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Symposium 18

Transitions Into and Out of Dual Use of Combustible and E-Cigarettes: Implications for Public Health

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Predictors of transitions to and from dual use of cigarettes and e-cigarettes

An overview of results from the Population Assessment of Tobacco and Health and the Exhale Longitudinal Cohort

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- The opinions expressed in this article are the authors' own and do not reflect the views of the National Institutes of Health, the Department of Health and Human Services or the US government.

Disclosures

	Tobacco Industry	E-cigarette & nicotine product industry	Pharma Industry
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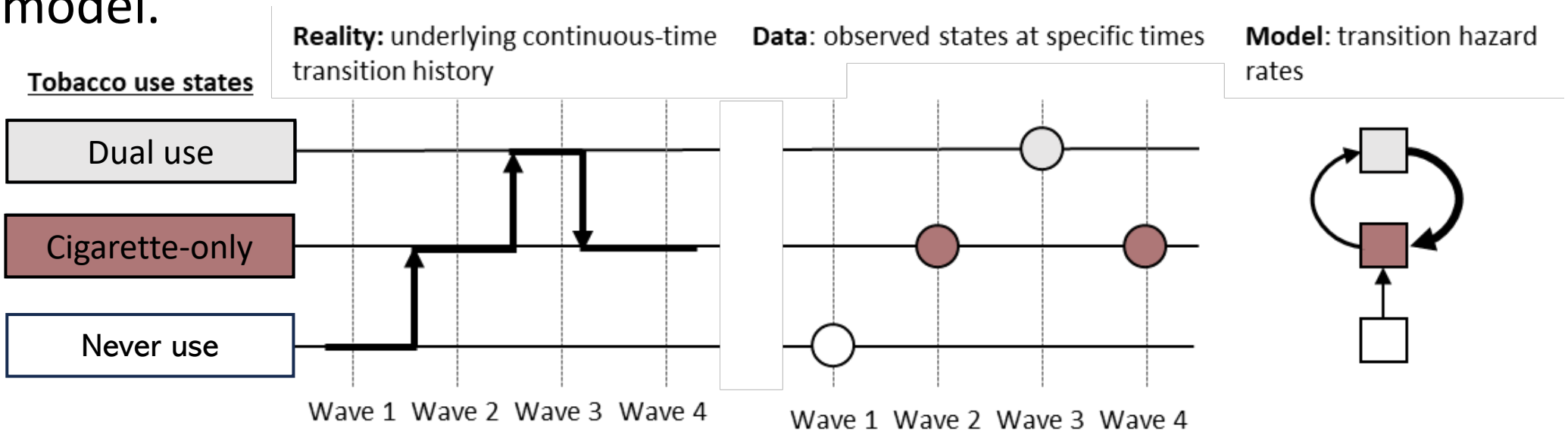
Dual use of cigarettes and e-cigarettes

- Dual use of cigarettes and e-cigarettes is becoming increasingly prevalent
- High heterogeneity in *who* is dual using and *how* they are using (frequency, intensity)
- Can be a temporary state as a transition from cigarette smoking to e-cigarette-only use, but can be sustained use of both products
- Understanding transitions to and from dual use will improve our understanding of the impact of e-cigarettes on public and develop smoking cessation interventions

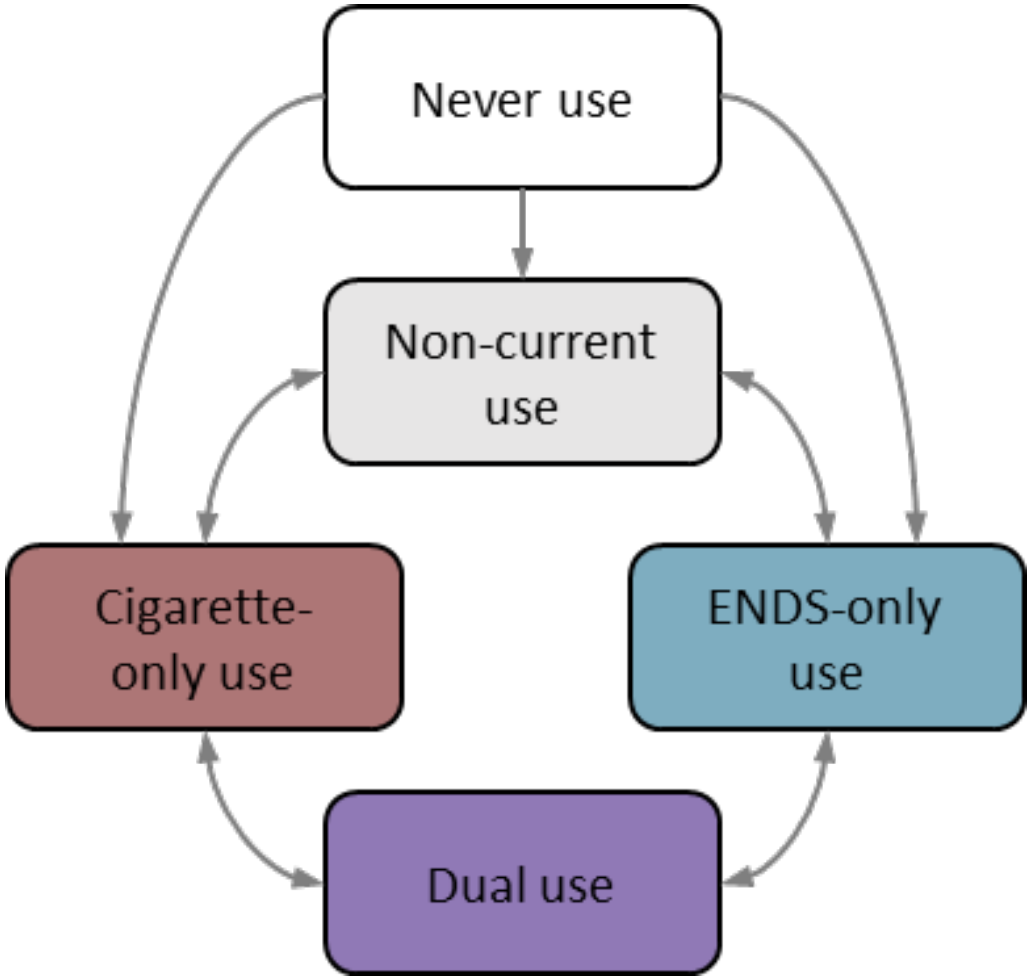
Transitions

Multistate transition models estimate underlying transition propensities (rates, hazards) assuming that a person's tobacco-use state over time can be approximated by a continuous-time, stochastic model.



