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COVID-19 Restrictions and Adolescent Cigarette and E-cigarette Use in California

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Introduction: Shelter-in-place orders altered facilitators and barriers to tobacco use (e.g., outlet closures, restricted social gatherings). This study examined whether the duration of time in shelter in place and compliance with different shelter-in-place orders influenced adolescent cigarette and E-cigarette use and how the use may differ by demographic characteristics.

Methods: Shelter-in-place policy data obtained from government websites were merged with cross-sectional 2020 survey data on adolescents in California. Treatment variables included the proportion of time in shelter in place and self-reported compliance with shelter-in-place orders (for essential businesses and retail spaces and social and outdoor contexts). Multilevel logit models for dichotomous past 6-month cigarette and E-cigarette use and multilevel negative binomial regression models for past 6-month frequency of use were used. Moderation analyses were conducted on demographic measures. The sample included 1,196 adolescents (mean age=15.8 years, age range=13−19 years, 49.2% female, 50.0% White). Analyses were conducted in 2022.

Results: No associations were found between the proportion of time in shelter in place and outcomes. Shelter-in-place compliance with essential business and retail space orders was associated with lower odds of using cigarettes and E-cigarettes in the past 6 months. Compliance with social and outdoor context-related orders were associated with lower odds of using E-cigarettes and fewer days using cigarettes and E-cigarettes. Being aged ≥18 years moderated the associations between essential business/retail space and social/outdoor context-related shelter-in-place compliance orders and past 6-month frequency of cigarette smoking.

Conclusions: Findings support tailored interventions for less compliant and older adolescents for future pandemic mitigation measures.

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tobacco use may contribute to the understanding of longer-term effects and unintended consequences of SIP policies.

Adolescent cigarette and E-cigarette use are highly prevalent, with 3.1% of U.S. middle and high-school–aged youth reporting cigarette use and 12.7% reporting E-cigarette use in 2020.\(^5\) Tobacco and nicotine use is also highly varied depending on demographic characteristics, with higher rates of past 30-day cigarette and E-cigarette use among adolescents who identified as male (5.4% cigarettes and 20.4% E-cigarettes), are non-Hispanic White (5.3% and 23.2%), and are in high school versus in middle school (4.6% and 19.6%).\(^6\) Health risks associated with smoking and vaping are well established. Both cigarette and E-cigarette use can damage the respiratory and immune system,\(^6\) increasing the risks and complications associated with COVID-19.\(^3,7\)–\(^9\)

COVID-19 and consequent restrictions, such as SIP orders, significantly impacted daily activity and life in the U.S.,\(^1,2\) causing rapid changes to adolescents’ social and physical environments. These drastic environmental changes may have altered how adolescents accessed tobacco products, which types of products they used, where and with whom they used them, and their motivations for use (e.g., coping with stress).\(^1,2\) For example, most adolescents reported that they accessed cigarettes and E-cigarettes from friends and tobacco outlets before the COVID-19 pandemic, whereas during and after, they purchased these products online.\(^3,9\) Another study found E-cigarette outlets or vape shops to be noncompliant with essential business regulations and more likely to remain open and accessible early in the pandemic.\(^10\)

In addition, COVID-19 influenced adolescent social use and access to cigarettes and E-cigarettes.\(^1,12\) How, with whom, and in what spaces adolescents socialized changed during COVID-19 SIP, particularly in-person school closures, which may be associated with social isolation.\(^13\)–\(^15\) Other research has suggested that adolescents’ social landscapes included more remote, digital, and social media–based social interaction during the pandemic,\(^11,12\) which may have additional implications for social access to tobacco products during SIP. Changes in adolescents’ access to tobacco products may have influenced adolescents’ tobacco use behavior, including which products were used and how often.

