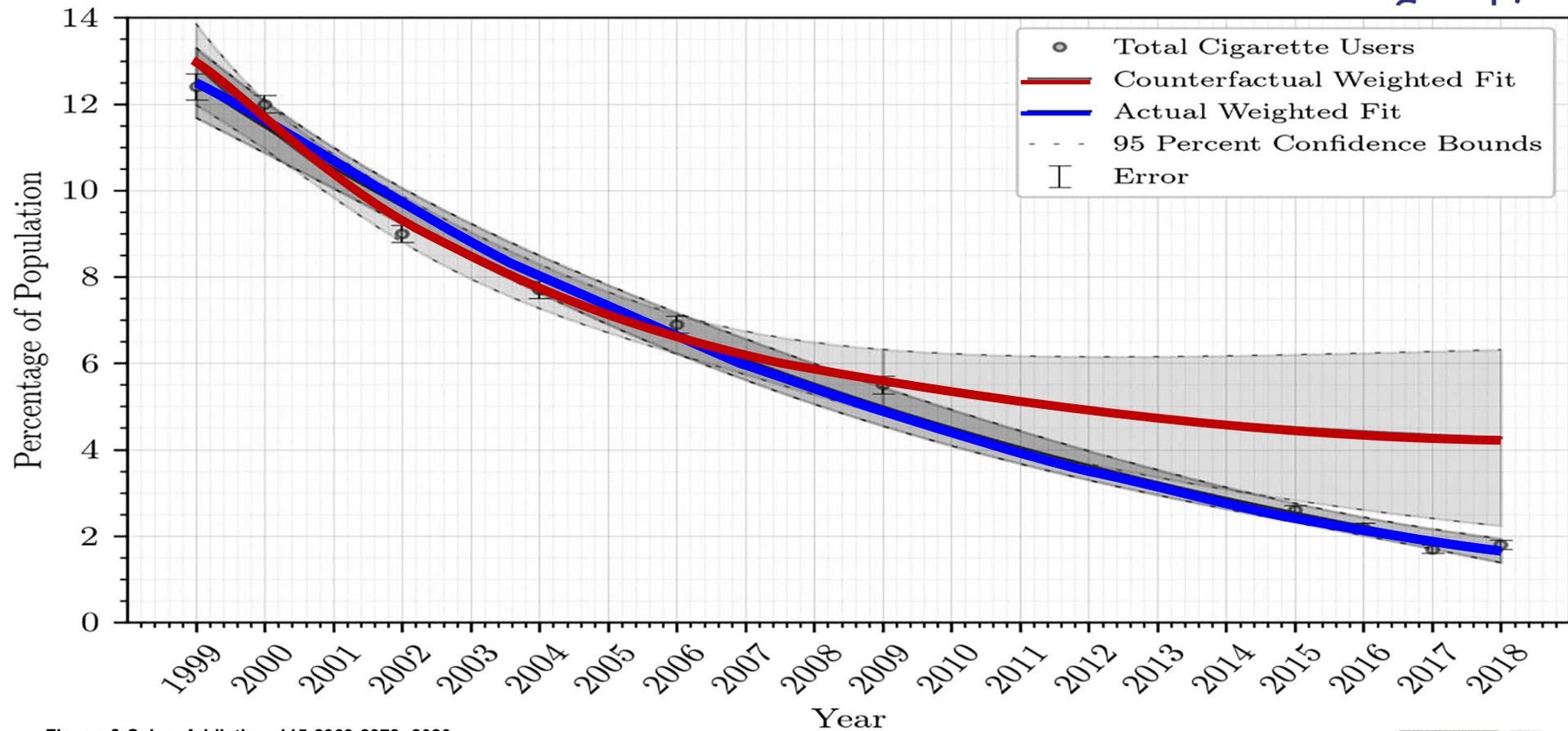


— Hypothetical time-series 1 (differentiated) — Hypothetical time-series 2 (differentiated)

- **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 **eX**ogenous input (to model impact of one on another time-series)
 - If seasonality is present, also need to have seasonal q, d, p

