Published in final edited form as:

Addict Behav. 2016 June ; 57: 30–34. doi:10.1016/j.addbeh.2016.01.014.

E-cigarette use and disparities by race, citizenship status and language among adolescents

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Abstract

Introduction—E-cigarette use among adolescents is on the rise in the U.S. However, limited attention has been given to examining the role of race, citizenship status and language spoken at home in shaping e-cigarette use behavior.

Methods—Data are from the 2014 Adolescent California Health Interview Survey, which interviewed 1,052 adolescents ages 12–17. Lifetime e-cigarette use was examined by sociodemographic characteristics. Separate logistic regression models predicted odds of ever-smoking e-cigarettes from race, citizenship status and language spoken at home. Sociodemographic characteristics were then added to these models as control variables and a model with all three predictors and controls was run. Similar models were run with conventional smoking as an outcome.

Results—10.3% of adolescents ever used e-cigarettes. E-cigarette use was higher among ever-smokers of conventional cigarettes, individuals above 200% of the Federal Poverty Level, US citizens and those who spoke English-only at home. Multivariate analyses demonstrated that citizenship status and language spoken at home were associated with lifetime e-cigarette use, after accounting for control variables. Only citizenship status was associated with e-cigarette use, when controls variables race and language spoken at home were all in the same model.

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Contributions: Alcalá, conceived of the study, analyzed data and contributed to all manuscript drafts. Albert and Ortega helped in writing all drafts and provided feedback to the analyses and discussion. All authors contributed to and have approved the final manuscript

Conflicts of Interest: Authors have no conflicts of interest to disclose.

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Conclusions—Ever use of e-cigarettes in this study was higher than previously reported national estimates. Action is needed to curb the use of e-cigarettes among adolescents. Differences in lifetime e-cigarette use by citizenship status and language spoken at home suggest that less acculturated individuals use e-cigarettes at lower rates.

1. Introduction

Use of electronic cigarettes (i.e. e-cigarettes) among adolescents in the U.S. is becoming increasingly common. Between 2011 and 2012, the percentage of adolescents who had ever tried e-cigarettes more than doubled from 3.1% to 6.5% (Dutra & Glantz, 2014). During that same time, current use increased from 1.1% to 2.0% (Dutra & Glantz, 2014) and has continued to increase since (Barnett, Soule, Forrest, Porter, & Tomar, 2015). This parallels a more than two-fold increase in adolescent exposure to televised e-cigarette advertisements between 2011 and 2013 (Duke et al., 2014), which is important considering exposure to pro-tobacco marketing is associated with increased e-cigarette use and intent to use among adolescents (Agaku & Ayo-Yusuf, 2014; Farrelly et al., 2015).

The health effects of e-cigarettes are of growing concern. E-cigarettes are aerosolized nicotine and produce a vapor; this vapor may contain chemicals such as propylene glycol, glycerol and flavoring (Yamin, Bitton, & Bates, 2010). E-cigarette vapor contains many of the harmful toxins found in conventional cigarettes, including formaldehyde, acetaldehyde, cadmium, lead and others, although frequently at lower levels (Goniewicz et al., 2014; Harrell, Simmons, Correa, Padhya, & Brandon, 2014). Currently, e-cigarettes are only regulated by the Food and Drug Administration if they are being marketed for therapeutic use (U.S. Food and Drug Administration, 2015), leaving the federal government with limited ability to curtail potential harm. While there is limited research on the long-term impact of e-cigarette use, short-term impacts have been documented including impaired respiratory function (Callahan-Lyon, 2014).