This research is framed by the Social Cognitive Theory, which postulates a multifaceted causal structure wherein beliefs, personal characteristics, and experiences operate conjointly with outcome expectations and environmental facilitators and barriers to produce an individual’s motivation and behavior.\(^16\)–\(^18\) On the basis of recent findings from the literature, SIP-related changes in adolescent environments (e.g., school closures, social restrictions, stay-at-home mandates) may have created competing influences on adolescents’ tobacco and nicotine use.\(^19\) Furthermore, the types of products used may be affected by changing environments, such that increases in E-cigarette use during the pandemic may be due to the need to conceal tobacco use around parents or caregivers.\(^3,7,20,21\) Finally, there is evidence suggesting that behavior under COVID-19 SIP orders and other restrictions may differ by demographic characteristics, with younger and female-identified adolescents being more compliant with safety precautions such as SIP, social distancing, masking, and handwashing.\(^22\)–\(^25\)

This study aimed to assess how the proportion of time in SIP orders and individual’s self-reported compliance with SIP, by orders impacting essential businesses and retail spaces and orders aimed at social and outdoor contexts, are associated with adolescent self-reported past 6-month cigarette or E-cigarette use (yes/no) and past 6-month frequency (number of days) of cigarette or E-cigarette use. In addition, this study assessed how these associations may differ for adolescents by age, gender, racial or ethnic identities, and SES. Given the limited research in this area, directional relationships are not predicted for time in SIP or SIP compliance and cigarette or E-cigarette use. Results may have implications for policy considerations with future COVID-19 variants or other viruses.

**METHODS**

Multilevel, cross-sectional analyses were conducted on the third, web-based follow-up survey from an existing longitudinal study on substance use among adolescents in California. The third follow-up survey was administered from April 1, 2020 through December 3, 2020 and was the first in the series to include COVID-19–related questions, which is why it was selected for analysis. The response rate for the third follow-up was 91.4% from baseline (n=1,229). The sample was recruited from commercially available listings of California households and through social media, with additional recruitment details referenced by Kaner et al.\(^26\) Parental and guardian consent and adolescents’ assent were obtained, and participant privacy was ensured throughout all data collection processes. The study was reviewed and approved by the IRB of the Pacific Institute for Research and Evaluation.

**Study Sample**

Overall, 1,229 adolescents participated in the third follow-up survey from 51 California counties, with 33 participants excluded on the basis of self-reported age for the survey not being accurate (e.g., the participant had aged negative years since baseline) and no other missing data, yielding a sample of 1,196 participants from 49 counties (Table 1). Of study participants, 50.6% identified as male (n=605), 50.0% identified as White (n=598), 29.18% identified as >1 race or other race (n=349), 7.78% identified as African American/Black (n=73), and 35.03% identified their ethnicity as Hispanic/Latino (n=419). The mean age was 15.82 years.
(SD=1.54, range=13–19 years). Of all study participants, 78.26% (n=936) reported subjective SES as about or above average. For cigarette use, 6.1% of participants (n=73) reported past 6-month use, with a mean number of days of use of 9.4 days (SD=32.7). For E-cigarette use, 19.8% of participants (n=237) reported past 6-month use, with a mean number of days using E-cigarettes of 23.8 days (SD=50.1).

Measures
Participants self-reported their gender, age, race, ethnicity, and subjective SES (Table 1). Participants who did not respond to a demographic characteristic question were coded as missing for that characteristic. Previous studies among young people have used measures of perceived or subjective SES. Studies have found that subjective SES is associated with health behaviors and health outcomes, rationalizing its use for this study.

Participants were asked, In the past 6 months, on how many days, if any, did you smoke cigarettes? (Number of days from 0 to 180/Refused), and the same question for use of an E-cigarette or vape device to get nicotine? E-cigarette or vape device was defined in a previous survey question as a JUUL, e-pen, vape pen, cigelike, e-hookah, personal vaporizer, or mod to get nicotine. A variable was generated to reflect dichotomous past 6-month use from the question mentioned earlier (Yes ≥1 day of E-cigarette use, No=0 days of use). Past 6-month frequency of cigarette and E-cigarette use was reported as a number (0–180 days).

SIP compliance was obtained by the following survey question: During the COVID-19 Shelter-in-Place order in your area, how often have (did you go out to a variety of contexts, e.g., grocery store, friend’s house). The full question and responses are found in Appendix Table 1 (available online). The possible responses were (1) Never (most compliant with SIP in original survey question), (2) Rarely, (3) Sometimes, (4) Often, and (5) Very often (least compliant with SIP in survey question). This SIP compliance variable was invented such that a higher SIP compliance score (5) indicates greater compliance with state and county SIP orders. Overall reliability was assessed (Cronbach’s α=0.86).