Brouwer et al. (2020). *Tobacco Control.*
Example code using PATH weights is available at *tcors.umich.edu*

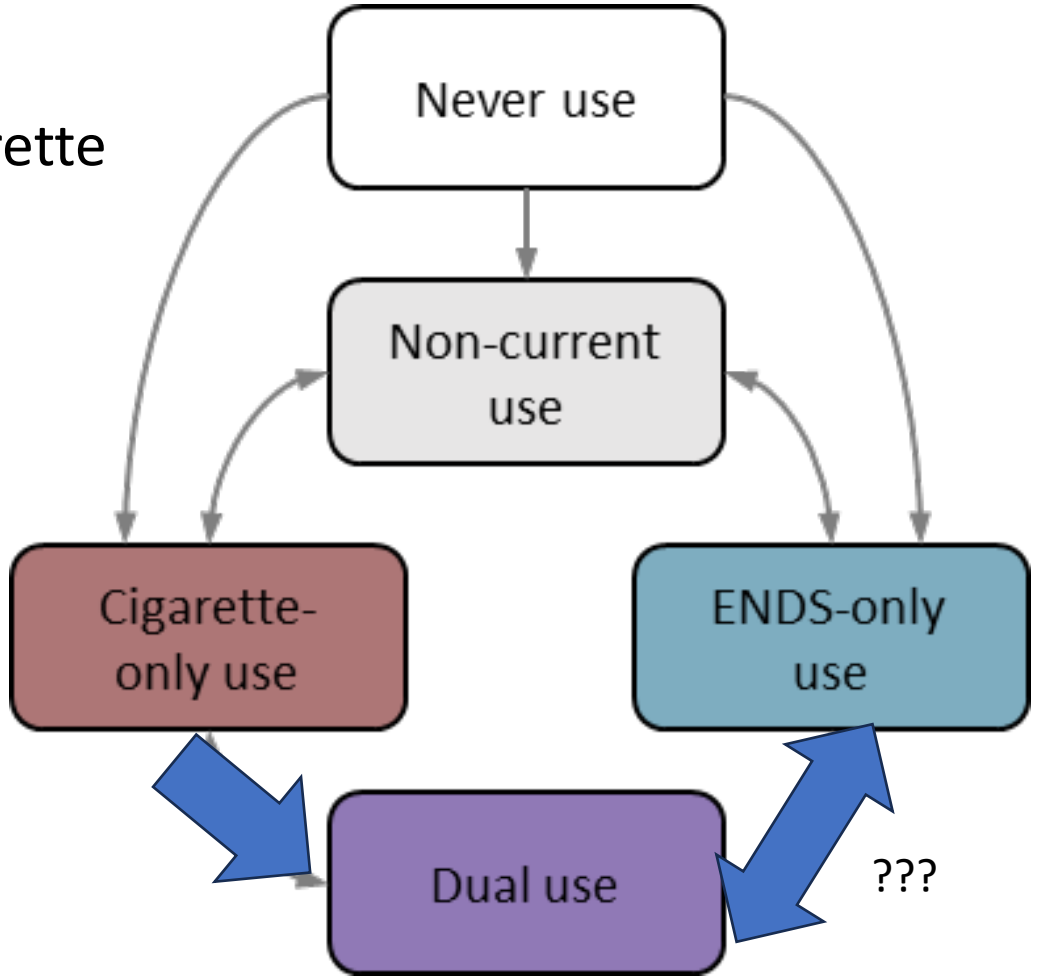
There are many competing transitions in product use that we need to account for.



ENDS = Electronic nicotine delivery system (e-cigarettes)

There are many competing transitions in product use that we need to account for.

A factor that facilitates e-cigarette initiation among those smoking cigarettes…



… could be a **facilitator** of cigarette cessation or it could be a **barrier** to cessation among those using both products

ENDS = Electronic nicotine delivery system (e-cigarettes)

Data

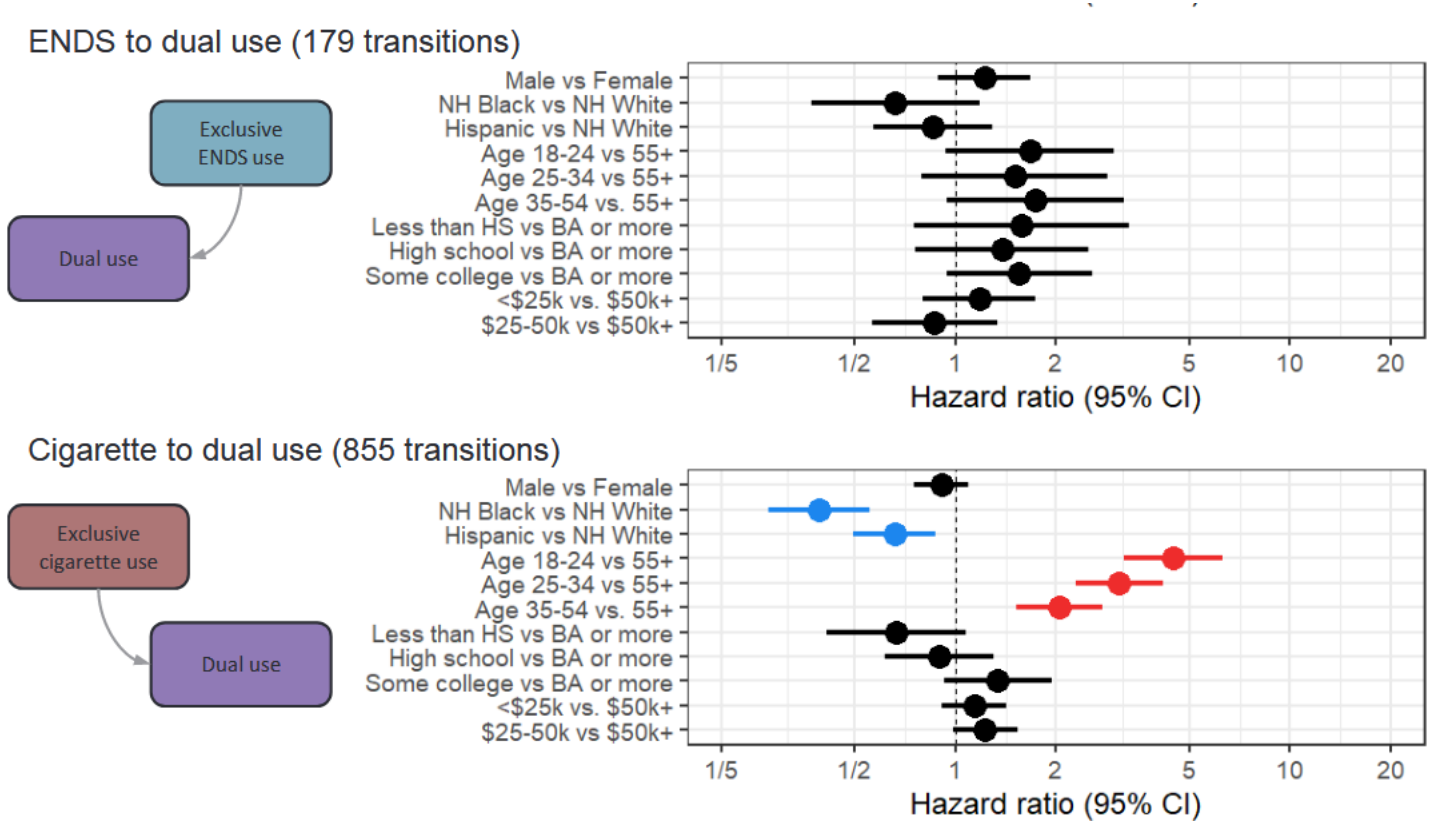
- Population Assessment of Tobacco and Health
  - 20-30k adults of any product use
  - 1–2-year follow-up
  - Nationally representative

