




The Association of Electronic Cigarette Use With SARS-CoV-2 Infection and COVID-19 Disease Severity

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ABSTRACT

BACKGROUND: Although combustible cigarette use is an established risk factor for severe COVID-19 disease, there is conflicting evidence for the association of electronic cigarette use with SARS-CoV-2 infection and COVID-19 disease severity.

METHODS: Study participants were from the Kaiser Permanente Research Bank (KPRB), a biorepository that includes adult Kaiser Permanente members from across the United States. Starting in April 2020, electronic surveys were sent to KPRB members to assess the impact of the COVID-19 pandemic. These surveys collected information on self-report of SARS-CoV-2 infection and COVID-related risk factors, including electronic cigarette and combustible cigarette smoking history. We also used electronic health records data to assess COVID-19 diagnoses, positive PCR lab tests, hospitalizations, and death. We used multivariable Cox proportional hazards regression to calculate adjusted hazard ratios (HRs) and 95% confidence intervals (CIs) comparing the risk of SARS-CoV-2 infection between individuals by e-cigarette use categories (never, former, and current). Among those with SARS-CoV-2 infection, we used multivariable logistic regression to estimate adjusted odds ratios (ORs) and 95% CIs comparing the odds of hospitalization or death within 30 days of infection between individuals by e-cigarette use categories.

RESULTS: There were 126,475 individuals who responded to the survey and completed questions on e-cigarette and combustible cigarette use (48% response rate). Among survey respondents, 819 (1%) currently used e-cigarettes, 3,691 (3%) formerly used e-cigarettes, and 121,965 (96%) had never used e-cigarettes. After adjustment for demographic, behavioral, and clinical factors, there was no association with SARS-CoV-2 infection and former e-cigarette use (hazard ratio (HR) = 0.99; CI: 0.83–1.18) or current e-cigarette use (HR = 1.08; CI: 0.76–1.52). Among those with SARS-CoV-2 infection, there was no association with hospitalization or death within 30 days of infection and former e-cigarette use (odds ratio (OR) = 1.19; CI: 0.59–2.43) or current e-cigarette use (OR = 1.02; CI: 0.22–4.74).

CONCLUSIONS: Our results suggest that e-cigarette use is not associated with an increased risk of SARS-CoV-2 infection or severe COVID-19 illness.

KEYWORDS: vaping, electronic cigarettes, COVID-19, infection, hospitalization

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Introduction

The US Centers for Disease Control and Prevention (CDC) includes current and former smoking of combustible cigarettes on the list of “underlying conditions” that increase risk for severe COVID-19 disease.¹ This is supported by a meta-analysis of 40 studies that concluded the risk of severe COVID-19 disease and death was more than double among current combustible cigarette smokers.² Despite evidence linking combustible cigarette use to poor COVID-19 outcomes, the association between electronic cigarettes (e-cigarette) and COVID-19 is unclear and in need of further investigation.³ One study among youth aged 13–24 years

old reported an increased risk of a self-reported COVID-19 diagnosis associated with having ever used e-cigarettes but no association with current e-cigarette use.⁴ Another study used an ecological study design to demonstrate an association between increased state-wide e-cigarette use prevalence and increased numbers of COVID-19 cases and deaths.⁵ However, two other studies in multi-aged cohorts that used survey data to collect self-reported COVID-19 diagnoses or electronic health records to assess COVID-19 diagnoses reported no association of e-cigarette use with SARS-CoV-2 infection.^{6,7} The objective of this study was to determine the risk of SARS-CoV-2 infection



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and severe COVID-19 disease associated with e-cigarette use in a large cohort in the United States.

Methods

Study participants were from the Kaiser Permanente Research Bank (KPRB), a biorepository that includes adult Kaiser Permanente (KP) members from across the United States (<https://researchbank.kaiserpermanente.org/>). All KPRB participants provided written informed consent for survey completion, electronic health record (EHR) access, and biospecimen collection. This study was reviewed and approved by the Institutional Review Board (IRB) at KP Mid-Atlantic States, the IRB of record for the KPRB.