A factor analysis was conducted using principal component factor methods on the 10 SIP compliance items. Results indicated a pattern of factor loadings in which essential business and retail space-related SIP compliance survey items were loaded onto 1 factor (Items 1–4, listed in Appendix Table 1, available online) and social and outdoor context-related SIP compliance items loaded onto the second factor (Items 5–10 listed in Appendix Table 1, available online). Because this distinction in the factor loadings was conceptually supported, 2 SIP compliance measures were constructed taking the mean score for all items for the 2 types of compliance: (1) essential business and retail space (business/retail orders) and (2) social and outdoor contexts (social/outdoor orders). Reliability was assessed on business/retail SIP compliance (Cronbach’s α=0.75) and social/outdoor SIP compliance (Cronbach’s α=0.81).

County-level dates of the first SIP orders were obtained through California state and county government websites. SIP was characterized as the implementation date of a SIP order by county or the start of Governor Gavin Newsom’s order on March 19, 2020 and the county attestation for Phase 2 reopening, which denoted a formal end to SIP. Using these data, the proportion of days each participant spent in an SIP order in the past 6-month period was calculated from the date on which they completed their survey. This treatment variable was created to align with cigarette and E-cigarette use outcomes measured in the 6-month period.

### Table 1. Demographic Characteristics of Adolescents in the Analytic Sample

| Characteristics                  | All surveys, frequency (%) |
|----------------------------------|-----------------------------|
| Total surveys by completion date | 1,196 (100.0)               |
| Cigarettes                       |                             |
| Past 6-month use (yes)           | 73 (6.1)                    |
| E-cigarettes                     |                             |
| Past 6-month use (yes)           | 237 (19.8)                  |
| Cigarettes, mean (SD)/range      |                             |
| Past 6-month number of days used | 9.39 (32.69)/0–180 days     |
| E-cigarettes, mean (SD)/range    |                             |
| Past 6-month number of days used | 23.80 (50.11)/0–180 days    |
| Age (at survey response date), mean (SD)/range | 15.82 (1.54)/13–19 years |
| Sex                              |                             |
| Male                             | 605 (50.6)                  |
| Female                           | 589 (49.2)                  |
| Gender not reported              | 2 (0.2)                     |
| Race                             |                             |
| American Indian Alaska Native    | 20 (1.7)                    |
| Asian                            | 49 (4.1)                    |
| African American/Black           | 93 (7.8)                    |
| Native Hawaiian/Pacific Islander | 12 (1.0)                    |
| Ethnicity                        |                             |
| Non-Hispanic/Latino              | 755 (63.1)                  |
| Hispanic/Latino                  | 419 (35.0)                  |
| Ethnicity not reported           | 22 (1.8)                    |
| Subjective SES                   |                             |
| Well below average               | 12 (1.0)                    |
| Below average                    | 61 (5.1)                    |
| A little below average           | 180 (15.1)                  |
| About average                    | 493 (41.2)                  |
| A little above average           | 278 (23.2)                  |
| Above average                    | 125 (10.5)                  |
| Well above average               | 40 (3.3)                    |
| Subjective SES not reported      | 7 (0.6)                     |

Statistical Analysis
Adolescent survey data were merged with COVID-19 SIP order start and end dates to derive the proportion of time in SIP for participant’s past 6 months by county. Descriptive statistics were
included (Table 1). Mixed effects logit models were used to analyze the associations of the proportion of time in SIP orders and order compliance with past 6-month cigarette and E-cigarette use (yes/no). Results were reported as ORs for ease of interpretation. Multilevel negative binomial regression models were used to assess associations with past 6-month cigarette and E-cigarette consumption frequency with results reported as incident rate ratios (IRRs). Moderation analyses were used to assess whether race/ethnicity, gender, age, and subjective SES moderated the associations between the proportion of time in SIP orders and SIP order compliance with past 6-month use and consumption frequency of cigarettes and E-cigarettes. All models included control variables for race, ethnicity, gender, age, and subjective SES and took the nesting of individuals within counties into account. Analyses were conducted using Stata, Version 16.