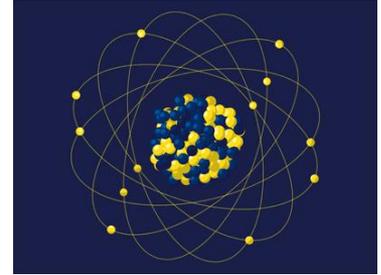
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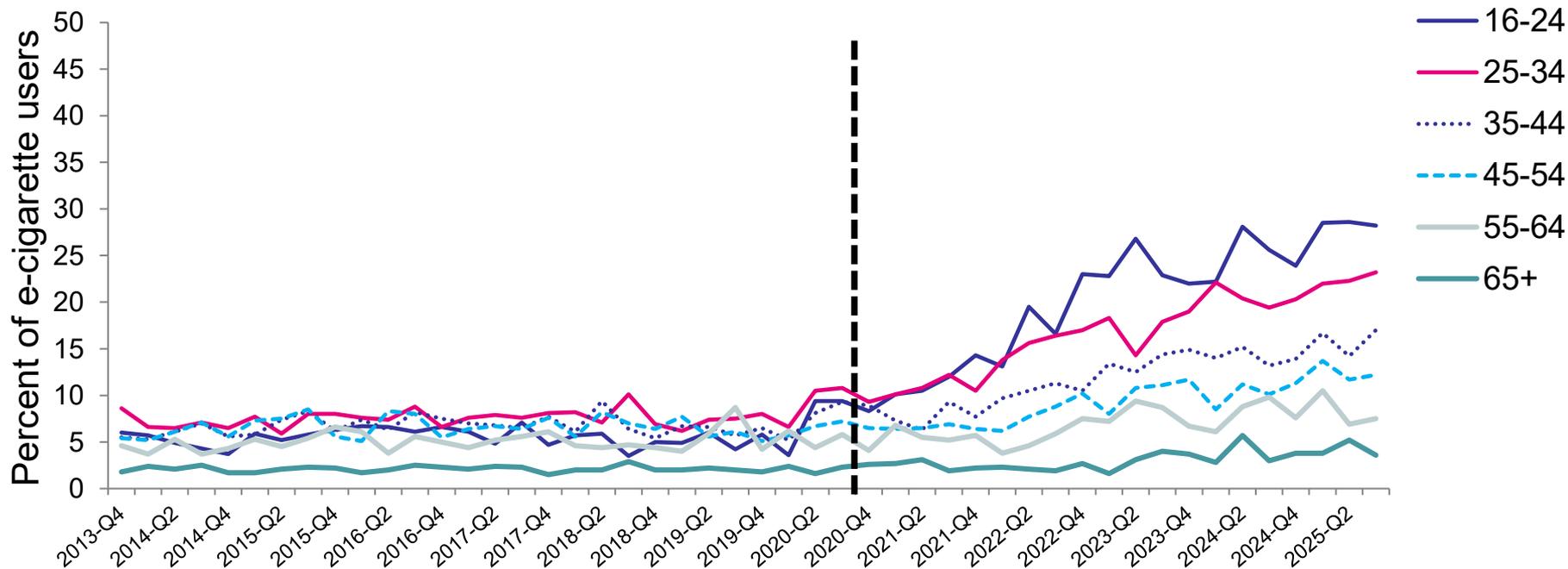


✓ Across different methods, ECs shown not to be strong gateway into smoking and may even divert youth away from cigarettes

3) Gateway and Youth Appeal

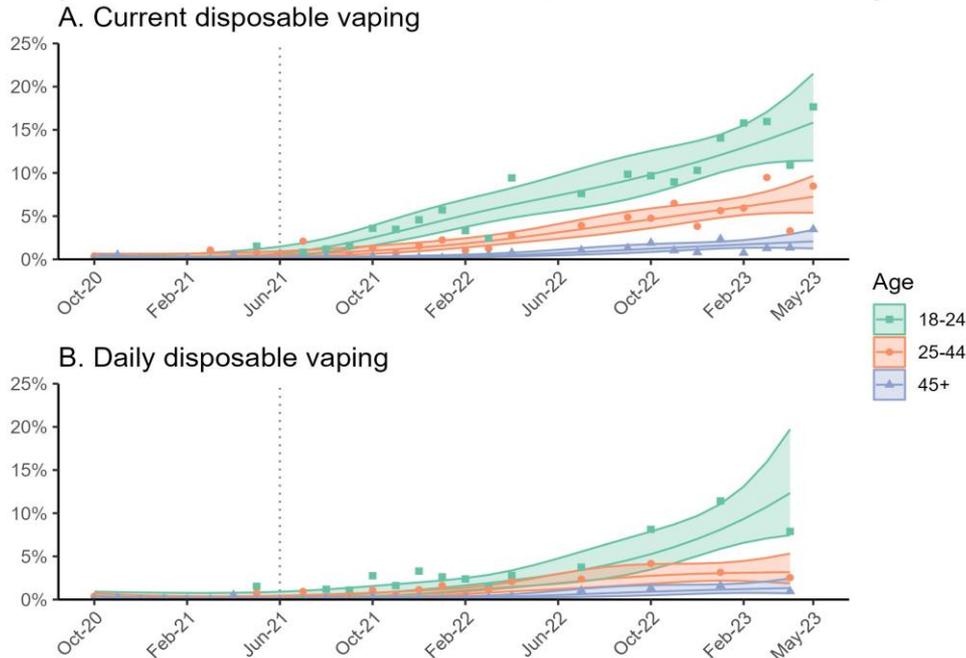
The Bad

- EC mainly used by adult smokers in the past
- More recently have seen an increase in use by youth



