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**ASSOCIATIONS
BETWEEN E-CIGARETTE
USE AND SUBSEQUENT
SMOKING IN YOUNG
PEOPLE: PATTERNS BY
GENDER**

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Acknowledgements and declarations of interest


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I have never received funding from tobacco, vaping, or pharmaceutical industries.

I have no conflicts of interest to declare.

What I'll cover today



Background to our broader program of work investigating the relationship between e-cigarette use/availability and subsequent smoking behavior in young people

What the data show when analyzed by gender

Conclusions and future directions

‘Competing’ hypotheses

Though data consistently show that young people who vape are more likely to smoke, it is highly contested as to whether this is a causal relationship.

It is possible that vaping could act as:

- a ‘gateway’ into smoking
- a ‘diversion’ from smoking
- an ‘off ramp’ from smoking

Some people describe these as competing, but at an individual level they could all hold true.



'Net' impact

- Public health practitioners and policymakers have a particular interest in what happens at the population level – if, overall, vaping is contributing to more people starting to smoke than would have otherwise, then the net public health effect of vaping is going to be negative.
- We also are (or should be) interested in whether patterns differ based on socially stratifying characteristics – smoking rates differ by groups, and this is a leading driver of health inequalities – 'net' effects can sometimes mask important differences.



Our program of work

Evidence and Gap Map currently under peer review; allows users to identify relevant studies and reviews on multiple dimensions, including socially stratifying characteristics

Cochrane Review to assess the evidence on the relationship between the use and availability of e-cigarettes and subsequent cigarette smoking in young people (aged 29 years or less), and whether the relationship differs by socioeconomic status, gender, or other demographic characteristics.

Methods consensus exercise to guide further research

The Cochrane review

- We searched electronic databases and issued a call for evidence in April 2023
- Primary outcome: association between EC use/availability and change in population rate of combustible tobacco use in young people, assessed through the proportion reporting current cigarette use or, where this information is not available, proxy measures such as cigarette sales data.
- Secondary outcomes: association between EC use/availability and incidence, progression, and cessation of cigarette smoking



Cochrane
Library

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Electronic cigarettes and subsequent cigarette smoking in young people

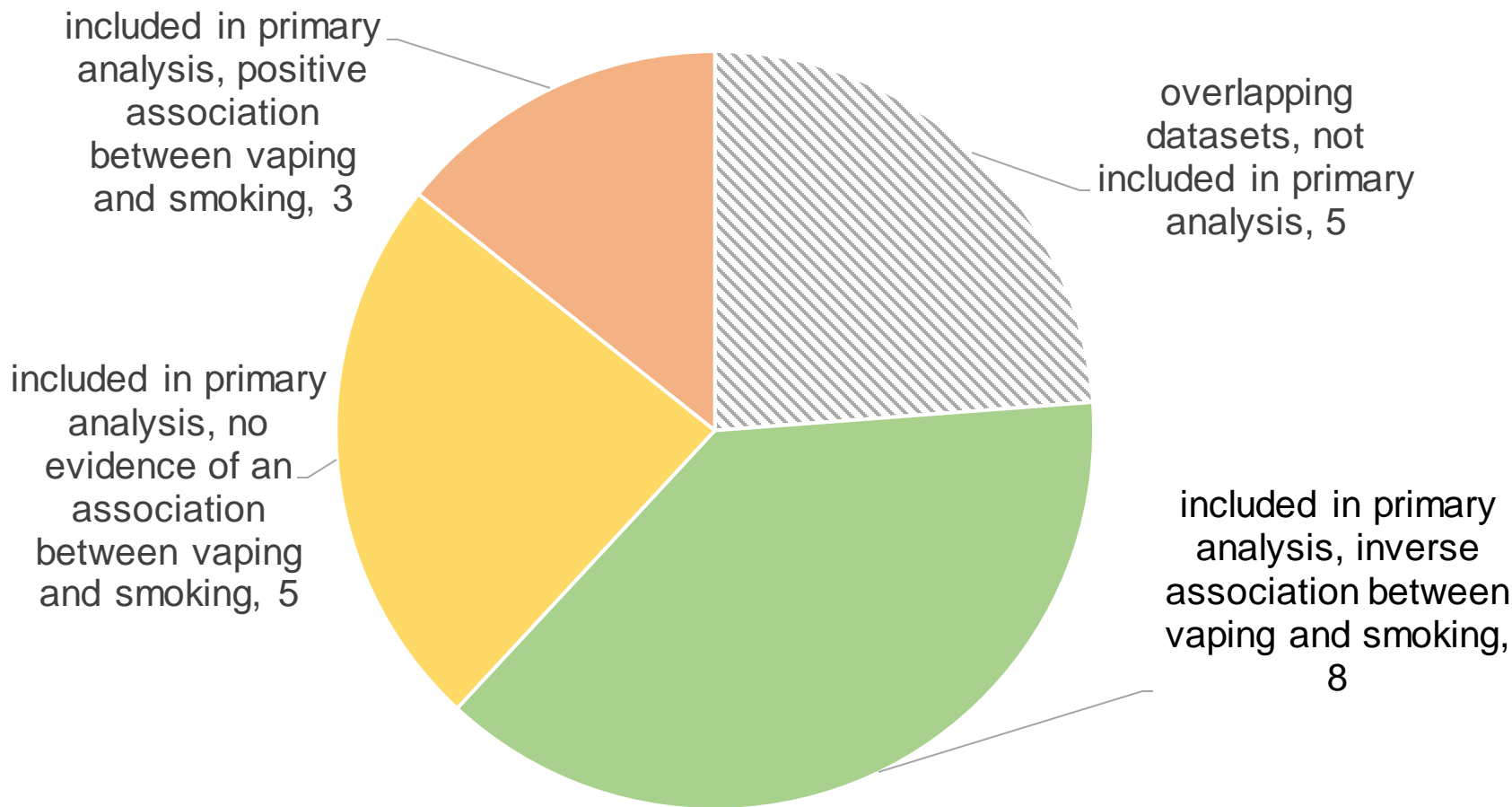
✉ **Jamie Hartmann-Boyce^a, Rachna Begh^a, Nicola Lindson, Jonathan Livingstone-Banks, Thomas R Fanshawe, Ann McNeill, Lion Shahab, Nancy A Rigotti, Dylan Kneale, James Thomas, Paul Aveyard** Authors' declarations of interest

Version published: 24 March 2022 Version history

<https://doi.org/10.1002/14651858.CD015170>

Our findings so far: smoking prevalence in young people

! Preliminary findings: confidential and subject to change (please do not share)