RESULTS

For main effects models (Table 2), results indicate that no significant associations were found between the proportion of time in SIP orders and participant self-reported past 6-month use (yes/no) and past 6-month frequency (number of days) of cigarette or E-cigarette use. However, results also show that greater compliance with SIP orders was associated with lower odds of past 6-month cigarette and E-cigarette use and lower frequency of use. Specifically, for business/retail orders, with each 1-point increase in the 5-point Likert-type scale SIP compliance score (where 5 indicates greater compliance with orders), there were 43% lower odds that the participant would report past 6-month cigarette use (OR=0.57; p<0.05) and 22% lower odds that participants would report past 6-month E-cigarette use (OR=0.78; p<0.05). For social/outdoor orders, with each 1-point increase in the compliance score, there were 40% lower odds that the participant would report past 6-month cigarette use (OR=0.60; p<0.001). For past 6-month frequency of use outcomes, for each 1-point increase in the social/outdoor SIP compliance score, participants reported fewer days of cigarette use by 69% (IRR=0.31; p<0.01) and 43% fewer days using E-cigarettes (IRR=0.57; p<0.05) in the past 6 months. For moderation analyses (Appendix Table 2, available online), results suggest that being aged ≥18 years and more compliant was associated with a greater number of days cigarettes were used (business/retail orders: IRR=6.06; p<0.01; social/outdoor order compliance: IRR=10.02; p<0.01). In addition, being non-Hispanic White and more compliant with SIP orders was associated with a greater number of days cigarettes were used (business/retail orders: IRR=4.67; p<0.05).

DISCUSSION

Results did not indicate significant relationships between the proportion of time in a SIP order and adolescent past 6-month cigarette or E-cigarette use and past 6-month frequency of use. This finding is substantiated by a recent large-sample analysis assessing pre- and post-COVID-19 trends for adolescents who were either under SIP orders or not at a follow-up survey, finding no significant impact of being in SIP on cigarette and E-cigarette use outcomes.29 However, SIP order compliance and tobacco and nicotine use are less studied. Results show compliance with business/retail SIP orders to be significantly associated with lower odds of past 6-month cigarette and E-cigarette use among participants. Greater social/outdoor SIP order compliance was associated with lower odds of past 6-month E-cigarette use and fewer days of cigarette and E-cigarette use in the past 6 months. Results supported findings from a recent study among adolescents showing that less compliance with COVID-19 measures was associated with increased tobacco use.25

A multitude of factors may contribute to the mechanisms behind this study’s results suggesting that compliance with SIP orders influences adolescent tobacco and nicotine use more than the orders themselves. For one, compliance and COVID-19 precautions could suggest that increased attention to health risks from the pandemic also influenced adolescent tobacco and nicotine use by limiting opportunities to use with more time spent at home and indoors.3 Fewer social use opportunities and obtaining cigarettes and E-cigarettes from peers may also have contributed to lower odds of use when participants were more compliant with social/outdoor SIP orders.11,12 In addition, for adolescents who were more compliant with business/retail SIP orders, this may have diminished opportunities to purchase and procure tobacco and nicotine products.

Additional considerations include that other individual characteristics that were not available in these data may relate to SIP compliance. For example, participants who were more compliant with SIP orders may have also had greater concern for COVID-19–related health risks, especially considering that tobacco use is a known risk factor for respiratory conditions and more severe COVID-19–related outcomes.3,7–9 More generally, there may be an underlying unobserved characteristic and endogenous variable factoring into the relationship between SIP compliance and tobacco and nicotine use, which is overall health conscientiousness. The literature suggests that individual personality attributes, including increased health conscientiousness, are associated with less tobacco use in U.S. and Canadian adults30 and that childhood health conscientiousness is a predictor of lifetime smoking.31 Given that the results of this study did not yield significant associations between participant time in SIP orders but did find that greater SIP
| Variables                      | Proportion of past 6 months in SIP order | Compliance by context and place (scales 1−5, 5 is the most compliant) |
|-------------------------------|------------------------------------------|---------------------------------------------------------------|
|                               | Past 6-month use: yes/no                 | Past 6-month use: number of days                              |
|                               | Cigarettes, E-cigarettes, OR (95% CI)    | Cigarettes, E-cigarettes, IRR (95% CI)                        |
| Time in SIP: past 6 months    | 0.512 (0.06, 4.698)                      | 1.603 (0.0366, 70.22)                                        |
| Average compliance: essential | —                                        | 0.345 (0.926)                                                |
| Average compliance: social    | —                                        | 0.621 (0.988)                                                |
| and outdoor contexts         | —                                        | 0.504 (2.139)                                                |
| Non-Hispanic White            | 0.965 (0.568, 1.64)                      | 1.048 (0.651, 1.687)                                         |
| Age                           | 1.248** (1.09, 1.43)                     | 1.134 (0.936, 1.374)                                         |
| Gender                        | 1.642* (1.103, 2.44)                     | 1.752* (1.08, 2.84)                                          |
| Subjective SES                | 0.83 (1.445)                             | 1.069 (2.307)                                                |
| N                             | 1.187                                   | 1.075                                                       |

