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Short communication

Longitudinal associations between use and co-use of cigars and cigarettes: A pooled analysis of three adolescent cohorts

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ABSTRACT

Introduction: Patterns of adolescent tobacco product use are evolving rapidly and need examination. We assessed whether ever use of cigars (i.e., lifetime use) was related to an increased risk of subsequent cigarette initiation and dual use of cigars and cigarettes.

Methods: Leveraging data from three prospective cohort studies of adolescents (n = 6258), we assessed the odds of initiating cigarettes at one-year follow-up among ever cigar users at baseline, relative to never cigar users, after adjusting for demographics and e-cigarette use. We also assessed patterns of transition between exclusive use of cigars, exclusive use of cigarettes, and dual use of both cigars and cigarettes between baseline and follow-up and whether these associations differed by e-cigarette use.

Results: Among never cigarette smokers (n = 4876; 79.3% of the total sample), 3.4% reported ever cigar use by baseline. Ever cigar use by baseline was associated with higher likelihood of initiating cigarettes by follow-up (31.3%) relative to never cigar use at baseline (8.4%; adjusted odds ratio = 2.26, 95% confidence interval: 1.52, 3.35). Effect estimates were stronger if e-cigarette was used by baseline. Furthermore, exclusive ever cigar use by baseline was associated with a 2-4-fold increase in the odds of transition to exclusive cigar, exclusive cigarette, and dual use at follow-up relative to non-users of either product by baseline.

Conclusions: Comprehensive tobacco regulations and early prevention efforts focused on reducing youth appeal of cigars may be warranted, as cigar use may place youth at risk for subsequent cigarette use as well as dual use of cigars and cigarettes.

1. Introduction

The adolescent tobacco use landscape has changed rapidly in recent years. Cigarettes are no longer the most frequently used tobacco product among adolescents and use of other tobacco or nicotine products has become common (Gentzke et al., 2019). Currently, 7.6% of U.S. adolescents have used a cigar in the past 30 days, making it the third most commonly used product among adolescents, following e-cigarettes (20.8%) and cigarettes (8.1%) (Gentzke et al., 2019). Adolescents are now likely to be introduced to nicotine through non-cigarette products. While there is substantial evidence that youth who use e-cigarettes are at high risk for subsequently initiating cigarette smoking (Soneji et al., 2017), whether use of cigars or cigarillos (hereafter referred to as "cigars") is also associated with increased odds of future cigarette initiation is unknown.

A relative lack of regulation surrounding cigars has resulted in multiple unique features that may make these products particularly attractive to youth and potential entry points into combustible tobacco use prior to cigarettes. Although the Family Smoking Prevention and Tobacco Control Act banned flavors (except menthol) from cigarettes in 2009, flavors that appeal to youth remain permissible in cigars sold in the U.S. (FDA, 2017). Flavors make tobacco products easier to initiate, as they can mask the product's natural harshness (Delnevo et al., 2015). Indeed, adolescent cigar users cite the availability of appealing flavors as a top reason for cigar initiation (Kong et al., 2017a). Additionally, adolescents are attracted to cigars because of their low prices (Kong

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et al., 2017a, b). A comparably sized package of cigars costs much less than a package of cigarettes; in 2013, the price of a pack of 20 little cigars was as low as $0.88 (Campaign for Tobacco-Free Kids, 2013). Moreover, cigars can be sold in packages of one or two, further reducing an already low price point. Adolescents also find cheap cigars appealing because they can be converted to blunts (i.e., hollowed out cigar filled with marijuana) (Kong et al., 2018).

There are several reasons to suspect longitudinal associations between youth cigar and cigarette use initiation. Adolescents who enter into combustible tobacco product use via cigars and enjoy the sensory and pharmacological effects of cigar use may be inclined to try using cigarettes. It is also plausible that adolescents who smoke cigarettes may be at increased risk of initiating use of cigars. The strong physical resemblance of many little cigars to cigarettes (e.g., nearly identical size and shape) (Delnevo et al., 2017) may draw youth cigarette smokers to trying a very similar product in cigars that are at a lower price point.

In the current report, we pooled data from 3 adolescent cohorts to examine whether cigar use among cigarette-naïve adolescents was associated with increased odds of subsequent cigarette initiation at one-year follow-up, and, in separate models, whether trying a cigarette was associated with increased odds of subsequent cigar use initiation. To determine the generalizability of these results in the context of increasing e-cigarette use (Gentzke et al., 2019), we also examined whether these associations differed by concomitant e-cigarette use. We additionally assessed patterns of transition between exclusive use of cigars, exclusive use of cigarettes, and dual use of both cigars and cigarettes between baseline and follow-up.