E-cigarettes also pose harm to adolescent health because they are strongly associated with use of combustible tobacco products. Over 80% of e-cigarette smokers have used conventional cigarettes (Camenga et al., 2014; Chapman & Wu, 2014) and e-cigarette use is associated with increased odds of using hookah (Camenga et al., 2014), indicating a large overlap between users of e-cigarettes and other tobacco products. Among adults and adolescents, e-cigarettes are seen as a safer alternative to cigarettes and potential cessation aid (Ambrose et al., 2014; Amrock, Zakhar, Zhou, & Weitzman, 2015; Camenga et al., 2015; Choi & Forster, 2013), despite the inconsistent evidence of the veracity of these beliefs (Brown, Beard, Kotz, Michie, & West, 2014; Grana, Popova, & Ling, 2014). Simultaneously, e-cigarettes may function as a gateway to conventional cigarette use (Kmietowicz, 2014). Specifically, using e-cigarettes more than doubles the intent to smoke conventional cigarettes among adolescents (Bunnell et al., 2015), and smoking e-cigarettes predicts future conventional cigarette use (Leventhal, Strong, Kirkpatrick, & et al., 2015). Given that e-cigarettes have higher up-front costs, e-cigarettes have to be used for almost two months before the costs match those of conventional cigarettes (Vinik, 2014). As a result, financial motivations may incentivize a switch from e-cigarettes to conventional cigarettes. Finally, some have argued that increased use and acceptance of e-cigarettes may

cause harm by making traditional cigarette smoking socially acceptable (Fairchild, Bayer, & Colgrove, 2014; Schraufnagel et al., 2014).

Despite the concern over e-cigarettes among adolescents, limited research has examined disparities. Currently, racial disparities in e-cigarette use exist, with minorities having lower odds of e-cigarette use than whites (Dutra & Glantz, 2014; Lippert, 2014). However, much of the research has focused on making comparisons between blacks and whites (Dutra & Glantz, 2014; Lippert, 2014). To date, the impact of citizenship status and language spoken in the household has been overlooked. These are important oversights given the multilingual and immigrant populations in the U.S. These constructs can measure facets of acculturation, which has been associated with conventional smoking behaviors (Baluja, Park, & Myers, 2003; Gorman, Lariscy, & Kaushik, 2014). Thus, this study will address these shortcomings by exploring whether or not race, citizenship status, and language spoken at home influence e-cigarette use among adolescents and also examine if these associations differ for conventional cigarette use.

2. Materials and Methods

2.1 Data Source

Data come from the 2014 Adolescent California Health Interview Survey (CHIS). This cross-sectional telephone survey of California adolescents, ages 12-17, was administered in English, Spanish, Mandarin, Cantonese, Vietnamese, Korean, and Tagalog and was designed to be representative of California adolescents living in households (California Health Interview Survey, 2015). CHIS includes replicate weights and adjustments to account for differential selection probabilities, non-response bias, and stratification (California Health Interview Survey, 2015). Overall, 1,052 adolescents completed the survey. A response rate of 37.2% was achieved, which is comparable to other population-based telephone surveys (California Health Interview Survey, 2015). Missing data were imputed using hot deck imputation by CHIS investigators (California Health Interview Survey, 2015). Data were publically available and did not require IRB approval.

2.2 Variables

The main outcome of interest was whether or not respondents had ever used e-cigarettes in their lifetimes (yes versus no). Race, citizenship status and language spoken at home were included as demographic predictors in analyses. Race/ethnicity was measured using a series of dummy variables (i.e. non-Latino white, non-Latino Asian, non-Latino other race and Latino). Citizenship status was measured using three categories: US citizen, naturalized citizen and non-citizen. Language spoken at home was measured using a dichotomous measure (English-only versus any language other than English with or without English also being spoken). Non-Latino whites, US citizens, and individuals living in a home with any language other than English spoken served as the respective reference categories in analyses. For bivariate analyses, secondary school type was examined as a predictor. Secondary school type was measured using three categories: middle school or lower, high school and not attending school/other.

Gender, age, household poverty level, and conventional cigarette use were included as control variables in multivariate analyses. Males served as the reference group for gender. Age was measured continuously. Poverty level was measured using a dichotomous measure, with those under 200% of federal poverty level (FPL) serving as the reference group. For conventional smoking, never smokers served as the reference category.