Starting in April 2020, electronic surveys aimed at assessing the impact of the COVID-19 pandemic were sent to all KPRB members who were enrolled in a KP health plan on April 1, 2020; this included approximately 270,000 KPRB members. The initial COVID-19 pandemic survey collected information on SARS-CoV-2 infection and potential COVID-related risk factors, including e-cigarette and combustible cigarette smoking history. The survey included standardized instruments based on Behavioral Risk Factors Surveillance Surveys to assess nicotine use, including type and recency of use.⁸ Among those who completed the initial COVID-19 pandemic survey, up to 11 follow-up surveys were sent via email from May 2020 through January 2021. SARS-CoV-2 infections were identified using (1) self-report of a positive COVID-19 test on a follow-up survey; (2) COVID-19 diagnosis codes (U07.1) from EHR data; and/or

estimate odds ratios (ORs) and 95% CIs comparing the 30-day odds of hospitalization or death between individuals by e-cigarette use categories. All models were adjusted for age, sex, race, ethnicity, KP region, combustible cigarette use (pack-years), marijuana use (never, former, and current), body mass index, and Charlson comorbidity score. Statistical analyses were conducted using SAS 9.4 (SAS Institute, Inc., Cary, North Carolina).

Results

Survey response rate was about 48%, including 126,475 individuals with survey data on e-cigarette and combustible cigarette use who did not have known SARS-CoV-2 infection prior to survey completion. Among survey respondents, 819 (1%) currently used e-cigarettes, 3,691 (3%) formerly used e-cigarettes, and 121,965 (96%) had never used e-cigarettes. Those who currently or formerly used e-cigarettes tended to be younger and were more likely to have a history of combustible cigarette or marijuana use. During the study follow-up period, there were 3,219 new SARS-CoV-2 infections. After adjustment for demographic, behavioral, and clinical factors, there was no association with SARS-CoV-2 infection and former e-cigarette use (HR = 0.99; CI: 0.83–1.18) or current e-cigarette use (HR = 1.08; CI: 0.76–1.52) (Table 1). Among those with SARS-CoV-2 infection, there was no association with hospitalization or death within 30 days of infection and former e-cigarette use (odds ratio (OR) = 1.19; CI: 0.59–2.43) or current e-cigarette use (OR = 1.02; CI: 0.22–4.74) (Table 2).

Table 1. Hazard Ratios (HRs) and 95% CIs for SARS-CoV-2 Infection in Relation to E-Cigarette Use (N = 126 475).

	PERSON-DAYS OF FOLLOW-UP	N WITH SARS-COV-2 INFECTION	ADJUSTED HR (95% CI)
E-cigarette Never	31,466,093	3,049	Ref
E-cigarette Former	957,842	137	0.99 (0.83, 1.18)
E-cigarette Current	215,737	33	1.08 (0.76, 1.52)

^a Adjusted for age at COVID baseline survey, sex, race, ethnicity, region, combustible cigarette smoking pack-years, marijuana use, body mass index, and Charlson comorbidity score.

(3) COVID-19 positive PCR tests in the EHR. Among those with SARS-CoV-2 infection, we used EHR data to identify those with hospitalization or death within 30 days of infection.

We used Cox proportional hazards regression to calculate hazard ratios (HRs) and 95% confidence intervals (CIs) comparing the risk of SARS-CoV-2 infection between individuals by e-cigarette use categories (never, former, and current). Cohort members without SARS-CoV-2 infection prior to initial COVID survey completion were followed for infection from the time of initial COVID survey completion through November 30, 2020 or March 31, 2021, depending on EHR data availability. Members were censored at the date of disenrollment from the health plan, death, or study follow-up completion. Among those with SARS-CoV-2 infection, we used logistic regression to

Table 2. Odds Ratios and 95% CIs for Hospitalization or Death Within 30 Days of Infection in Relation to E-Cigarette Use Among Those With SARS-CoV-2 Infection (N = 3,219).