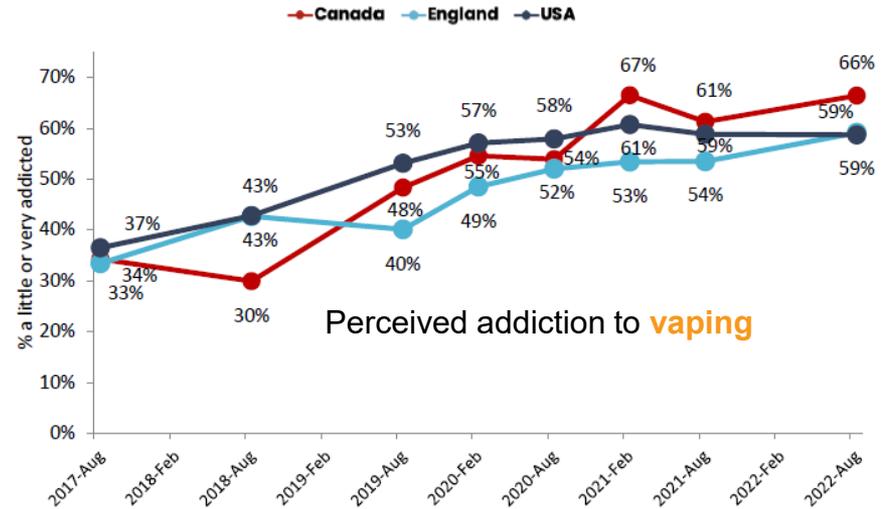
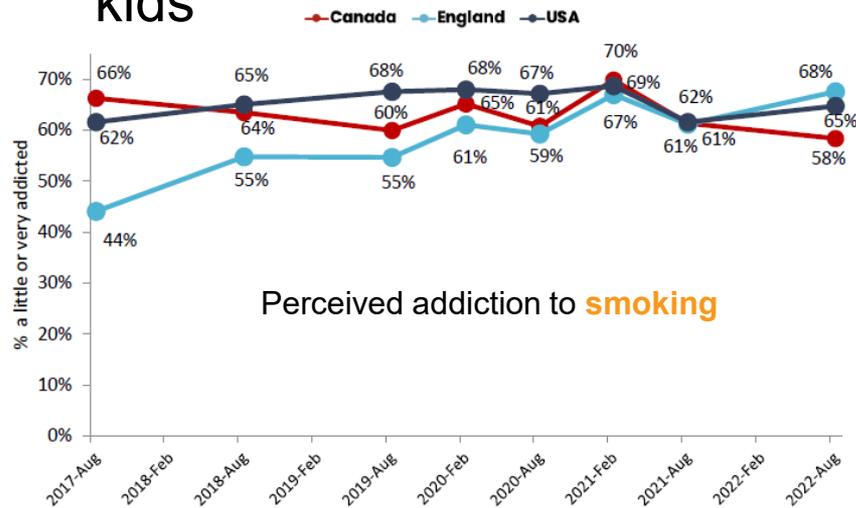
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- Likely driven by arrival of new “disposable” e-cigarettes



The Bad

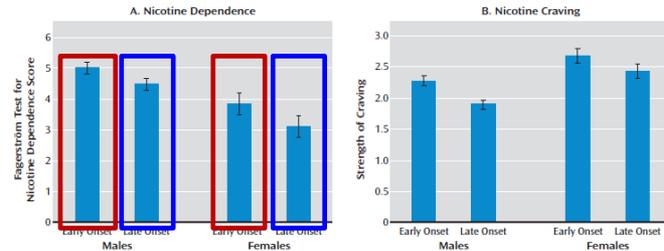
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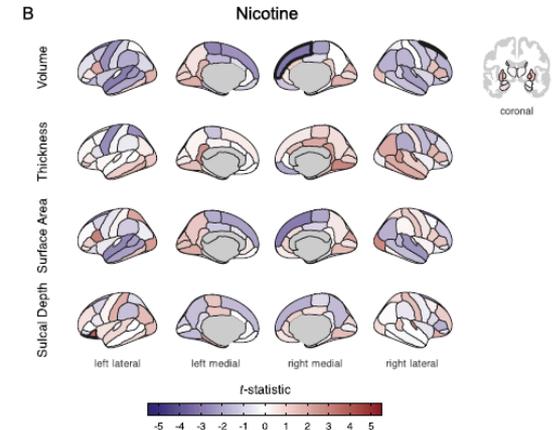
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- There are concerns about a new generation of nicotine-addicted kids
 - Greater the younger you start

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



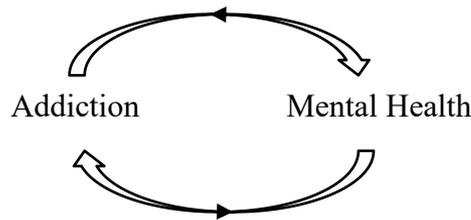
Kendler, K.S. et al, Am J Psychiatry 2013; 170: 408-413



© 2024 Miler AP et al. JAMA Network Open.