! Risk of bias ranged between moderate to critical in these 21 studies

Studies categorized by direction of association in primary analysis

Our findings so far: data from longitudinal cohorts

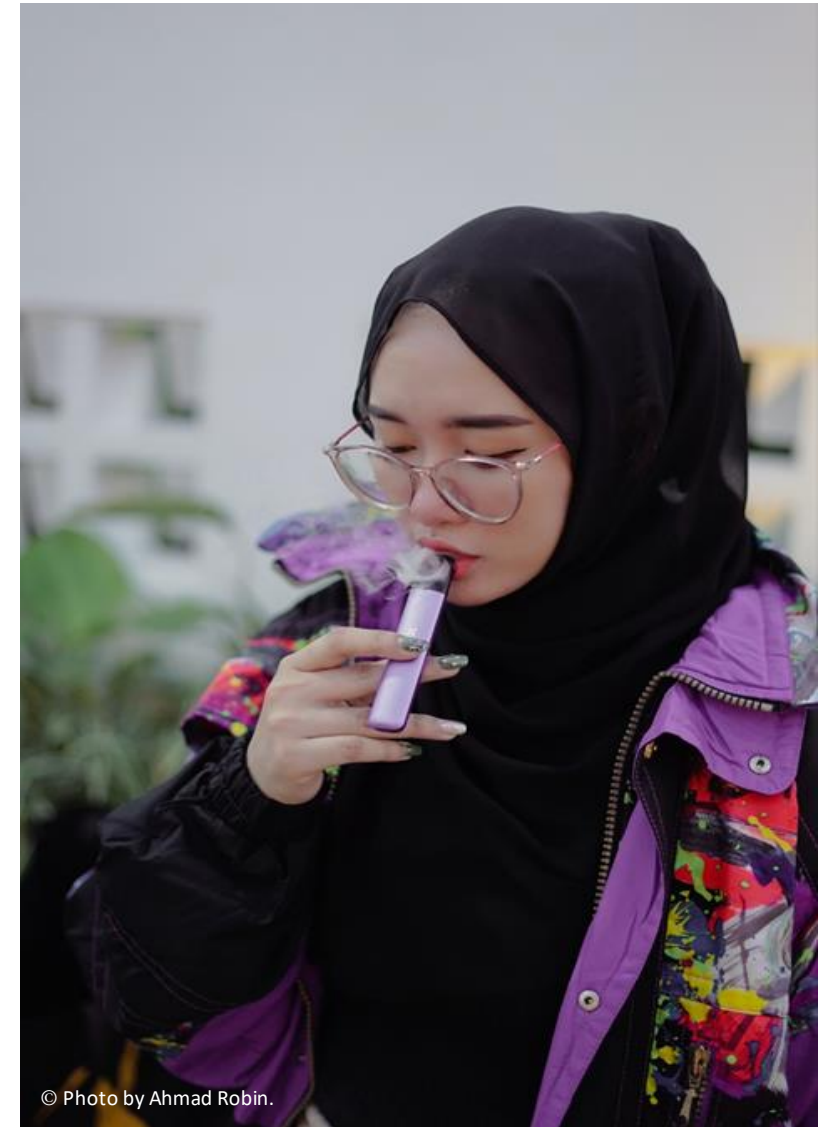
! Preliminary findings: confidential and subject to change (please do not share)

- Forty-six cohort studies assessed whether young people who vaped were at higher risk of subsequent smoking than young people who did not.
- Most found evidence that young people who vaped were **more likely to start smoking** than non-vaping peers. Many studies did not try to establish causality; of those that did, conclusions varied, sometimes linked to the confounders included in analyses. Our analyses were also unable to determine causality.
- There were insufficient data on associations between youth vaping and **smoking cessation** or **relapse**.

! Multiple critical risk of bias issues

Analyses by gender

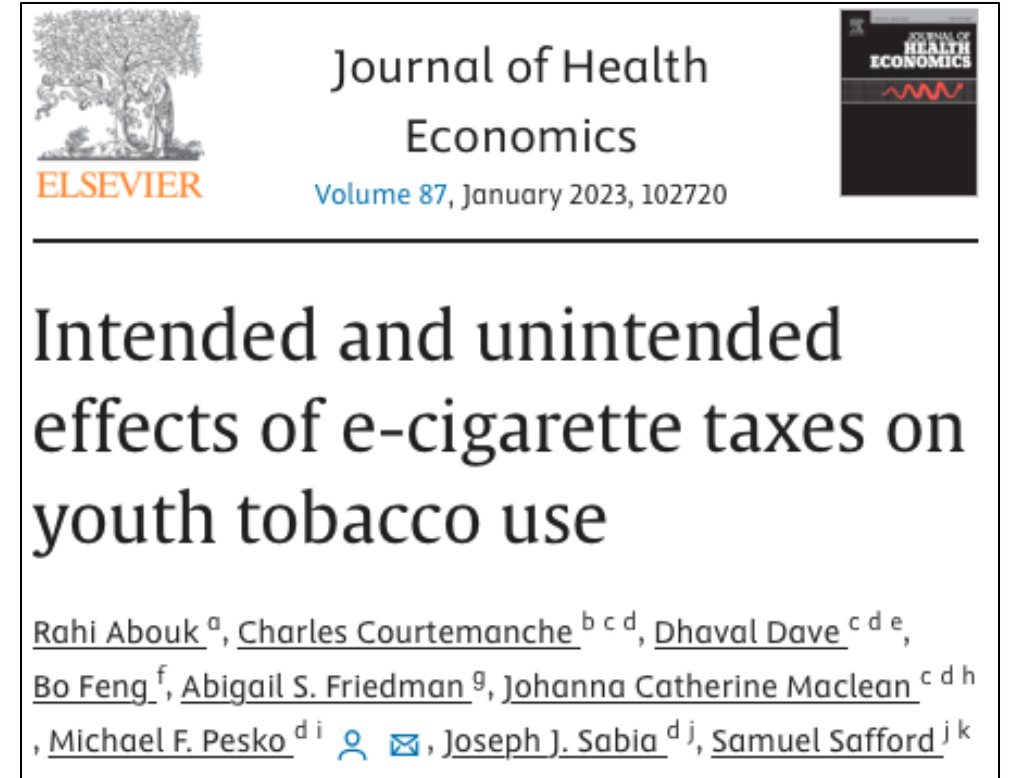
- Four of 21 population level studies analyzed whether associations differed by gender
- Four of 46 individual level studies contained >5,000 participants *and* examined whether associations differed by gender.
- Many more studies controlled for gender in their analyses (e.g. by matching or including gender as a covariate) but did not provide data on whether associations differed by gender



© Photo by Ahmad Robin.