2. Methods

We pooled data from three prospective cohort studies across two Tobacco Center of Regulatory Science sites: two from California: the Children's Health Study (CHS; Barrington-Trimis et al., 2015; McConnell et al., 2006) and the Happiness and Health Study (H and H; Leventhal et al., 2015a), and one from Connecticut: the Yale Adolescent Survey Study (YASS; Kong et al., 2015; Krishnan-Sarin et al., 2015b).

The current cohort of the CHS (n = 1553) includes adolescents in Southern California initially surveyed regarding tobacco product use in 11th or 12th grade in the spring of 2014 and again approximately 18 months later. The H and H Study includes adolescents in different regions of Southern California who were surveyed throughout high school; we used data from the spring of 2014 (9th grade; baseline) and spring of 2015 (10th grade; follow-up, total n = 3190). The YASS (n = 1404) is an anonymous schoolwide survey assessing tobacco use behaviors and perceptions in three southeastern Connecticut high schools in the fall of 2013 and spring of 2014. Sampling strategies, procedures, and attrition rates of CHS (Barrington-Trimis et al., 2015), H and H (Leventhal et al., 2015b), and YASS (Krishnan-Sarin et al., 2015a) have been reported elsewhere.

2.1. Measures

Ever use of cigars/cigarettes/e-cigarettes was assessed at both time points. Participants were considered ever users of cigarettes if a valid age was provided in response to a question asking about the age in which adolescents took "even one or two puffs" of a cigarette. CHS and H and H determined ever use of e-cigarettes and cigars (defined as "cigar, cigarillo, or little cigar") also based on the age of onset questions. For YASS, ever use of e-cigarettes and cigars were determined by a response of "yes" to questions that asked if they had ever tried e-cigarettes (defined as "electronic devices that are shaped like cigarettes and contain a liquid, which is vaporized and inhaled") or cigars or cigarillos (defined as "cigars the same size as cigarettes. A common brand is Black and Mild").

Past-30-day use of cigars/cigarettes was assessed at both time points in all studies with a question, "During the past 30 days, on how many days did you use (tobacco product)?" Response options were 0 days, 1–2 days, 3–5 days, 6–9 days, 10–19 days, 20–29 days, and all 30 days. Covariates included sex (male/female), baseline school grade (9th-12th grade), race/ethnicity (White, Black, Hispanic, Asian, bi-/multi-race, other race), study (CHS, H and H, YASS), and ever e-cigarette use (yes/no).

2.2. Data analysis

First, we conducted logistic regression analyses to assess whether the odds of initiating cigarettes by follow-up were greater for adolescents who had (vs. had not) used cigars at baseline in a sample restricted to those who had never used cigarettes at baseline. Second, we conducted logistic regression analyses to assess whether the odds of initiating cigars by follow-up were greater for adolescents who had (vs. had not) used cigarettes at baseline in a sample restricted to those who had never used cigars at baseline. Third, we conducted multinomial logistic regression analysis to evaluate the association of ever use of only cigarettes ("exclusive cigarette use"), only cigars ("exclusive cigar use"), and both cigarettes and cigars ("dual use") at baseline with past 30-day exclusive cigarette use, exclusive cigar use, and dual use at follow up. In the analysis examining dual use, only CHS and YASS data were used because past-30-day cigar use at follow-up was not assessed for H and H. All models included covariates as fixed effects. We also assessed interaction by site and e-cigarette use by including a product term for each to determine whether the effect estimates differed across the three samples and to assess whether e-cigarette use may impact the transition between the two products.

3. Results

The combined sample was 6147 (53.7% female, 37.9% White, 38.3% Hispanic, 15.5 years old (SD = 1.4); 9.7% were ever cigar users, 15.1% ever cigarette users, and 26.1% ever e-cigarette users at baseline.

Among never cigarette smokers at baseline (n = 4876; 79.3% of total sample; Table 1), 3.4% reported ever cigar use at baseline. Among those who had used a cigar at baseline, 31.3% tried cigarettes by follow up, compared to 8.4% of never-cigar users at baseline (adjusted odds ratio (AOR) = 2.26, 95% confidence interval (CI): 1.52, 3.35). Effect estimates did not differ by site (p = 0.65) but differed by e-cigarette use status ($p \leq 0.001$), where stronger associations were observed if e-cigarette was used at baseline (AOR = 5.87, 95% CI: 3.08, 11.21) than if e-cigarette was never used (AOR = 1.52, 95% CI: 0.96, 2.42).