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 - Possible impacts on mental health

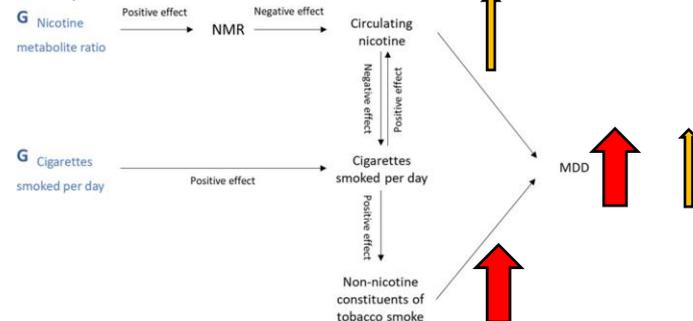


RESEARCH REPORT

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 Taylor³ | Tom P. Freeman³ | Hannah Sallis⁴ | Robyn E. Wootton^{1,2,5,6} | Marcus R. Munafó^{1,2,7} | Christina Dardani² | Jasmine Khouja^{1,2}



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- Likely driven by arrival of new “disposable” e-cigarettes
- There are concerns about a new generation of nicotine-addicted kids
 - Greater the younger you start
 - Possible impacts on mental health

✗ Increasing numbers of youth are starting to vape and seem dependent on EC

Putting 1) and 2) and 3) together

- Population impact!

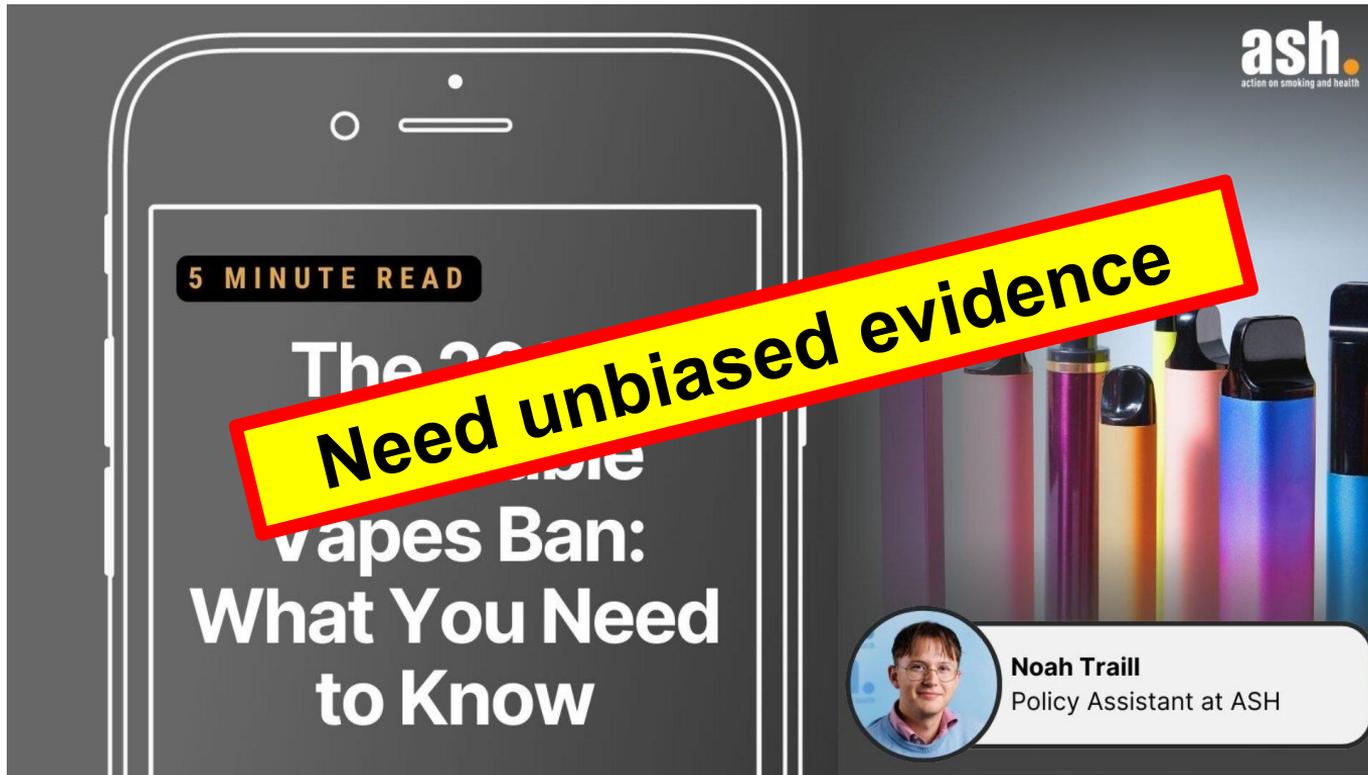
Table 2. Net Effects of Vaping on Mortality and Smoking Cessation by 2100