Abouk 2023

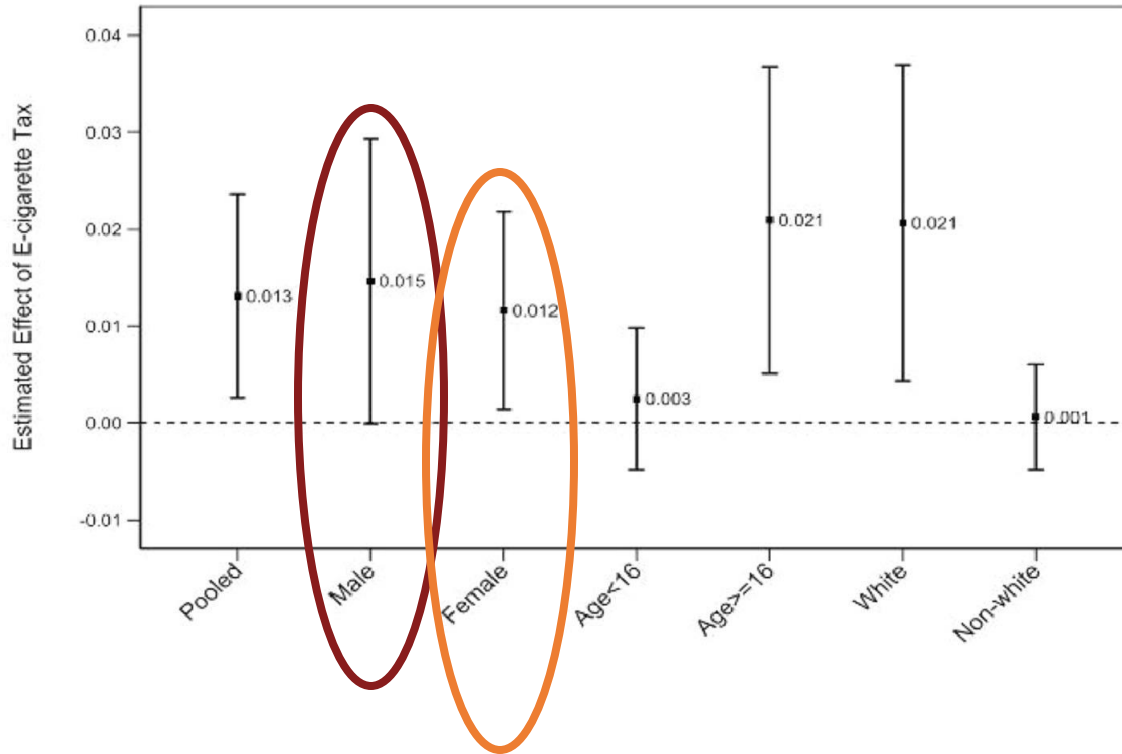
- Monitoring the Future and Youth Risk Behavior Surveillance System data (USA; 8th, 10th and 12th graders)
- Estimate impact of e-cigarette taxes on youth tobacco use
- Estimate positive cigarette cross-tax effects, suggesting substitution between cigarettes and e-cigarettes in youth



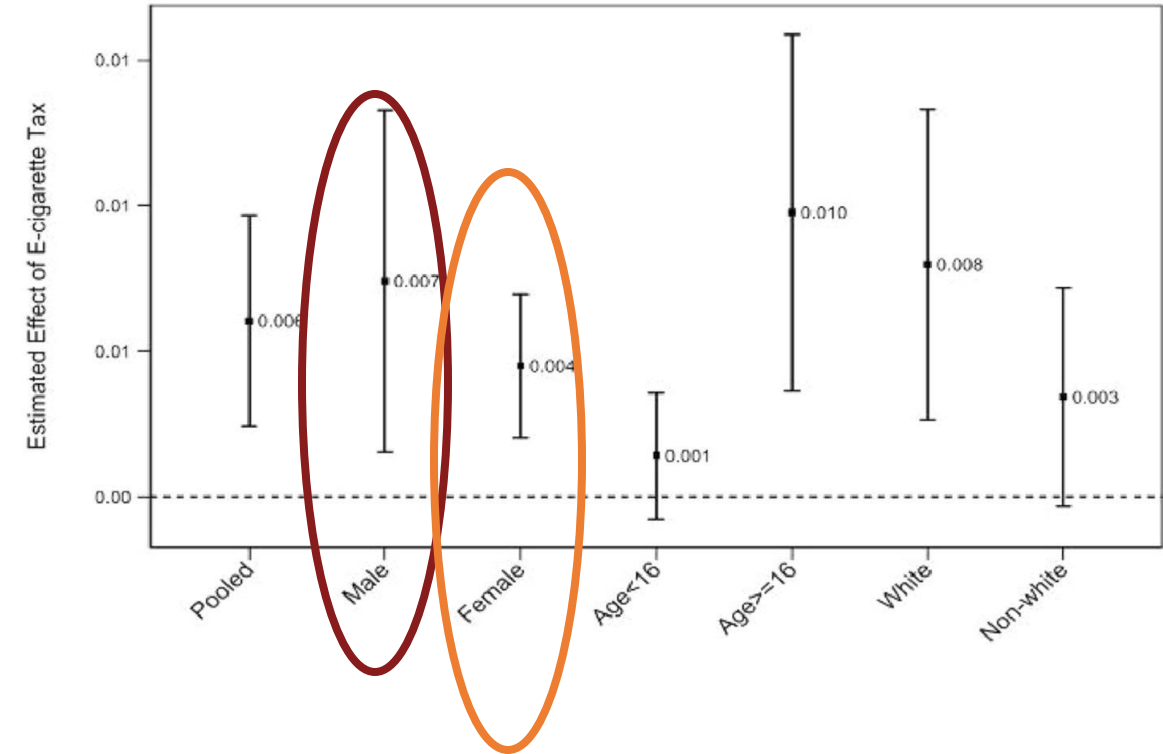
About 2023 continued

Assessment of heterogeneity in cross-tax effects on combustible cigarette use

Smoked Cigarettes In The Past 30d




Smoked >= One-half Pack Cigs/day In The Past 30d



Friedman 2022

- 18 to 25 year-olds from the Current Population Survey's Tobacco Use Supplements (USA)
- Multivariable linear regressions estimated two-way fixed effects analyses to assess EC and cigarette tax rates' relationships to recent and daily smoking and vaping
- Overall find higher EC tax rates are associated with decreased EC use but increased cigarette smoking among 18- to 25-year-olds

ADDICTION **SSA** SOCIETY FOR THE STUDY OF ADDICTION

RESEARCH REPORT |  Open Access |    

Young adult responses to taxes on cigarettes and electronic nicotine delivery systems