Among never cigar users at baseline (n = 5017; 81.6% of total sample; Supplementary Table 1), 8.8% had used cigarettes at baseline. Those who had used cigarettes were more likely to have used cigars by follow-up; 24.2% of ever cigarette users at baseline had tried a cigar by follow-up compared to 6.2% of never cigarette smokers at baseline. All three studies found a positive association between cigarette use and subsequent cigar initiation, though the size of the effect differed significantly across studies (p = 0.01). Stronger associations were observed for H and H (AOR = 4.07, 95% CI: 2.66, 6.23) and YASS (AOR = 2.57, 95% CI: 1.36, 5.15) than for CHS (AOR = 1.51, 95% CI: 0.96, 2.39). Effect estimates did not differ by e-cigarette use status (p = 0.18).

Among CHS and YASS participants, who comprised the analytic sample for dual product use analyses, dual product ever use was the most prevalent use pattern at baseline (7.5%; Table 2), followed by exclusive cigarette use (7.1%) and exclusive cigar use (3.7%). Exclusive ever cigar use at baseline was associated with a 2-4-fold increase in the odds of transition to all tobacco use patterns at follow-up, relative to non-users of either product, at baseline ($AOR_{exclusive\ cigar}$ = 4.47, 95% CI: 2.09, 9.57; $AOR_{exclusive\ cigarette}$ = 2.39, 95% CI: 0.93, 6.15; $AOR_{dual\ use}$ = 3.10, 95% CI: 1.22, 7.86), though the effect estimate for transition to exclusive cigarette use was not statistically significant. Exclusive cigarette use at baseline was associated with increased odds of

Table 1
Sample characteristics of never cigarette smokers at baseline and the association between cigar use at baseline and subsequent trying a cigarette at follow up (n = 4876).

	Never Cigarette Use (Baseline) (n = 4876) n (col %)	Ever Cigarette Smoking (Follow up)		Adjusted OR (95% Confidence Interval)[b]
		No (n = 4427) n (row %)[1]	Yes (n = 449) n (row %)[a]	
Ever Cigar Use (Baseline)				
Yes	166 (3.4)	114 (68.7)	52 (31.3)	**2.26 (1.52-3.35)**
No	4710 (96.6)	4313 (91.6)	397 (8.4)	Ref
Grade Level				
12	731 (15.0)	629 (86.1)	102 (14.0)	0.95 (0.50-1.82)
11	996 (20.4)	870 (87.4)	126 (12.7)	0.89 (0.47-1.69)
10	335 (6.9)	304 (90.8)	31 (9.3)	1.63 (0.87-3.05)
9	2814 (57.7)	2624 (93.3)	190 (6.8)	Ref
Gender				
Male	2234 (45.8)	2001 (89.6)	233 (10.4)	1.14 (0.93-1.39)
Female	2642 (54.2)	2426 (91.8)	216 (8.2)	Ref
Race/Ethnicity				
Non-Hispanic White	1897 (38.9)	1715 (90.4)	182 (9.6)	Ref
Hispanic	1794 (36.8)	1612 (89.9)	182 (10.1)	0.87 (0.67-1.12)
Other	1185 (24.3)	1100 (92.8)	85 (7.2)	0.83 (0.61-1.13)
Non-Hispanic Black	143 (2.9)	132 (92.3)	11 (7.7)	–
Asian	566 (11.6)	536 (94.7)	30 (5.3)	–
Other, including Bi- and Multi-Racial	476 (9.76)	432 (90.8)	44 (9.2)	–
Study				
CHS	1263 (25.9)	1057 (83.7)	206 (16.3)	**4.50 (2.93-6.92)**
HandH	2431 (49.9)	2258 (92.9)	173 (7.1)	1.45 (0.84-2.50)
YASS	1182 (24.2)	1112 (94.1)	70 (5.9)	Ref
Ever E-Cigarette Use (Baseline)				
Yes	807 (16.6)	630 (78.1)	177 (21.9)	**3.94 (3.13-4.96)**
No	4069 (83.5)	3797 (93.3)	272 (6.7)	Ref

Note: Bold font indicate statistically significant associations at $p \leq .05$. CHS = Children's Health Study; HandH = Happiness and Health Study; YASS = Yale Adolescent Survey Study; AOR = adjusted odds ratio; 95% CI = 95% confidence interval. The interaction between ever cigar use at baseline and site was not statistically significant ($p = 0.648$).

[a] Percentages may not sum to 100 due to rounding.

[b] Odds ratios are adjusted for baseline measures of ever cigar use, ever e-cigarette use, grade, gender, race/ethnicity (White, Hispanic, Other), and site (CHS, HandH, YASS).

continued exclusive cigarette use or transition to dual product use, relative to not using any tobacco product or relative to using exclusive cigar use at follow-up. The probability of transitioning from exclusive cigarette use at baseline to exclusive cigar use at follow-up was very low. Dual users had increased odds of continued dual use or transitioning to exclusive cigarette use relative to not using any tobacco product or relative to exclusive cigar use at follow-up. The odds of transitioning to exclusive cigar use was low. Effect estimates did not differ by site ($p = 0.28$).