- Exhale Longitudinal Cohort
  - 380 adult who smoked daily, with or without e-cigarettes
  - 2-month follow-up for 2 years

Sociodemographic predictors of transitions to and from dual use (PATH 2013-17)

Associations with transitions from cigarette-only to dual use

- Non-Hispanic White race & ethnicity
- Younger ages

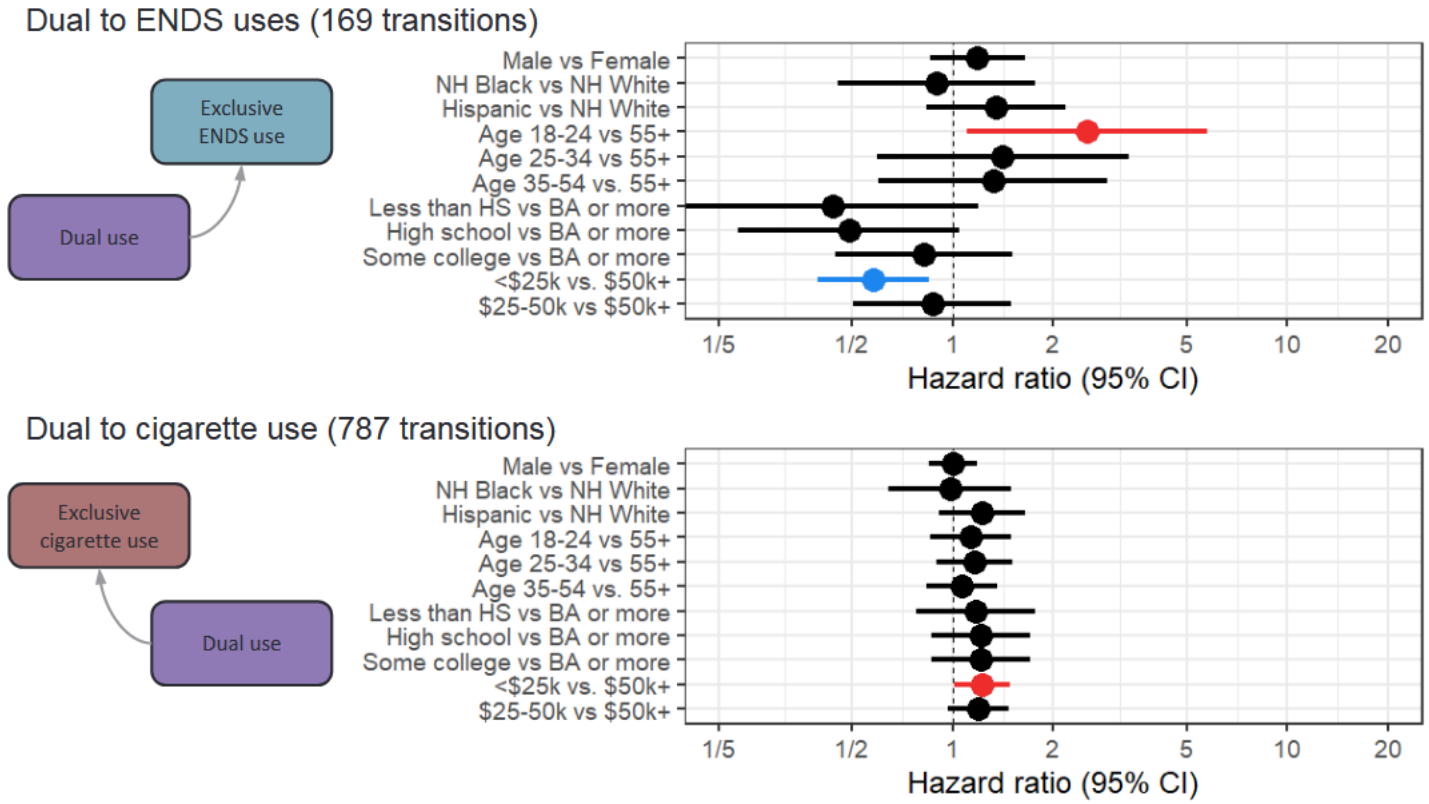


Brouwer et al. (2020). *Tobacco Control.* doi: 10.1136/tobaccocontrol-2020-055967

Sociodemographic predictors of transitions to and from dual use (PATH 2013-17)

Associations with transitions from dual use

- Younger ages more likely to transition from dual to e-cigarette only use
- Lower income more likely to transition from dual to cigarette only use