Vaping risk (% of cigarettes)	Annual cessation rate increase due to vaping (%)	Vaping does not increase smoking initiation			Smoking initiation by 10%	
		Life-years saved (LYS) (millions)	LYS as % of life-years lost (LYL) due to smoking in scenario e-cigarettes never existed	LYS as % of life-years lost (LYL) due to smoking in scenario e-cigarettes never existed	LYS as % of life-years lost (LYL) due to smoking in scenario e-cigarettes never existed	E-quitters (millions)
5	10	5.7	11.0	11.0	1.1	4.1
	25	13.4	22.0	22.0	3.6	9.4
	50	21.1	33.0	33.0	7.1	16.6
	100	25.7	37.4	37.4	12.3	26.9
10	10	3.9	7.8	7.8	0.8	4.1
	25	7.8	15.6	15.6	1.6	8.2
	50	11.7	23.4	23.4	3.0	12.3
	100	15.6	31.2	31.2	6.1	16.6
20	10	1.2	2.4	2.4	0.3	4.1
	25	2.4	4.8	4.8	0.6	8.2
	50	3.6	7.2	7.2	0.9	12.3
	100	4.8	9.6	9.6	1.2	16.6

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

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



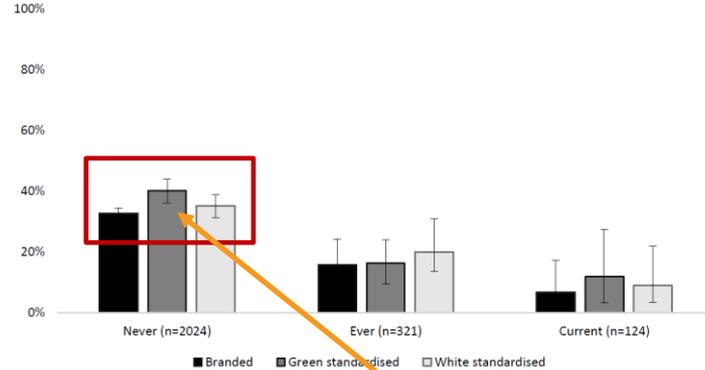
4) Regulation

The Ugly - Unintended consequences

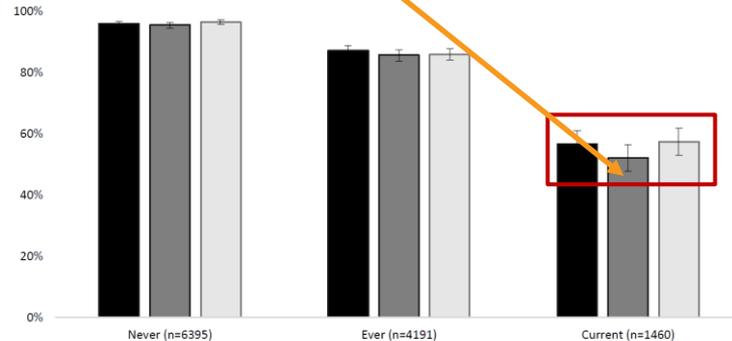
- Some measures make sense, impacting only intended groups (youth)
 - Plain packaging



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)