Abigail S. Friedman  Michael F. Pesko

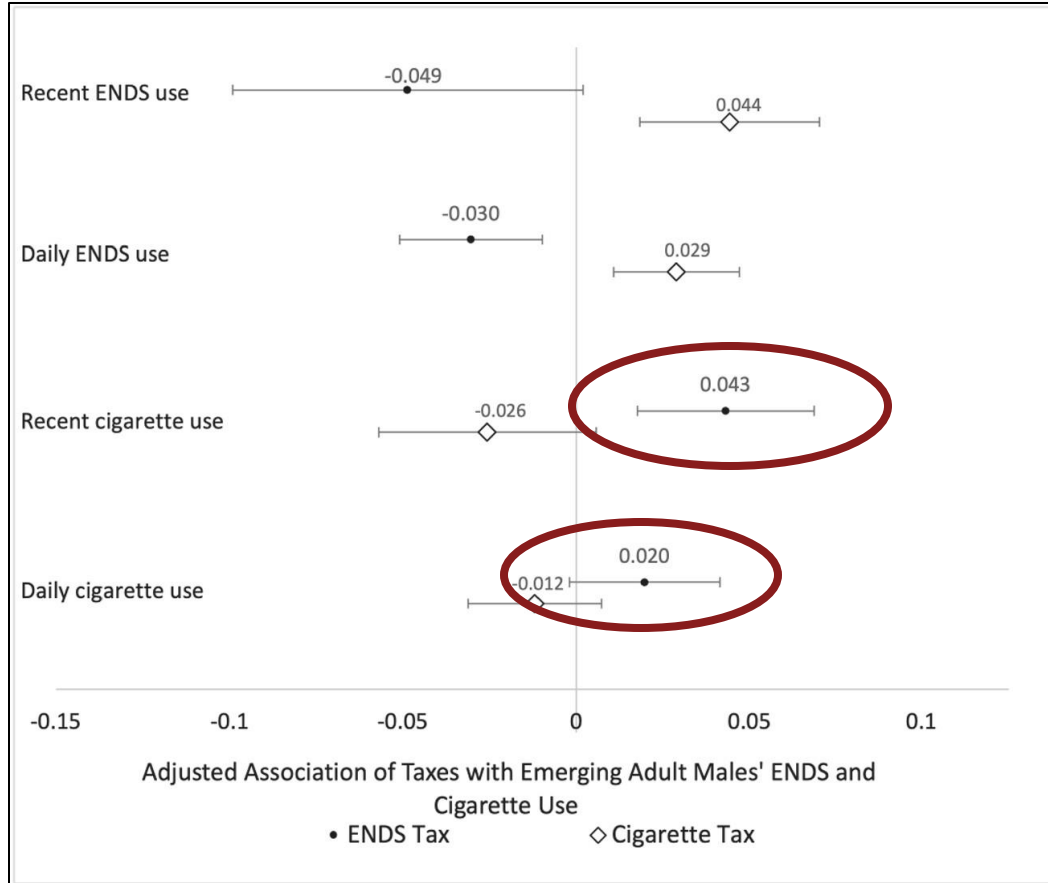
First published: 19 July 2022 | <https://doi.org/10.1111/add.16002> | Citations: 8

Author order is alphabetical: both authors contributed equally to the study design and analysis, as well as drafting and revision of the manuscript. Both authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

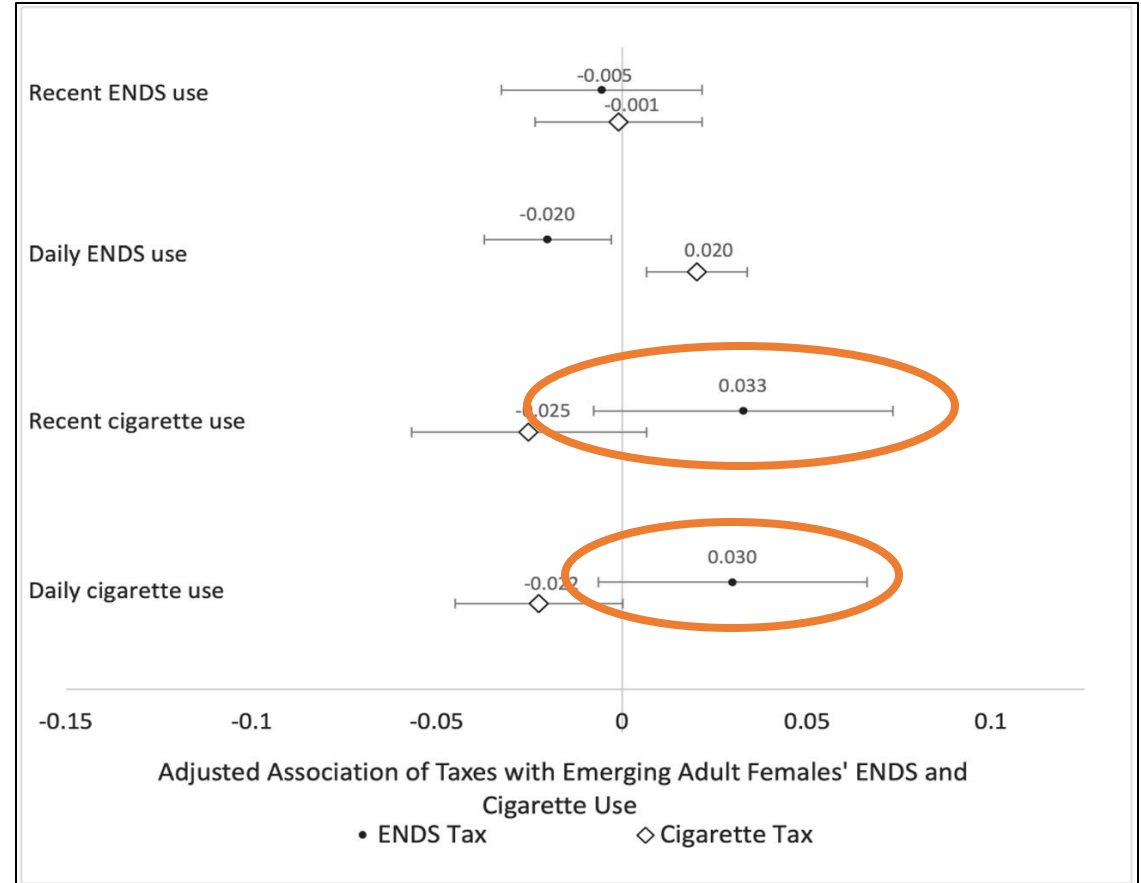
Funding information: National Institute on Drug Abuse, Grant/Award Number: R01DA045016; University of Kentucky's Institute for the Study of Free Enterprise; Robert Wood Johnson Foundation, Grant/Award Number: 74869

Friedman 2022 continued

Tax associations with ENDS and cigarette use, 18- to 25-year-olds



Males



Females

Hawkins 2021

- Massachusetts Youth Health Surveys (USA; 14-18 year olds)
- Difference-in-difference models to link changes in county-level policy (smoke free legislation prohibiting EC in smoke-free restaurants) to changes in adolescents' use of cigarettes and e-cigarettes
- Report no impact overall or by gender



The screenshot shows the BMJ Journals website interface. At the top, there is a navigation bar with 'BMJ Journals', 'Subscribe', 'Log In', and 'Basket'. Below this is a green header for 'Tobacco Control' with links for 'Home', 'Current issue', 'Anniversary', and 'Archive'. The main content area shows the article title 'Brief report: Flavoured tobacco product restrictions in Massachusetts associated with reductions in adolescent cigarette and e-cigarette use'. The authors listed are Summer Sherburne Hawkins, Claudia Kruzik, Michael O'Brien, and Rebekah Levine Coley. The article is available as a PDF. The journal information at the bottom of the article area is 'Volume 31, Issue 4'.