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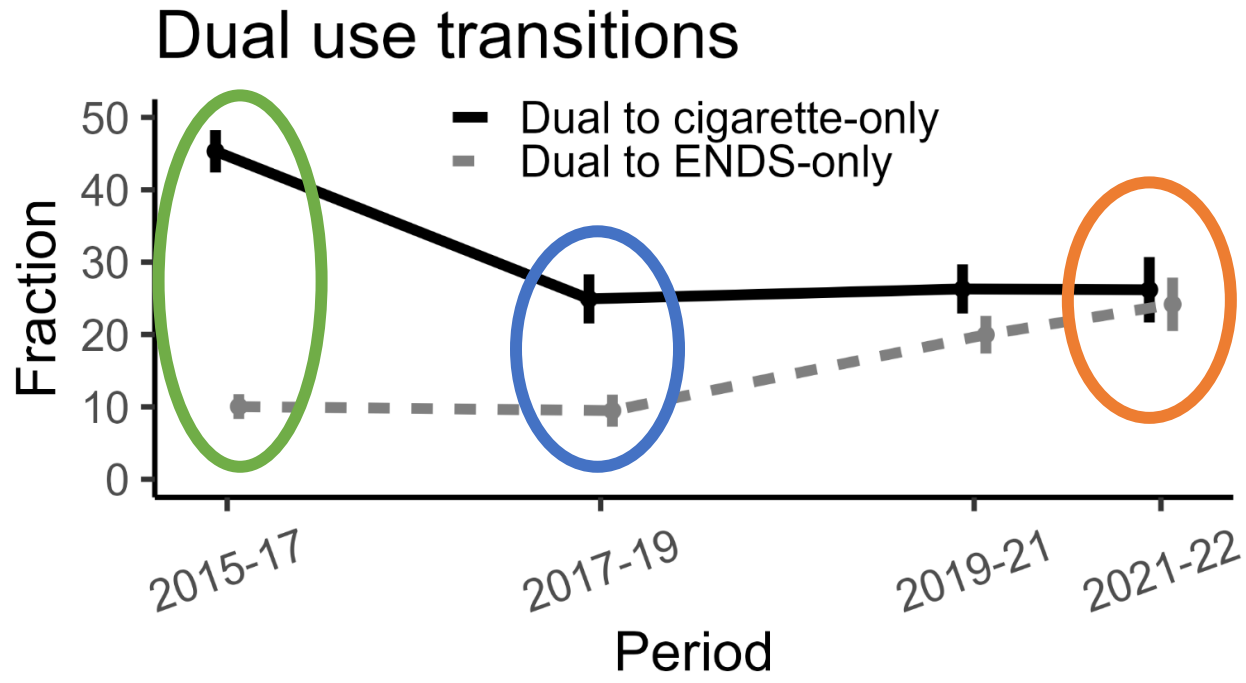
Trends in dual use transitions (PATH 2015-2022)



Only recently has the dual to e-cigarette transition caught up with the dual to cigarette transition.

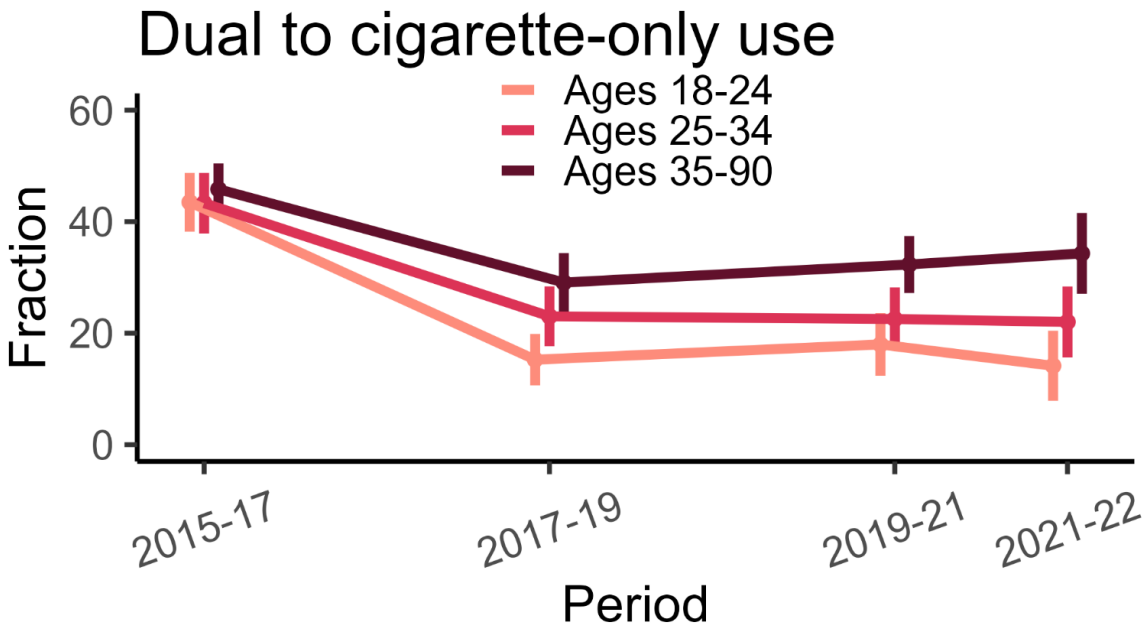
Initially, most dual use was experimental, with most people transitioning back to cigarettes

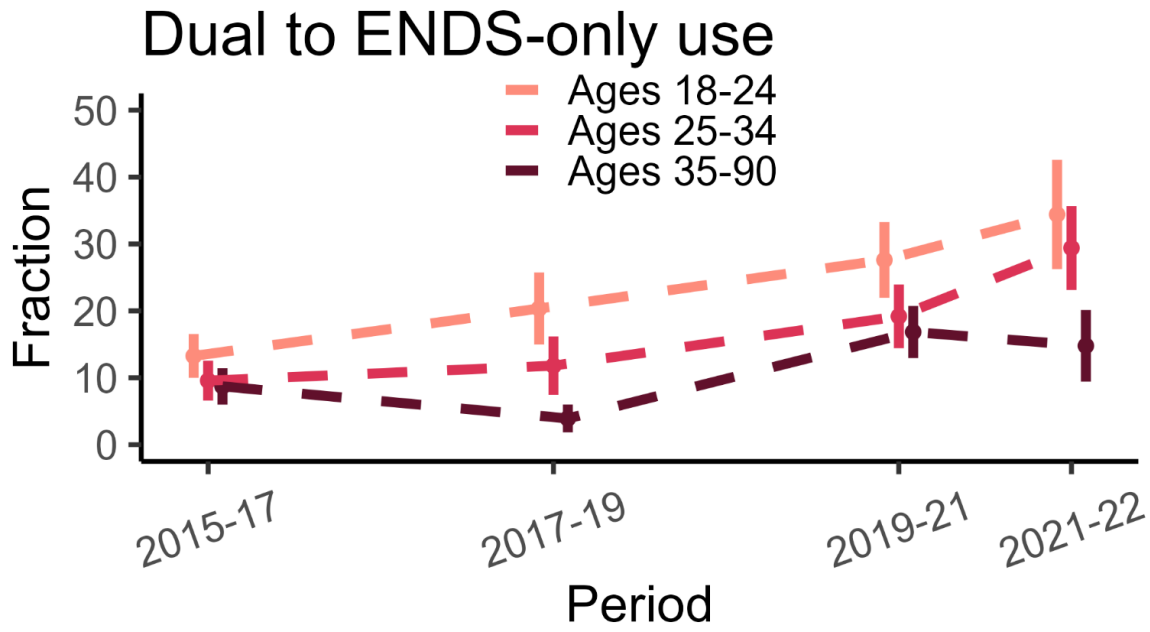
Increased persistence of dual use after 2018 (when nicotine salt use become more widespread)