2.3 Analyses

All analyses were conducted using Stata 14.0 and using replicate weights, as appropriate. Univariate statistics (i.e. means and frequencies) were run for all measures. The percentage of lifetime e-cigarette users was calculated for each of the categorical demographic predictors and control variables. Chi-squared tests were used to determine if e-cigarette use was associated with each variable. For age, a t-test was performed to compare average age among e-cigarette ever and never users, in addition to comparing usage rates by race using a chi-squared test. Three separate binary logistic regression models were run to predict odds of e-cigarette from race, citizenship status and language spoken at home. The same models were then fitted with conventional cigarette smoking, age, gender and poverty level as control variables. These three models were then replicated, with ever use of conventional cigarette smoking as an outcome, and e-cigarette use as a control.

3. Results

Among the sample, 10.31% and 6.99% of respondents used e-cigarettes and cigarettes in their lifetimes, respectively. As Table 1 shows, lifetime e-cigarette use was more common among ever-smokers of traditional cigarettes as compared to never smokers of traditional cigarettes (47.09% versus 7.54%; $p < .001$). Lifetime e-cigarette users were older than never users ($p < .05$). When e-cigarette use rates were examined by age, 12 to 17 year olds had rates of 5.95%, 7.70%, 5.35%, 9.37%, 20.49% and 12.58% respectively ($p < .05$). Overall, race and secondary school type were not associated with lifetime e-cigarette use. Lifetime e-cigarette use was more common among adolescents living in households over 200% of FPL (13.69% versus 6.77%; $p < .01$). Citizenship status was associated with lifetime e-cigarette use ($p < .01$). Specifically, US citizens had the highest rates (11.44%) and non-citizens had the lowest rates (1.46%; $p < .01$). Those who lived in homes where only English was spoken had higher rates of lifetime e-cigarette use than those who lived in homes where any language other than English was spoken (13.89% versus 6.76%; $p < .05$).

As model 1 in Table 2 shows, unadjusted logistic regression analyses revealed that Latinos had 49% lower odds of lifetime e-cigarette use when compared to non-Latino whites (OR=0.51). Non-citizens had 89% lower odds of lifetime e-cigarette use when compared to U.S. citizens (OR=0.11). Those who lived in homes where only English was spoken had 122% greater odds of lifetime e-cigarette use when compared to those who lived in homes where any language other than English was spoken (OR=2.22).

As model 2 in Table 2 shows, adjusted models that included conventional smoking, age, gender and poverty level as controls revealed that Latinos no longer had lower odds of lifetime e-cigarette use. When each control variable was introduced into this model individually, both conventional smoking and poverty level each accounted for the observed

racial/ethnic difference. However, the associations between citizenship status and language spoken at home remained significant in the adjusted models, although both associations were attenuated. When all variables were included in the same model (Model 3), only the association between citizenship status remained significant.

Table 3 mirrors the analyses in Table 2, with ever-use of conventional cigarettes as an outcome. In bivariate models, Asians had 80% lower odds of ever-smoking cigarettes when compared to whites (OR=0.20). Naturalized citizens had 83% lower odds of ever smoking cigarettes when compared to U.S. citizens (OR=0.17). Language spoken at home was not associated with ever smoking cigarettes. When control variables were introduced, race, citizenship status and language spoken at home were not associated with ever smoking cigarettes. When all variables were included in the same model (Table 3), Asians, once again, had lower odds of ever smoking cigarettes.

4. Discussion

The prevalence of lifetime e-cigarette use among adolescents in California is 10.3%, representing over 313,000 adolescents. This was both higher than the rate of ever using conventional cigarettes in the present study and higher than previously reported ever using e-cigarette nationwide rates of 6.5% (Dutra & Glantz, 2014). This is particularly alarming in a state like California where smoking rates are very low (Jamal et al., 2014), suggesting norms around e-cigarette use are more permissive than norms around cigarette use. Additionally, 7.54% of never smokers had ever used e-cigarettes, suggesting a proportion of adolescents are susceptible to using e-cigarettes as a gateway to conventional cigarette smoking. Overall, as some have argued, increased use and acceptance of e-cigarettes may make traditional cigarette smoking socially acceptable (Fairchild et al., 2014; Schraufnagel et al., 2014) and threaten one of the greatest public health success stories of the past century.