Wu 2022

- Canada (4 provinces), UK, and Australia; different definitions of ‘young people’
- Interrupted time series drawing on population of people who smoke, investigating year that vaping was widely introduced in each region
- Concluded e-cigarette consumption reduces overall cigarette consumption in ‘environments that enable substitution’

Open access Original research

BMJ Open Impact of vaping introduction on cigarette smoking in six jurisdictions with varied regulatory approaches to vaping: an interrupted time series analysis

Daphne C Wu,¹ Beverley M Essue,² Prabhat Jha ¹

To cite: Wu DC, Essue BM, Jha P. Impact of vaping introduction on cigarette smoking in six jurisdictions with varied regulatory approaches to vaping: an interrupted time series analysis. *BMJ Open* 2022;12:e058324. doi:10.1136/bmjopen-2021-058324

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-058324>).

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ABSTRACT

Objective We sought to quantify the impact of vaping introduction on cigarette smoking across settings with varied regulatory approaches to vaping.

Design Interrupted time series analysis, adjusted for cigarette tax levels.

Setting Four Canadian provinces, UK and Australia.

Participants Entire population of smokers in each country.

Interventions The year that vaping was widely introduced in each country.

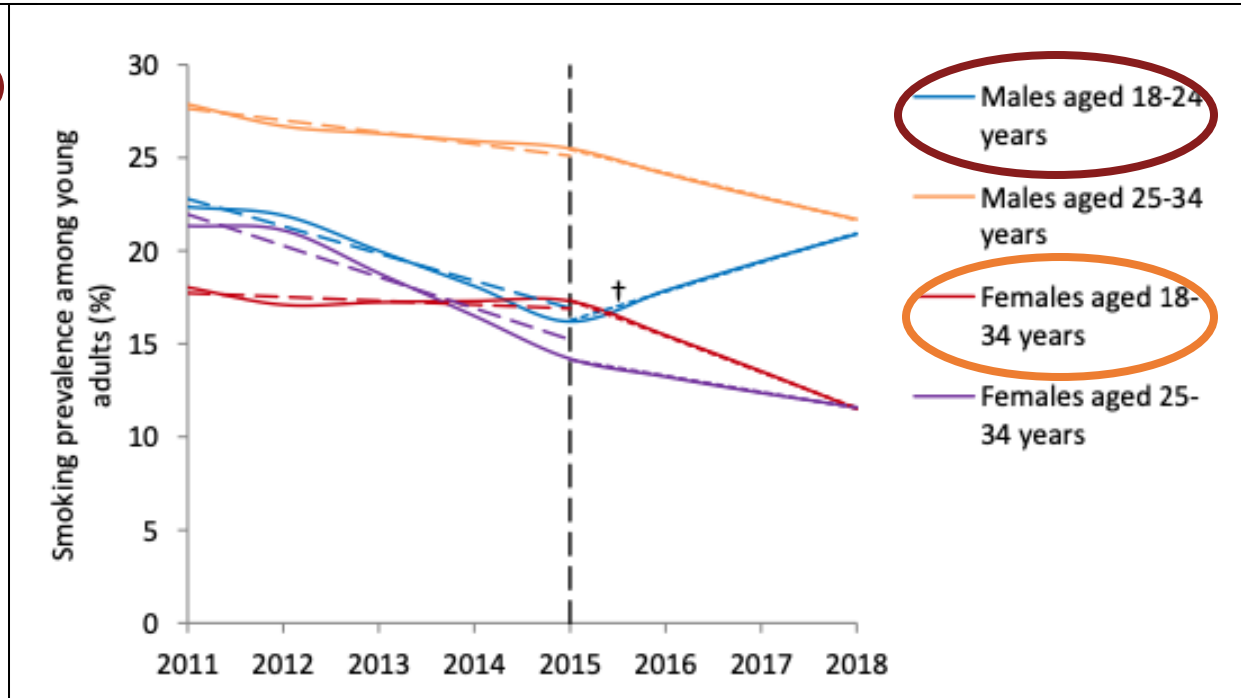
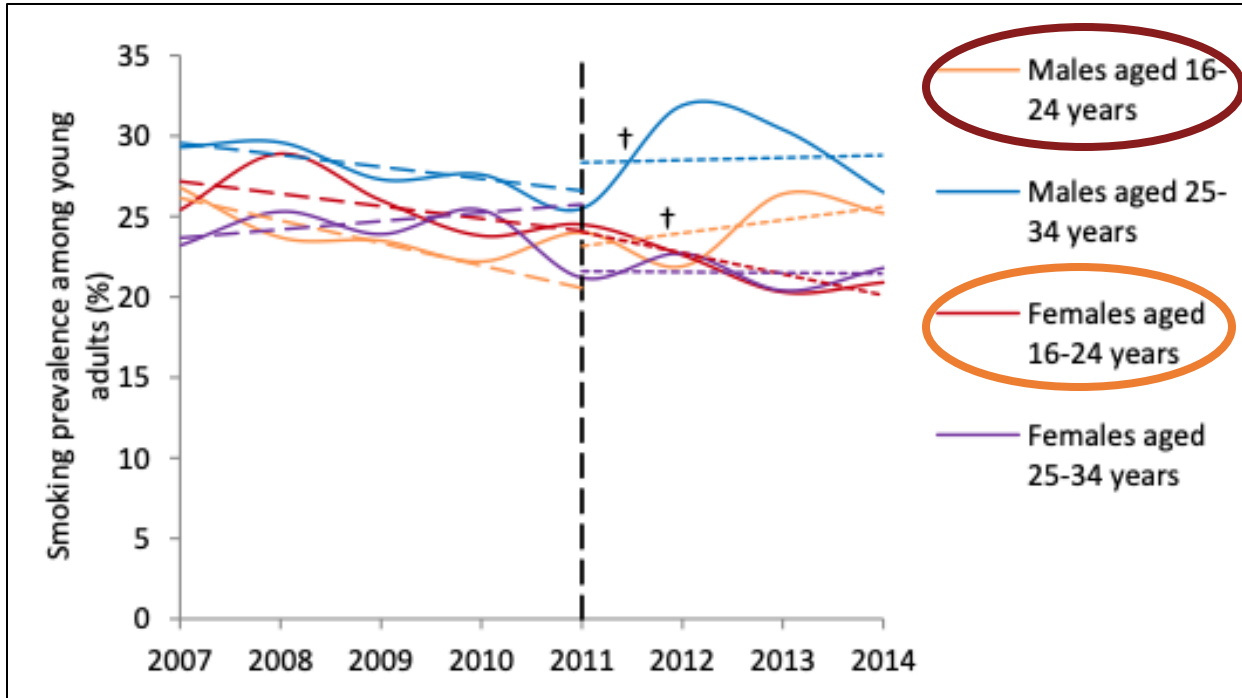
Primary and secondary outcome measures The primary outcome is cigarette consumption per adult, and the secondary outcome is smoking prevalence among young adults.