The Ugly - Unintended consequences

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

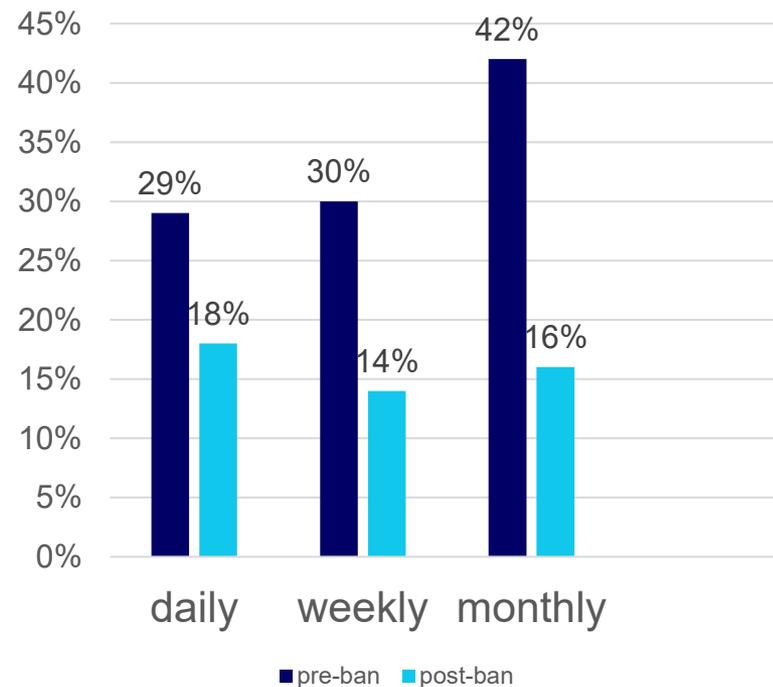
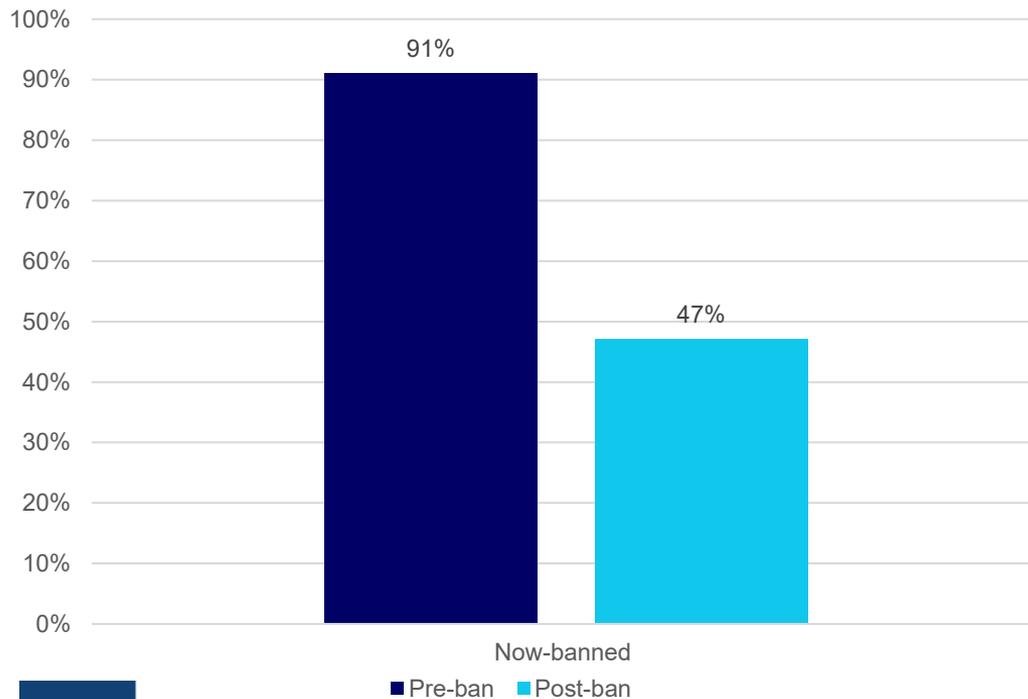
Vape firms have launched cheap reusable devices, so instead of refilling and recycling them, people were binning them and buying more, he said.

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



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

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

4) Regulation

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

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

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

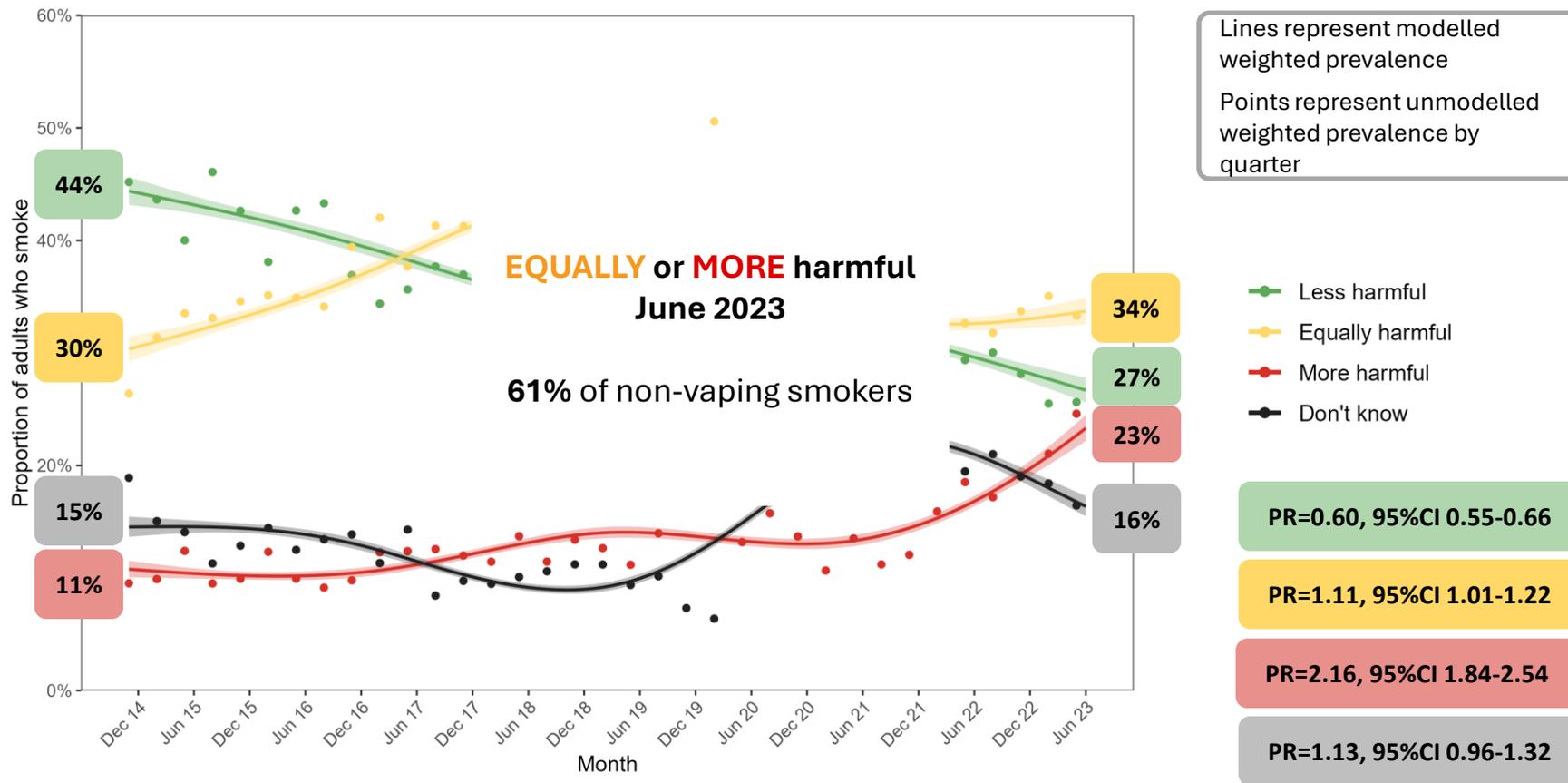
- Taxation on units possibly better than on nicotine concentration (effectiveness/titration)

