Electronic Nicotine Delivery Systems (ENDS) use during a six-year period is not associated with self-reported chronic obstructive pulmonary disease (COPD) after proper adjustment of cigarette smoking history: A longitudinal analysis of PATH data

Rafael Meza, Steven Cook, Jihyoun Jeon, David T. Levy, Jana Hirschtick, Nancy L. Fleischer

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The Public Health Burden of COPD

- noxious particles or gases³

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 Chronic Obstructive Pulmonary Disease (COPD) is a chronic and progressive disease encompassing emphysema and chronic bronchitis¹

 COPD is characterized by restrictive airflow to the lungs and an abnormal inflammatory response,² usually caused by exposure to

• COPD is the fourth leading cause of mortality in the US⁴

 COPD is projected to be responsible for 9.4 million COPD-attributable deaths and more than \$800 billion in direct medical costs by 2038⁵





Cigarette Smoking and COPD

- diagnosed with COPD^{2,6}
- COPD risk⁹

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 Cigarette smoking is the primary risk factor for COPD,^{3,6} and the risk of COPD is 200% higher among people who currently smoke than people who never smoked cigarettes⁷

• Years of chronic smoking are needed to develop COPD,⁸ and more than 20% of people who ever smoked are expected to be

 In addition to smoking status, <u>smoking duration</u> and <u>smoking</u> intensity are both important covariates in models predicting







$COPD^{10}$

- - <u>COPD</u> diagnosis

 - smoked cigarettes¹⁸⁻¹⁹

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ENDS use and COPD

• There is concern that ENDS product use may increase the risk of

Some cross-sectional studies have examined the ENDS-COPD association,¹¹⁻¹⁴ but these studies carry the risk of reverse causation:

1. Can't determine if ENDS use occurred before or after the

2. People who smoked cigarettes might have switched to ENDS after experiencing negative health effects¹⁵⁻¹⁷ 3. Most adult ENDS users either currently smoke or formerly





- with reverse causation

 - published studies have not done

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Study Objective

 Examine the prospective association between ENDS use and selfreported incident COPD among adults aged 40+ in the US

Address some of the limitations in previous research by: Examining the incidence of COPD prospectively, limiting concerns

2. Including ENDS use as a time-varying measure that was lagged one wave (t-1) to ensure that ENDS use preceded the COPD outcome 3. Controlling for the potential confounding effect of time-varying smoking status and baseline cigarette-pack-years, which previous





Data: W1-W5 of the Population Assessment of Tobacco and Health Study (PATH), a nationally representative longitudinal study of the US civilian population

Analytic Sample: Adult respondents aged 40+ at baseline (Wave 1) who reported no history of COPD at baseline and participated in at least one follow-up interview

- censored

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Methods

Each of the 9,861 individuals (N) contributed a separate row of data for each discrete-time interval (T), until they reported COPD or were right

Person-period data set, based on N x T, had 33,679 observations



Dependent variable: self-reported COPD

We examined the incidence of self-reported COPD at each follow-up wave based on the following question: "In the past 12 months, has a doctor, nurse, or other health professional told you that you had...(1) COPD, (2) chronic bronchitis, (3) emphysema?"

Consistent with the clinical definition of COPD, respondents who reported having any of these conditions were considered to have COPD

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Methods







 Every day or someday use of ENDS products among established users (ever fairly regular use of ENDS)

Sociodemographic covariates:

- Sex
- Race/ethnicity
- Household income
- Education

Baseline COPD risk factors:

• Obesity (BMI >30) and asthma

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Methods

• Time-varying smoking status (t-1): • Based on established use (100 cigarettes in life) & every day / some day use

- measure
- Never, former, current use

• Baseline cigarette pack-years (CPY): Duration X intensity

- smoke, SHS, (t-1):

Time-varying exposure to second hand-

• Past 7-day 'close exposure' to secondhand smoke (range 0-100 hours)





- Discrete-time hazard models were estimated using a complimentary log-log link function
- All analyses used W1 weights, including full-sample and 100 replicate weights
 - Variances were computed using the balanced repeated replication method with Fay's adjustment set to 0.3
 - Sensitivity analyses were conducted using the 'all waves weights'

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Statistical Analysis

Multivariable discrete time survival models



- 53% female
- 11.4% Hispanic; 11.2% Non-Hispanic Black
- 1.4 % ENDS user
- 8.7% with previous asthma diagnosis

• 33.5% with BMI >= 30

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13.8 % current cigarette use; 23.2% former use; 63% never use





Life table describing incidence of self-reported COPD, PATH Adults 40+ W2-W5

		COPD			
Interval	Total	Diagnosis	Censored	Survival Est	
Period 1 (W1-W2)	9861	314	646	0.968	
Period 2 (W2-W3)	8901	252	719	0.941	
Period 3 (W3-W4)	7930	158	785	0.922	
Period 4 (W4-W5)	6987	201	6785	0.896	
	Risk set N=33,789	Incident cases n=925			

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Average annualized incidence 0.020 (weighted)



Main Findings – Incremental Models

ENDS use - adding adjustment for sociodemographics

ENDS use - adding adjustment for smoking status

ENDS use - adding adjustment for cigarette pack-years

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Hazard Ratios Predicting Incident COPD





Time-varying ENDS use

Time-varying <u>cigarette</u> smoking status

Never cigarette use

Former cigarette use

Current cigarette use

Log cigarette pack-year **Time-varying second-ha** smoke exposure^b

a – baseline; per 10 pack-year increase

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b - per 10-hour increase of exposure in the past 7 days

	Hazard	
	1.1	
	REF	
	0.85	
	1.64**	
'S ^a	1.79***	
and	1.09***	

Final Model – ENDS and cigarette use variables



95% CI

.78-1.57

REF

.59-1.23

1.17-2.29

1.46-2.19

1.04-1.14





- - Increasing age
 - Female sex
 - Non-Hispanic Black race

 - Prior asthma diagnosis
 - BMI >= 30

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Final Model - Other Covariates

COPD self-reported incidence associated with:

Less than high school or some college education level







ENDS use prevalence by smoking status among analytic sample by Wave



- smoking among sample adults who use ENDS

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More than 90% of sample adults who use ENDS currently or formerly smoked

Decreasing proportion of never & current smoking and increasing proportion of former





Cigarette pack-years and secondhand smoke exposure in analytic sample by Wave



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Higher baseline mean cigarette smoking pack-years in sample adults who use ENDS

Higher exposure to second-hand smoke in sample adults who use ENDS





- Longitudinal study of COPD incidence in a nationally representative survey
- ENDS use was not associated with incident COPD risk after adjusting for smoking status and cigarette pack-years
- Cigarette smoking status, pack-years, second-hand smoke were all associated with COPD risk
- More than 90% of those in the analytic sample reporting ENDS use also reported current or former cigarette use
- The average pack-years (baseline) and second-hand smoke exposure was significantly higher in those reporting ENDS use

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Discussion





Some caveats and limitations:

- 2. to evolve
- 4. Self-reported data

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1. Results were based on approximately 5-years of data. Longer follow-up may be required to understand the role of ENDS use on incident COPD risk

Longer term longitudinal studies are needed, especially as ENDS products continue

3. ENDS use was only reported by a relatively small number of respondents



Collaborators

- Douglas A. Arenberg, MD
- Geoffrey D. Barnes, MD, MSc
- Luz Maria Sanchez-Romero, PhD

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