	HOSPITALIZATION OR DEATH WITHIN 30 DAYS OF SARS-COV-2 INFECTION	
	N (%)	OR (95% CI)
E-cigarette Never	295 (9.7%)	Ref
E-cigarette Former	11 (8.0%)	1.19 (0.59, 2.43)
E-cigarette Current	2 (6.1%)	1.02 (0.22, 4.74)

^a Adjusted for age at COVID baseline survey, sex, race, ethnicity, region, combustible cigarette smoking pack-years, marijuana use, body mass index, and Charlson comorbidity score.


Discussion

Our results suggest that e-cigarette use is not associated with an increased risk of SARS-CoV-2 infection or severe COVID-19 illness. These results are consistent with reports from prior studies that use survey and/or EHR data to assess e-cigarette use and SARS-CoV-2 infection in multi-aged cohorts.^{6,7} E-cigarette use has been linked to increased risk of bacterial lung infection,⁹ pulmonary toxicity, and other harms,¹⁰ but our results do not support the inclusion of e-cigarettes in CDC's list of "underlying conditions" for increased severe COVID-19 illness. Thus, given the limited supply of effective medications to mitigate risk of severe COVID-19 disease in those infected with SARS-CoV-2, electronic cigarette use alone should not be considered an indication for anti-viral therapy or monoclonal antibody use.

This is one of the largest studies to date to examine the association between e-cigarette use and COVID-19 outcomes and included a well-characterized cohort with ascertainment of SARS-CoV-2 infection and COVID-19 disease severity from multiple sources, including electronic health records. Despite these strengths, our results should be interpreted considering several limitations. First, e-cigarette use was based on self-report and may be under-reported due to stigma associated with nicotine use. Also, the study cohort included an insured population and is not representative of uninsured populations in the United States. Finally, we were unable to assess severity of COVID-19 illness in those with dual e-cigarette and combustible cigarette use due to limited numbers of hospitalizations and deaths in this subgroup.

Additional research on COVID disease severity is needed in those with dual e-cigarette and combustible cigarette use.

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REFERENCES

1. Centers for Disease Control and Prevention. People with certain medical conditions. 2022; <https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html>. Accessed January 15, 2022.
2. Umnuaipornlert A, Kanchanasurakit S, Lucero-Prisno DEI, Saokaew S. Smoking and risk of negative outcomes among COVID-19 patients: a systematic review and meta-analysis. *Tob Ind Dis*. 2021;19:09.
3. McAlinden KD, Eapen MS, Lu W, Chia C, Haug G, Sohal SS. COVID-19 and vaping: risk for increased susceptibility to SARS-CoV-2 infection? *Eur Respir J*. 2020;56(1):2001645.
4. Gaiha SM, Cheng J, Halpern-Felsher B. Association between youth smoking, electronic cigarette use, and COVID-19. *J Adolesc Health*. 2020;67(4):519-523.
5. Li D, Croft DP, Ossip DJ, Xie Z. The association between statewide vaping prevalence and COVID-19. *Prev Med Rep*. 2020;20:101254.
6. Jose T, Croghan IT, Hays JT, Schroeder DR, Warner DO. Electronic cigarette use is not associated with COVID-19 diagnosis. *J Prim Care Community Health*. 2021;12:21501327211024391.
7. Kale D, Herbec A, Perski O, Jackson SE, Brown J, Shahab L. Associations between vaping and Covid-19: cross-sectional findings from the HEBECO study. *Drug Alcohol Depend*. 2021;221:108590.
8. Centers of Disease Control and Prevention. Behavioral risk factor surveillance system—survey data & documentation, 2020. 2020. https://www.cdc.gov/brfss/data_documentation/index.htm. Accessed April 1, 2020.
9. Gilpin DF, McGown KA, Gallagher K, et al. Electronic cigarette vapour increases virulence and inflammatory potential of respiratory pathogens. *Respir Res*. 2019;20(1):267.
10. Winnicka L, Shenoy MA. EVALI and the pulmonary toxicity of electronic cigarettes: a review. *J Gen Intern Med*. 2020;35(7):2130-2135.