Brouwer et al. *In prep.*

Trends in dual use transitions (PATH 2015-2022)

Trends in dual use transitions are driven by trends by **age**





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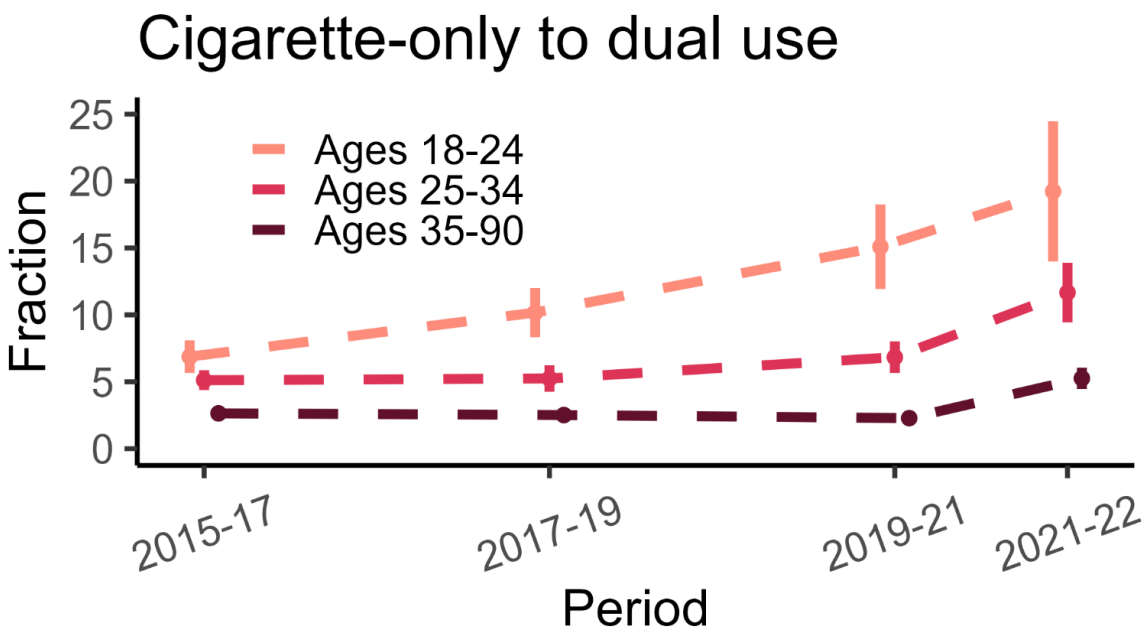

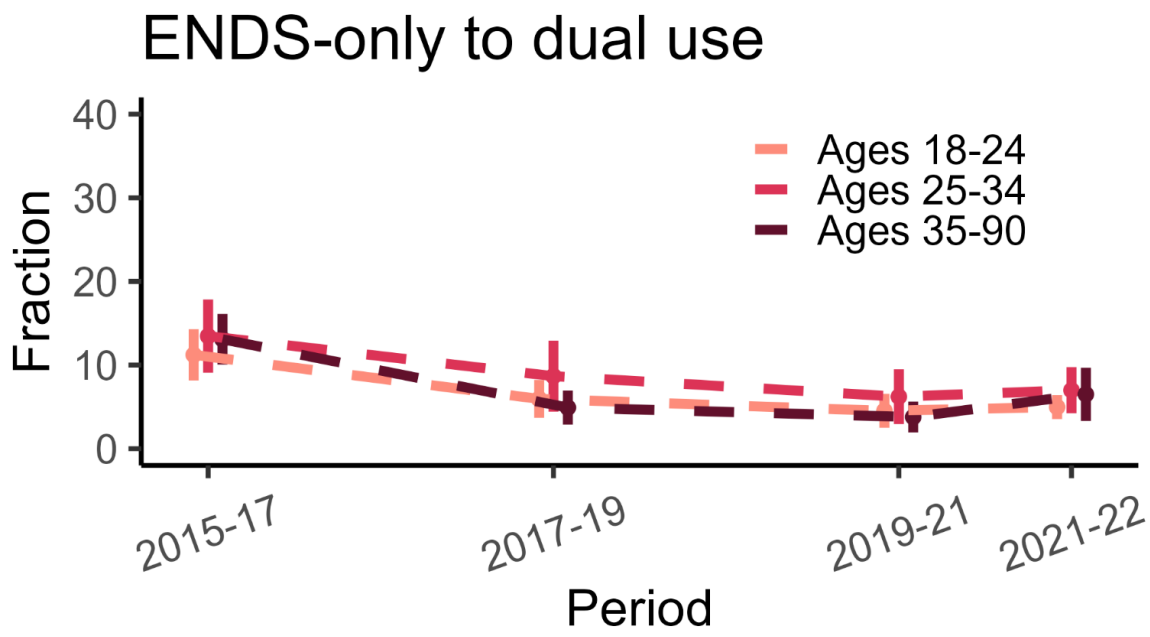

Brouwer et al. *In prep.*

Predictors of transitions: dual to e-cigarette-only vs dual to cigarette-only in the Exhale study (2015–19)

- Factors can differentially affect dual to cigarette-only and dual to e-cigarette-only use transitions
  - Many factors that reduce transitions back to cigarette-only use ALSO reduce cigarette cessation, thereby increasing persistence of dual use
- Taking *both* transitions into account, what are the strongest predictors of transitions from dual to cigarette-only vs. e-cigarette-only use?
  - To cigarette-only use:
    - 10+ cigarettes per day (vs <10)
    - High sensory/social/emotional dependence on cigarette (vs low)
  - To e-cigarette-only use
    - Low physiological dependence/compulsion for cigarette use (vs high)
    - Vaping every day (vs some days)
    - First product used in the morning is e-cigarette (≥50% of time vs <50% of the time)

Shafie-Khorassani et al. (2022). *Nicotine & Tob Res.*
doi: 10.1093/ntr/ntac207

Predictors of transitions: motivation to use e-cigarettes in the Exhale study (2015–19)

Do specific motivations to use e-cigarettes matter?