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**

4) Regulation

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

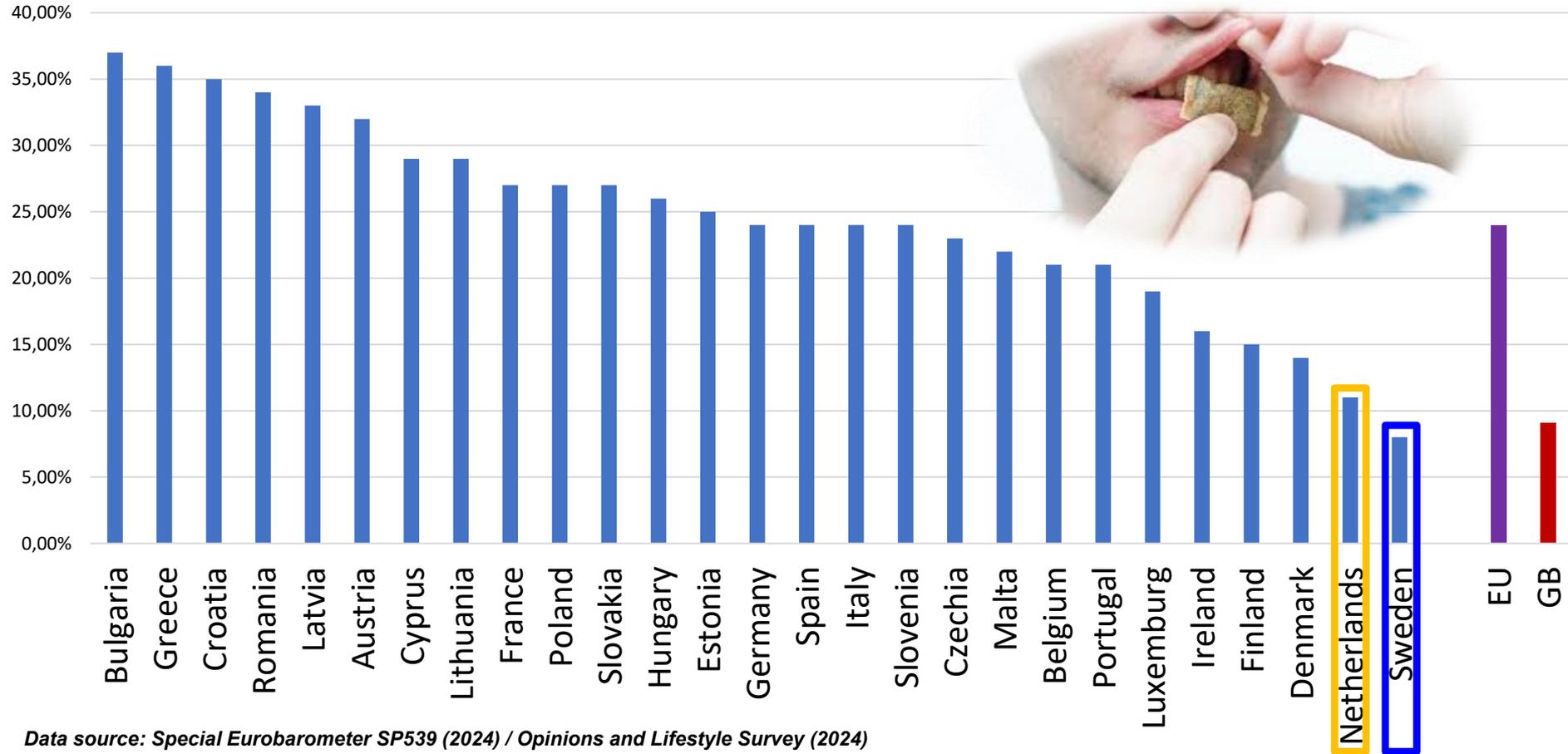


How to balance harm reduction risks & benefits?