Note: Boldface indicates statistical significance (*p<0.05, **p<0.01, ***p<0.001). IRR, incidence rate ratio; SIP, shelter in place.
compliance was associated with lower odds of tobacco and nicotine use, this may highlight the role of individual characteristics in tobacco and nicotine use in the context of greater environmental influences.

Although the scope of this study was to explore and establish the associations between SIP and compliance with tobacco and nicotine use, another important consideration for future research is the role of adolescent mental health during SIP. One study found that adolescents’ compliance with SIP and social distancing orders, potentially increasing isolation, was related to symptoms of anxiety, depression, and feelings of burdensomeness. A cross-sectional study conducted with Canadian adolescents 3 weeks after SIP found that most adolescents using substances, including tobacco, did so in solitary settings (49%) and that depression and fear of COVID-19 predicted this solitary substance use. Future research is needed to establish the relationships between potentially protective factors (health conscientiousness and SIP compliance as a possible proxy for this individual attribute) and risk factors (depression, anxiety, isolation, and other mental health concerns during the pandemic).

Although majority of the findings showed that compliance with SIP was associated with lower odds of cigarette and E-cigarette use and fewer number of days of use, there were 2 notable exceptions found in the moderation analyses. Respondents who were aged ≥18 years and more compliant with essential business/retail space and social/outdoor context SIP orders reported a greater number of days where cigarettes were used in the past 6 months than participants aged <18 years. A potential explanation for this finding is that the group aged ≥18 years may have used tobacco longer and more frequently and potentially developed more reliance or dependence on use than those aged <18 year. Older adolescents may be less likely to live with and be monitored by parents or guardians and have greater independence, which may lead to increased tobacco and nicotine use opportunities. The young adults aged ≥18 years may also experience more stressors related to work, school, and other responsibilities contributing to increased tobacco use. In addition, being non-Hispanic and White and more compliant with business/retail SIP orders was associated with more days of cigarette use. This may reflect the relatively greater prevalence of cigarette use among non-Hispanic White middle and high-school students in a national sample (5.3% reporting past 30-day use) than among adolescents identifying as Hispanic (4.6%) or non-Hispanic and Black (2.8%).

**Limitations**

There are several limitations to note. Other tobacco-related policies, specifically the law about persons aged 21 year to purchase tobacco enacted in California in 2016 and tobacco product flavor ban restrictions, may have contributed to lower odds and fewer days of cigarette and E-cigarette use. Cigarette and E-cigarette use outcomes were of relatively low prevalence within the sample (6.1% cigarette use, 19.8% E-cigarette use in the past 6 months). Small sample sizes when conducting subgroup moderation analyses potentially limit the ability to detect significant relationships in the interaction models. In addition, measures of nicotine concentration in products and participant nicotine dependence were not included in the survey and are a limitation of the data. In addition, outcomes are self-reported and are thereby affected by social desirability bias; however, the survey data collection process ensured privacy from parents or others to limit this bias. However, additional future research should investigate the long-term impacts of the pandemic on adolescents’ tobacco and nicotine use behaviors.

**CONCLUSIONS**

Tailoring interventions to adolescents who may exhibit less compliance with SIP orders and who are possibly health conscientious generally may be advantageous in reaching more at-risk groups. In addition, targeting adolescents who are aged ≥18 years may also be beneficial. Such interventions may be warranted if future restrictive measures are reinstated in response to the COVID-19 pandemic or for future viruses.

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