	E-cigarette to dual use (N=27)		Dual to cigarette-only use (N=259)		Dual to e-cigarette-only use (N=43)	
Motivation to use e-cigarettes	HR	95% CI	HR	95% CI	HR	95% CI
E-cigarettes might be less harmful to the people around me than regular cigarettes	**0.26**	**(0.10, 0.72)**	**0.27**	**(0.21, 0.35)**	0.80	(0.36, 1.77)
I am unable to stop using e-cigarettes	1.00	(0.47, 2.12)	**0.41**	**(0.30, 0.56)**	1.49	(0.84, 2.66)
They are affordable	1.06	(0.42, 2.66)	**0.35**	**(0.28, 0.45)**	1.00	(0.53, 1.87)
E-cigarettes are cheaper than smoking	0.71	(0.29, 1.69)	**0.37**	**(0.29, 0.47)**	0.97	(0.52, 1.80)
I can use e-cigarettes at times when or in places where smoking cigarettes isn't allowed	**0.32**	**(0.11, 0.94)**	**0.33**	**(0.26, 0.43)**	1.06	(0.47, 2.39)
To help with nicotine withdrawal symptoms when I can't smoke	0.62	(0.27, 1.42)	**0.31**	**(0.24, 0.39)**	0.73	(0.39, 1.37)
E-cigarettes come in flavors I like	1.04	(0.39, 2.76)	**0.45**	**(0.35, 0.57)**	1.65	(0.86, 3.15)
E-cigarettes might be less harmful to my health than regular cigarettes	**0.32**	**(0.11, 0.95)**	**0.27**	**(0.21, 0.35)**	0.84	(0.39, 1.84)
E-cigarettes may help me quit smoking cigarettes	0.45	(0.15, 1.32)	**0.32**	**(0.25, 0.41)**	0.97	(0.46, 2.05)
E-cigarette is less toxic than tobacco	**0.31**	**(0.10, 0.94)**	**0.32**	**(0.25, 0.41)**	0.93	(0.43, 2.02)
Using an e-cigarette feels like smoking a regular cigarette	0.89	(0.39, 2.04)	**0.48**	**(0.37, 0.61)**	1.43	(0.77, 2.63)
People in the media or other public figures use e-cigarettes	2.71	(0.65, 11.3)	1.09	(0.73, 1.63)	0.78	(0.22, 2.83)
To avoid bothering others with cigarette smoke	0.45	(0.15, 1.32)	**0.34**	**(0.27, 0.44)**	1.05	(0.49, 2.21)
To completely quit smoking regular cigarettes	0.44	(0.15, 1.30)	**0.35**	**(0.27, 0.44)**	1.34	(0.63, 2.84)
To cut down on the amount of cigarette smoking	0.45	(0.15, 1.33)	**0.27**	**(0.21, 0.35)**	0.98	(0.45, 2.17)
People who are important to me use an e-cigarette	0.84	(0.32, 2.21)	0.77	(0.54, 1.09)	0.77	(0.34, 1.74)
E-cigarettes don't smell	0.65	(0.22, 1.92)	**0.32**	**(0.25, 0.41)**	1.05	(0.50, 2.18)
To avoid having to go outside to smoke	0.44	(0.15, 1.31)	**0.39**	**(0.31, 0.50)**	1.27	(0.59, 2.75)
I like socializing while using an e-cigarette	1.59	(0.75, 3.36)	**0.70**	**(0.52, 0.93)**	1.53	(0.83, 2.80)
I prefer the taste of an e-cigarette	0.50	(0.17, 1.49)	**0.41**	**(0.32, 0.53)**	1.92	(0.92, 4.01)

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Yes, health-based motivations reduce cigarette smoking relapse among those using e-cigarettes only

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No, almost any motivation reduces transitions from dual to cigarette-only use

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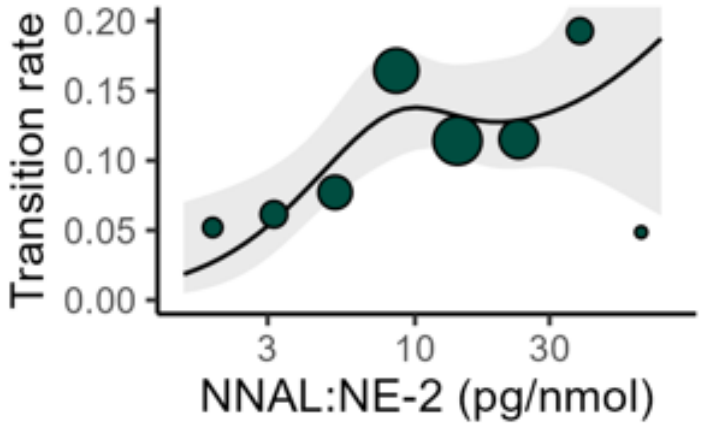
No, no motivation predicts cigarette cessation from dual use

Shafie-Khorassani et al. (2022). *Nicotine & Tob Res.* doi: 10.1093/ntr/ntac207

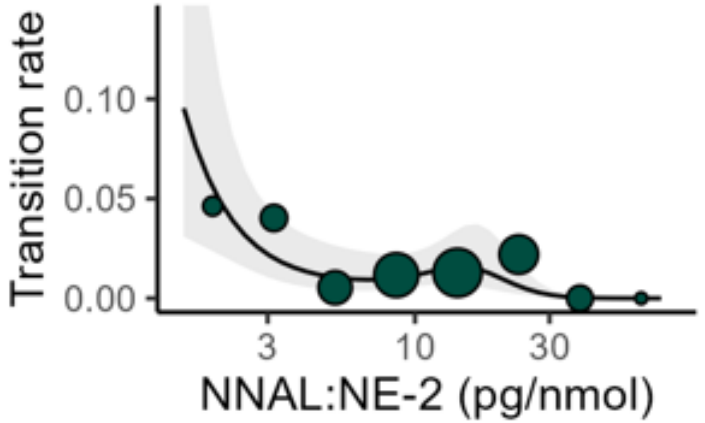
Biomarker predictors of dual use transitions in the Exhale study (2015–19)

- The ratio of NNAL (a tobacco smoke biomarker) to nicotine equivalents 2 (cotinine + hydroxycotinine) may be indicative how much of one's nicotine intake comes from cigarettes vs e-cigarettes
- Higher ratio: more likely to transition from dual to cigarette-only use
- Lower ratio: more likely to transition from dual to e-cigarette-only use