Results Based on allowable nicotine levels, restrictions on e-cigarette advertising, sales and access, and taxation, the least to most restrictive jurisdictions were

Strengths and limitations of this study

- This study uses an interrupted time series (ITS) design, which provides credible evidence on the longitudinal effects of interventions where randomisation is not possible.
- We are able to assess e-cigarette introduction in the context of permissible nicotine levels and regulations for their use, which is appropriate when considering substitution effects of vaping on cigarette demand.
- Since our definition of the intervention year is based on the first year when nationally representative surveys included questions on e-cigarette use, there may be a delay in capturing the effect of the intervention, and the ITS results are sensitive to the intervention year.

Wu 2022 continued



UK

Australia

Summary of ‘population level’ data

Study ID	Exposure of interest	Association between e-cigarette use/availability and smoking in young people	Statistically significant difference by gender
Abouk 2023	E-cigarette taxes	↓	X
Friedman 2022	E-cigarette taxes	↓	X
Hawkins 2021	Bans on indoor vaping	↔	X
Wu 2022	Widespread introduction/uptake of vaping	↓	X

Duan 2021

- Waves 1-4 PATH (USA)
- Generalized estimation equations to estimate associations between baseline EC use and subsequent cigarette smoking
- Past-30-day EC use at baseline was significantly associated with past-30-day cigarette smoking at follow-up waves (aOR = 3.90, 95% CI: 2.51–6.08).
- This association was significantly stronger for **boys (aOR = 6.17, 95% CI: 2.43–15.68)** than for **girls (aOR = 1.10, 95% CI: 0.14–8.33)**



The screenshot shows the MDPI article page. At the top is the MDPI logo. Below it is a search bar with options for 'Title / Keyword', 'Author / Affiliatic', 'Internati...', and 'All Artic...'. The breadcrumb trail reads 'Journals / IJERPH / Volume 18 / Issue 4 / 10.3390/ijerph18041695'. There is a button for 'Order Article Reprints'. The article is marked as 'Open Access Article'. The title is 'Sex Difference in the Association between Electronic Cigarette Use and Subsequent Cigarette Smoking among U.S. Adolescents: Findings from the PATH Study Waves 1–4'. The authors are Zongshuan Duan, Yu Wang, and Jidong Huang. The affiliation is 'School of Public Health, Georgia State University, Atlanta, GA 30303, USA'. A note indicates that Jidong Huang is the author to whom correspondence should be addressed. The citation is 'Int. J. Environ. Res. Public Health 2021, 18(4), 1695; https://doi.org/10.3390/ijerph18041695'. The dates are 'Received: 22 December 2020 / Revised: 28 January 2021 / Accepted: 8 February 2021 / Published: 10 February 2021'. A note at the bottom states '(This article belongs to the Special Issue Addressing Tobacco and Nicotine Use among Adolescent and Young Adult Populations)'.

Gueorguieva 2020

- PATH waves 1 and 2 (USA)
- Set intersection bar plots and heat maps

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Article Navigation

JOURNAL ARTICLE

Data Visualization Tools of Tobacco Product Use Patterns, Transitions and Sex Differences in the PATH Youth Data [Get access >](#)

Ralitza Gueorguieva, PhD ✉, Eugenia Buta, PhD, Patricia Simon, PhD, Suchitra Krishnan-Sarin, PhD, Stephanie S O'Malley, PhD

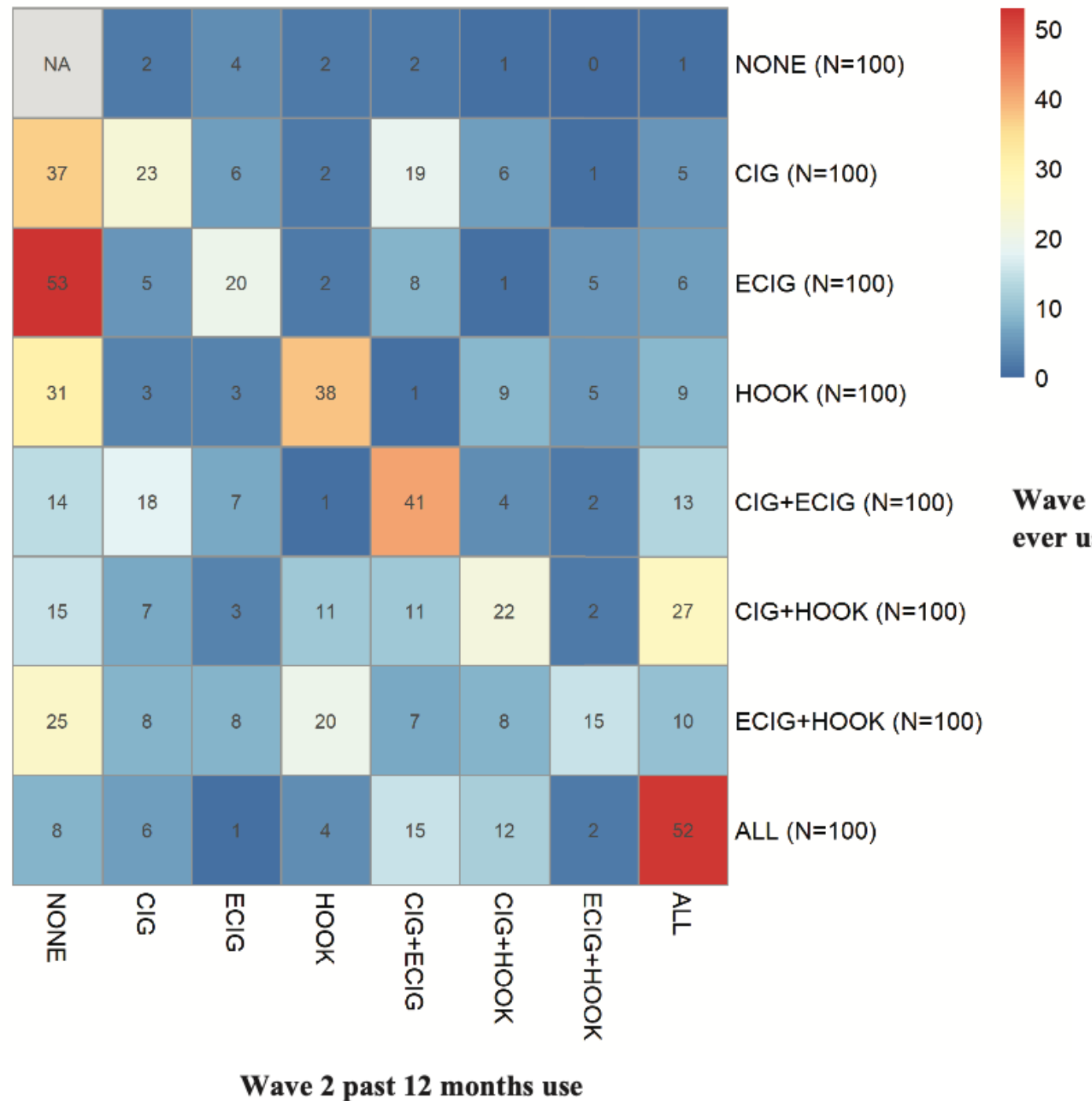
Nicotine & Tobacco Research, Volume 22, Issue 10, October 2020, Pages 1901–1908, <https://doi.org/10.1093/ntr/ntaa056>