- 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



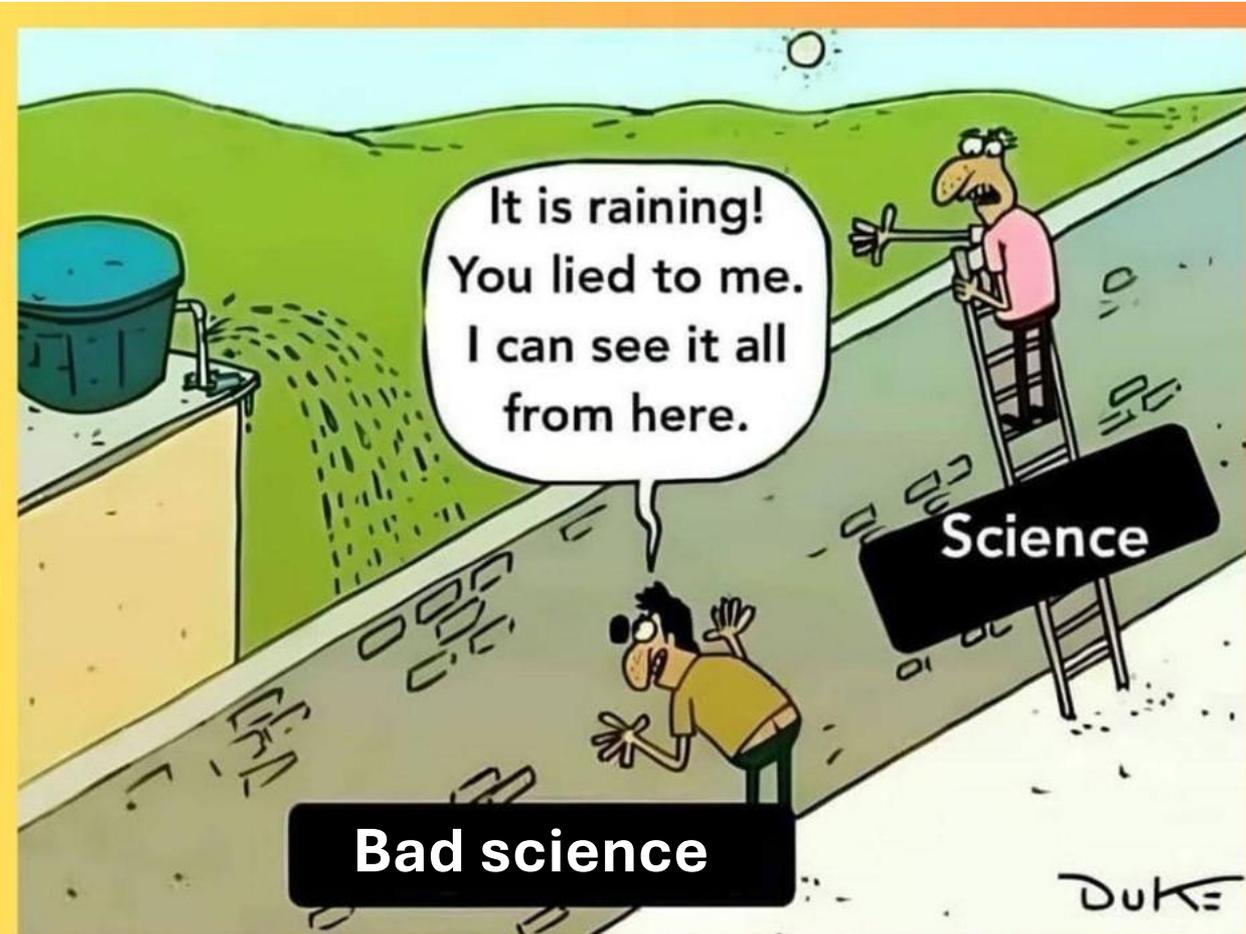
Smoking Prevalence (15+/16+)



Data source: Special Eurobarometer SP539 (2024) / Opinions and Lifestyle Survey (2024)

How to balance harm reduction risks & benefits?

- Clear evidence of harm reduction, less harmful and less risky than the original product
- To engage with the public, key, favourable messages:
 - Preventing harm
 - Reinforcing the benefits of the original product
 - Tightening up regulations
 - Emphasizing the benefits of the original product
 - Considering the risks of the original product
 - Restricting the use of the original product
 - Over the long term
 - Encouraging harm reduction
 - Swap to a less harmful product
- Key thing is to get people to swap from cigarettes to e-cigarettes
- Once in the harm reduction phase out



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