Dual to cigarette-only use



Dual to e-cigarette-only use



Brouwer et al. *Under review.*

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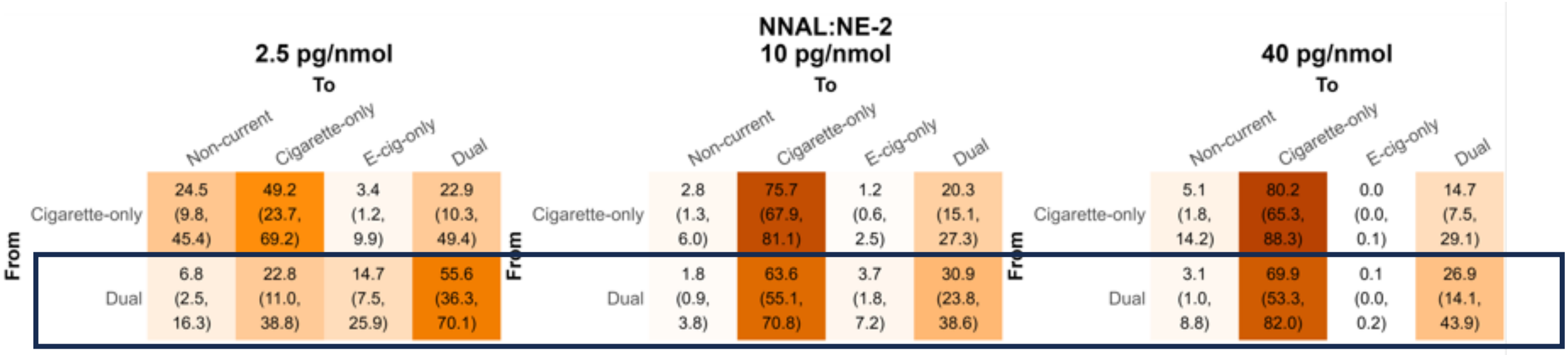


Low ratio: more nicotine from e-cigarette

- Higher persistence of dual use
- Reduced transitions to cigarette-only use
- Higher transitions to e-cigarette-only use

Higher ratio: more nicotine from cigarette

- Lower persistence of dual use
- High reversion to cigarette-only use
- Negligible transitions to e-cigarette-only use

Brouwer et al. *Under review.*

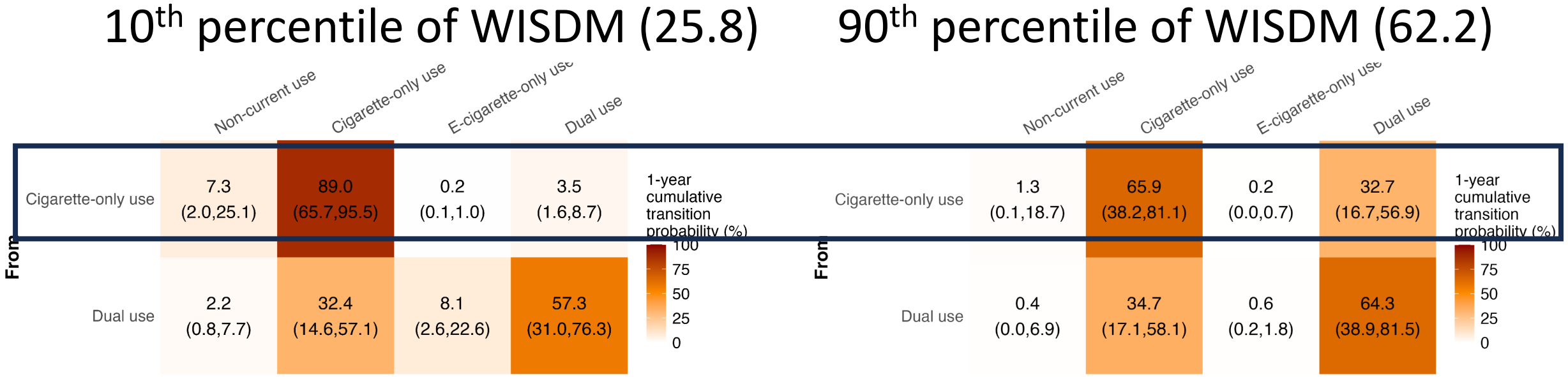
Nicotine dependence and predictors of dual use transitions in the Exhale study (2015–19)

The Wisconsin Inventory of Smoking Dependence Motives (WISDM) and it's e-cigarette equivalent (e-WISDM) measure dependence across multiple motivational domains

- Primary motives (physical dependence, compulsion to use)
- Secondary motives (sensory, social, and emotional dependence)

Nicotine dependence and predictors of dual use transitions in the Exhale study (2015–19)

Participants with lower dependence on their cigarette (lower WISDM scores) were less likely to transition from cigarette-only use to dual use.