4. Discussion

Our prospective data provide novel findings indicating bi-directional associations between adolescent use of cigars and cigarettes across time. While concomitant e-cigarette use did not alter the transition risk from cigarettes to cigars, e-cigarette use amplified the extent

Table 2
The association between baseline ever use patterns and subsequent past 30-day use patterns (n = 2780).

Baseline Ever Tobacco Use	Past 30-day Tobacco Use at Follow-up n (%)[a]			Adjusted OR (95% Confidence Interval)[b]					
	Cigar Only	Cigarette Only	Dual Use	Cigar Only (v. No Use[r])	Cigarette Only (v. No Use[r])	Dual Use (v. No Use[r])	Cigarette Only (v. Cigar Only[r])	Dual Use (v. Cigar Only[r])	Dual Use (v. Cigarette Only[r])
No use (n = 2273, 81.8%)	34 (1.5)	46 (2.0)	26 (1.1)	Ref	Ref	Ref	Ref	Ref	Ref
Exclusive cigar use (n = 102, 3.7%)	18 (17.7)	6 (5.9)	8 (7.8)	**4.47 (2.09-9.57)**	2.39 (0.93-6.15)	**3.10 (1.22-7.86)**	0.53 (0.17-1.71)	0.69 (0.22-2.15)	1.30 (0.36-4.62)
Exclusive cigarette use (n = 197, 7.1%)	3 (1.5)	37 (18.8)	16 (8.1)	0.56 (0.16-1.98)	**7.53 (4.32-13.1)**	**4.36 (2.04-9.32)**	**13.39 (3.47-51.77)**	**7.76 (1.85-32.55)**	0.58 (0.24-1.43)
Dual product use (n = 208, 7.5%)	8 (3.9)	54 (26.0)	53 (25.5)	1.24 (0.50-3.11)	**14.6 (8.13-26.1)**	**13.2 (6.68-26.0)**	**11.73 (4.13-33.35)**	**10.62 (3.58-31.51)**	0.91 (0.39-2.09)

Note: Bold font indicates statistically significant associations at $p \leq .05$. The reference group for the comparison is denoted by a superscript "r." The interaction between ever cigar use at baseline and site was not statistically significant ($p = 0.282$).

[a] Percentages shown are row percentages.

[b] Odds ratios are adjusted for ever e-cigarette use, grade, gender, race/ethnicity (White, Hispanic, Other) and site (not including HandH).

to which cigar use increased the risk for subsequent cigarette use initiation, which raises concern whether recent increases in adolescent e-cigarette use may eventually translate to increased incidence of cigar-to-cigarette use sequences.

Several mechanisms may underlie adolescent tobacco product use transitions. Perhaps flavors in cigars may mask the harshness of combustible tobacco products at first use and thus lessen the harshness of experimentation with cigarettes. Youth may also begin use with flavored cigars and transition to menthol cigarettes, though data on the type of cigarettes smoked was not available in all three studies so we could not assess this potential risk pathway. Moreover, those who first initiate with cigarettes may later initiate cigars because cigars, especially little cigars, are physically indistinguishable from cigarettes, are cheaper, and are available in more flavors. Future studies should assess whether these cigar product features influence risk of transition to and from cigarettes to inform regulation.

Initiation of either cigars or cigarettes was associated with greater odds of dual product use of cigars and cigarettes, which is particularly concerning given that adolescents' nicotine dependence increases with each additional tobacco product used (Ali et al., 2016). Thus, tobacco prevention efforts and regulations focused on adolescents should include cigars, as use of cigars places adolescents at risk for subsequent cigarette use as well as dual use of cigars and cigarettes.

Although the strength of our study is leveraging three large prospective datasets from different geographic regions, we did not have the same covariates because each was a unique study. Future studies should adjust for measures of susceptibility or risk-taking, as well as ever use of smokeless tobacco or hookah. Future studies should also use longer periods of follow-up to assess how patterns of tobacco use evolve. Finally, small cell sizes precluded characterization of other poly-tobacco product use configurations. Despite the small cell sizes, this work provides an important starting estimate for future longitudinal studies with national samples to comprehensively characterize adolescent tobacco use trajectories involving cigar use.

Contributors

JBT, AML, RM, GK, and SKS were involved in designing the three cohort studies used here and oversaw data collection. GK and JBT contributed to the development of the research question. GK wrote the initial draft of the manuscript. MM harmonized the studies, analyzed the data, and led revisions to subsequent drafts. All authors were actively involved in providing critical review of the manuscript, and all authors approved of the final manuscript before submission.

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Conflict of interest

No conflict declared.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2019.03.022.

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