Published: 27 March 2020 **Article history** ▼

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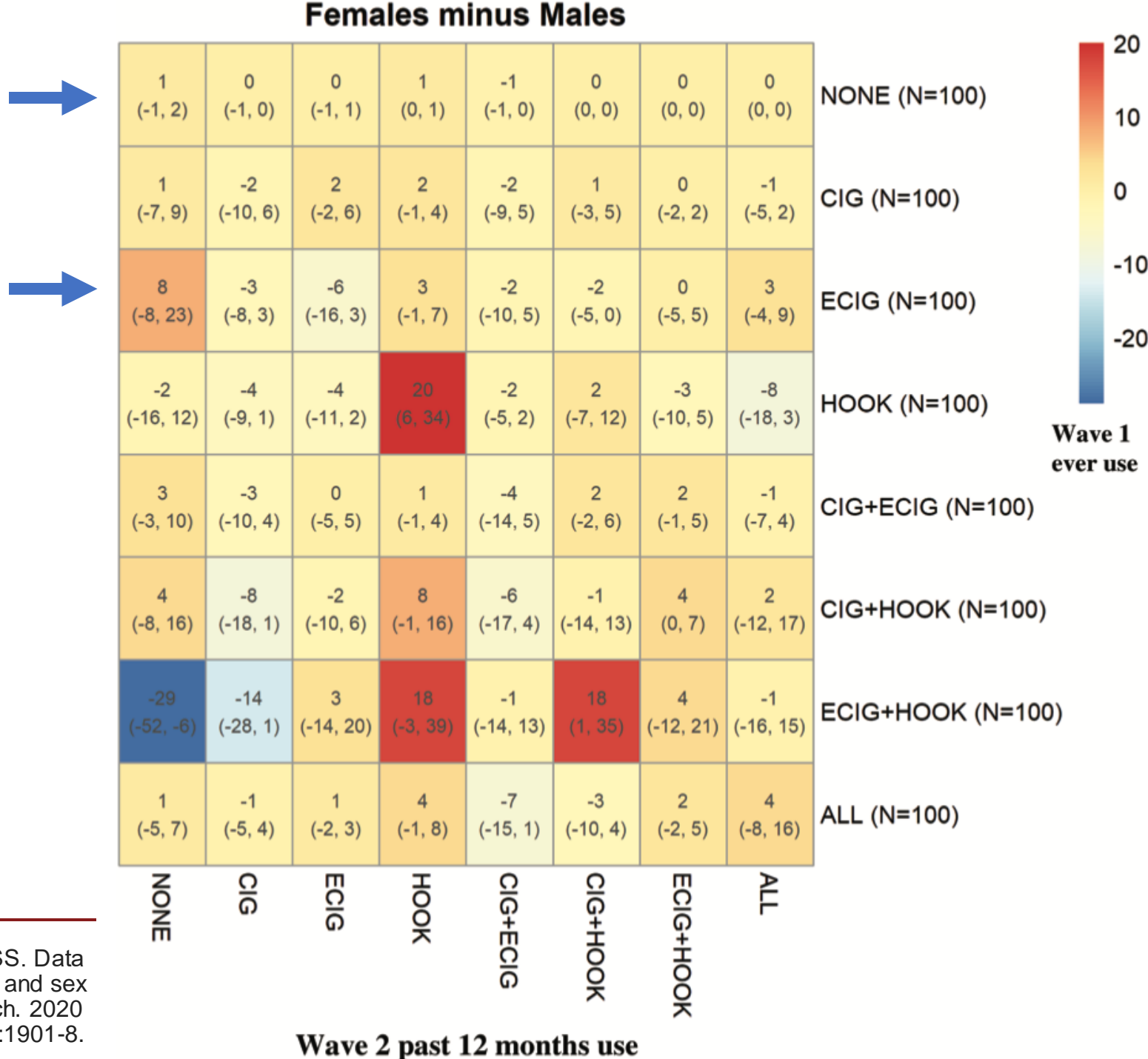
Gueorguieva 2020 cont

Calibrated heat map of ever tobacco product use at wave 1 (rows) vs. past 12 months use at wave 2 (columns) among PATH study youth, assuming 100 subjects in each row at wave 1. The numbers in the cells represent the number of subjects (out of 100) who made the transition from the pattern of use in the corresponding row to that in the corresponding column calculated based on the weighted proportions.