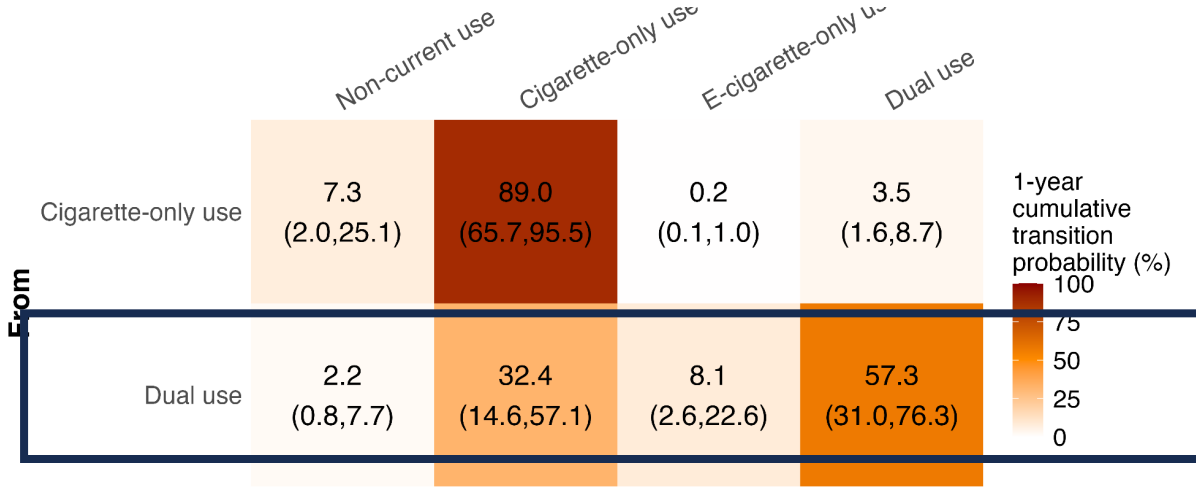


Shi et al. *In preparation.*

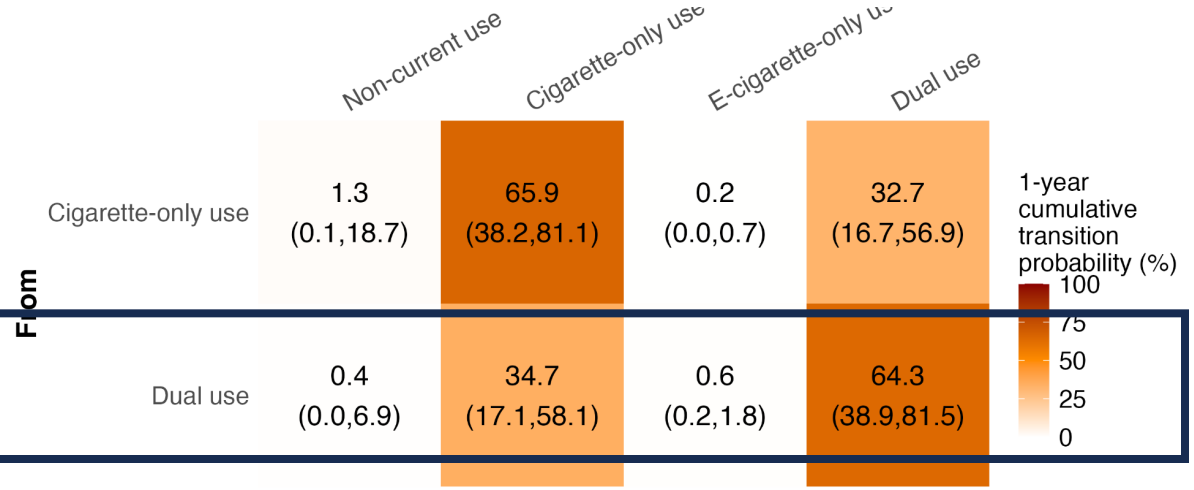
Nicotine dependence and predictors of dual use transitions in the Exhale study (2015–19)

Cigarette dependence (WISDM) was largely not predictive of transitions for participants using both cigarettes and e-cigarettes, although transitions to e-cigarette-only use decreased substantially for high dependence scores.

10th percentile of WISDM (25.8)



90th percentile of WISDM (62.2)

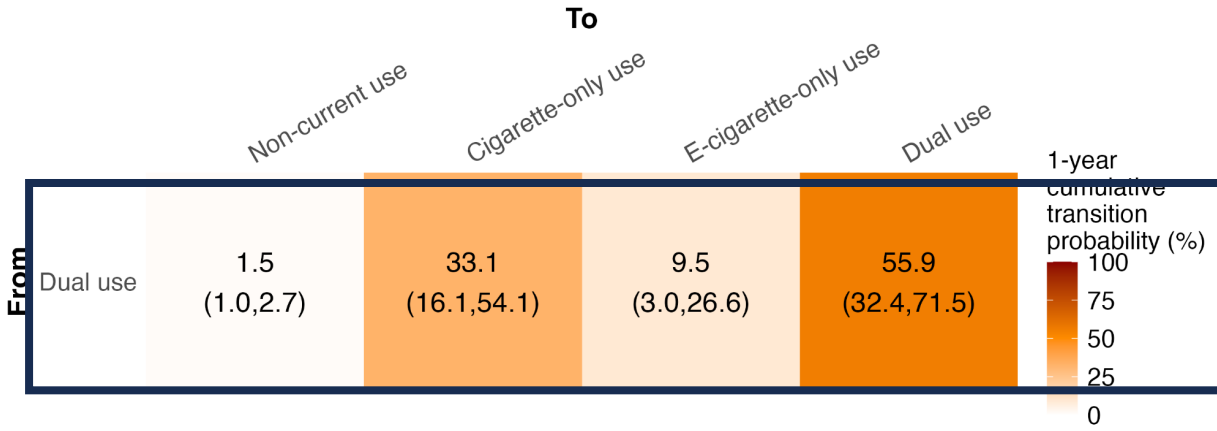


Shi et al. *In preparation.*

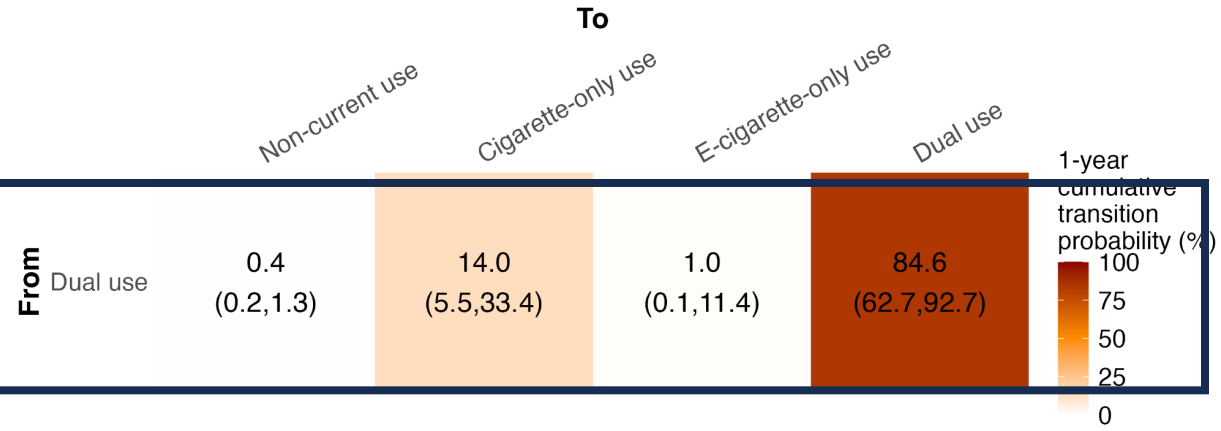
Nicotine dependence and predictors of dual use transitions in the Exhale study (2015–19)

Dependence on e-cigarettes (e-WISDM) was only associated with transitions from dual use at the highest levels of dependence, with high dependence associated with dual use persistence

10th percentile of e-WISDM (15.3)



90th percentile of e-WISDM (50.6)



Shi et al. *In preparation.*

Take-aways

- Persistence of dual use is changing with the marketplace. Trends in dual use transitions are largely driven by trends for young adults.
- **Factors that discourage transitions from dual use back to cigarette-only use also tend to encourage dual use persistence rather than smoking cessation.**
- **Relative product use is emerging as an important predictor of transitions from dual use.**
- Limitation: e-cigarette products are quickly changing, and many these studies were prior to the widespread adoption of nicotine salt e-cigarettes

Broader implications and questions

Dual use paradox. Those successfully transitioning from dual to e-cigarette use tend to use their e-cigarette more than cigarettes, but higher dependence on the e-cigarette is also associated with higher persistence of dual use. Is it possible to thread the needle?

Personalized approaches. Can we leverage behavior, biomarker, and product-specific dependence to develop personalized cigarette cessation approaches?

Changes in the marketplace. The introduction of nicotine salt e-cigarettes appears to have affected transition patterns. How will other marketplace changes affect transitions in the future?

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Questions?