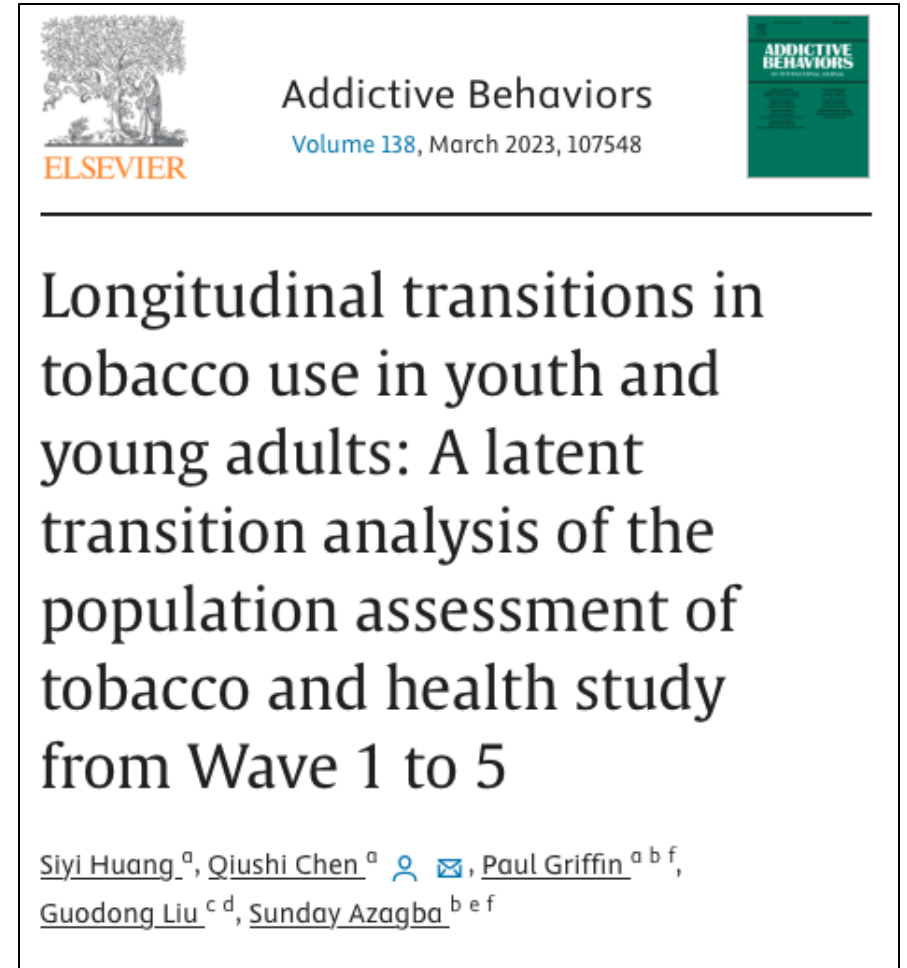
Gueorguieva 2020 cont

Calibrated difference heat map of ever tobacco product use at wave 1 (rows) vs. past 12 months use at wave 2 (columns) among PATH study youth in females vs. males, assuming 100 subjects of each sex in each row at wave 1. The numbers inside cells are estimated differences in calibrated transition counts between females and males, with 95% confidence intervals, calculated based on weighted proportions.



Huang 2023

- PATH waves 1-5 (USA)
- Latent class analysis and latent transition analysis of tobacco use classes and longitudinal transitions between classes (C1 non-current user, C2 moderate EC user, C3 poly-tobacco user)
- Conclude that EC may be an intermediate progression from non-current into poly-tobacco use
- **Males** were more likely to transition from C1 to C2 (OR 1.51, 1.28 to 1.80) and from C1 to C3 (OR 1.75, 95% CI 1.19 to 2.58) compared to females (females were reference group)
- **Females** were more likely than males to transition to non-use of any product from C2 (OR 0.66, 95% CI 0.56 to 0.78) or C3 (OR 0.38, 95% CI 0.20 to 0.70)



Sun 2023

- PATH waves 3-5 (USA)
- Statistically significant odds of continued smoking comparing baseline EC users with nonusers OR 1.81 (95% CI 1.03-3.18)
- The association was less pronounced in **females** versus **males** regardless of smoking measure used (OR 0.81 and 0.57, females versus males)



The screenshot shows the JAMA Network Open interface. At the top, there is a navigation bar with the JAMA Network Open logo and a search bar. Below the navigation bar, the article title is displayed: "Association of Electronic Cigarette Use by US Adolescents With Subsequent Persistent Cigarette Smoking". The article is categorized as an "Original Investigation" in the field of "Substance Use and Addiction". It was published on March 27, 2023. The authors listed are Ruoyan Sun, PhD¹; David Méndez, PhD²; and Kenneth E. Warner, PhD². The article has 5,265 views, 4 citations, and an Altmetric score of 122. There are buttons for PDF, More, Cite, and Permissions. The citation information at the bottom of the article is: JAMA Netw Open. 2023;6(3):e234885. doi:10.1001/jamanetworkopen.2023.4885.

Summary of 'individual level' data

Study ID	Association between baseline e-cigarette use and subsequent smoking	Difference by gender (females versus males)
Duan 2021	↑	↓ Statistically significant positive association in boys; weaker and non statistically significant positive association in girls
Huang 2023	↑	↓ Association weaker in females than males; subgroup analysis not available
Gueorguieva 2020	↑	↓ Association weaker in females than males; subgroup analysis not available
Sun 2023	↑	↓ Positive association in both groups, but weaker in females than males

Summarizing the data overall

- Of the 4 population-level studies providing analyses by gender, 3 found an inverse association between vaping/EC availability and subsequent smoking in young people; the fourth found no difference. There was no evidence of differences by gender.
- Of the 4 individual level studies, all found at least some evidence of positive associations between vaping and subsequent smoking. All found these associations were weaker in females than males.
- Many limitations – including risk of bias, possible selective reporting, little to no data on other gender identities, little to no data on intersectionality. Almost all data is from the USA. Methodological heterogeneity precludes pooling – though directions of associations strikingly consistent.

We need more...

- Studies designed to evaluate causality
- Studies conducted outside of the USA
- Studies looking at socially stratifying characteristics, including but not limited to gender
- Acknowledgement of uncertainty in this space

Thank you!

To authors of the included studies who conducted *and reported* these analyses

To the team identifying and extracting these data:

- Monserrat Conde (Oxford)
- Rachna Begh (Oxford)
- Sufen Zhu (Oxford)
- Kate Tudor (NESTA)
- Sarah Jackson (University College London)
- Dimitria Kale (University College London)

To the conference organizers for inviting me

To all of you for listening

QUESTIONS & ANSWERS

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Shahab 2021

- **78,265 adolescents in NYTS (USA)**
- **Cross-sectional matched cohort study**
- **Females were less likely than males to have used other non-combustible tobacco/nicotine products before initiating combustible tobacco use**
- **Overall female students were still less likely than male students to have initiated any product use**

The screenshot shows the BMJ Journals website interface. At the top, there is a navigation bar with 'BMJ Journals', 'Subscribe', 'Log In', and 'Basket'. Below this is a green header for 'Tobacco Control' with sub-navigation for 'Current issue', 'Anniversary', 'Archive', and 'Authors'. The main content area displays the article title, authors (Lion Shahab, Emma Beard, Jamie Brown), and options to view the article as text or PDF. There are also icons for citation tools, sharing, and rapid responses.

Wu 2022 continued