Results also highlighted important disparities in e-cigarette ever use. Specifically, e-cigarette ever-users were more likely to be conventional cigarette users, older, U.S. citizens, over 200% FPL, and living in households that spoke English-only. The association between language was not observed for conventional cigarette use. Whites had higher odds of using e-cigarettes than did Latinos and conventional cigarettes more than did Asians. When accounting for conventional cigarette smoking, age, gender and poverty level differences in smoking between Latinos and whites disappeared. Consequently, future longitudinal studies should examine if economic advancement or increased conventional smoking among Latinos is associated with an increase in e-cigarette usage among Latinos.

Disparities by citizenship status and language were robust and remained significant after accounting for controls. The general pattern suggests that less acculturated groups (i.e. non-citizens and individuals who speak a language other than English at home) are less likely to use e-cigarettes. This mirrors patterns seen in conventional smoking in other studies (Baluja et al., 2003; Gorman et al., 2014), and is consistent with the “healthy immigrant effect” that has been observed among adolescent smoking behavior, where children of immigrants adopt smoking at higher rates than immigrants themselves (O’Loughlin, Maximova, Fraser, & Gray-Donald, 2010). The use of citizen status allows for the splitting of the people

traditionally collapsed into a “foreign-born” category for analyses. Given that naturalized citizens were not different from U.S. citizens and non-citizens, they represent a middle ground in the adoption of mainstream U.S. health behaviors. While the overall observed disparities show a health advantage for traditionally disadvantaged groups, we do not know if this advantage will persist with the increasing integration into U.S. society of these groups. Given that only citizenship status remained a significant predictor of e-cigarette use when it was in a model along with race and language spoken at home, some of the variation in e-cigarette use attributed to each was overlapping.

Despite the use of a racially diverse and representative data source, the study is not without limitations. For example, the sample size may not have adequate power to examine associations between a relatively uncommon outcome among smaller population subgroups. As a result, findings may be biased towards the null. Also, the measure of e-cigarette use is limited to ever use of e-cigarettes and did not permit for examination of current e-cigarette use or frequency of e-cigarette use. Despite these limitations, results highlight important disparities in e-cigarette use.

5. Conclusions

The results underscore the emerging threat of e-cigarettes among adolescents. While the long-term health impacts of e-cigarette use are not understood, they pose a great danger because they are closely linked to conventional cigarette use. Results also revealed that e-cigarette use varies by population subgroups. Because non-citizens and individuals who speak a language other than English at home have lower odds of e-cigarette use, future research should examine the reasons these groups do better than their peers. Understanding the factors that make these groups resilient could help promote these factors among more susceptible groups. Conversely, tobacco companies may treat the relatively low rates of e-cigarette usage in these groups as an untapped market to grow, much like they did with women and conventional cigarettes in the United States (Amos & Haglund, 2000; Pollay, 1996).

Acknowledgments

This work was supported by grants from the National Heart, Lung, and Blood Institute (NHLBI) (grant number: P50 HL105188); the National Institutes of Health (NIH) (grant number: R25 HL108854) and the California Center for Population Research (CCPR) Population Research Infrastructure Grant (grant number: R24-HD041022). Alcalá and would like to thank the California Center for Population Research for providing office space and equipment to support the present study.

Role of Funding Sources: This work was supported by grants from the National Heart, Lung, and Blood Institute (NHLBI) (grant number: P50 HL105188); the National Institutes of Health (NIH) (grant number: R25 HL108854) and the California Center for Population Research (CCPR) Population Research Infrastructure Grant (grant number: R24-HD041022). NHLBI, NIH and CCPR had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication

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Highlights

1. 10.3% of adolescents ever used e-cigarettes.
2. Foreign-born individuals were less likely to have used e-cigarettes.
3. Those who spoke English-only at home more likely to have used e-cigarettes.
4. Whites were more likely to have used e-cigarettes, relative to Latinos.
5. Predictors of e-cigarette and cigarette use varied.

Table 1
Sample Characteristics and E-cigarette use by Sub-Groups, CHIS 2014 (N=1,052)

Variable	Level	Full Sample		E-Cigarette Use ¹	
		N	% or mean	% or mean	P-Value
Ever-Use E-Cigarette (Overall)	No	930	89.69%	--	--
	Yes	122	10.31%	--	--
Race	White	395	32.79%	15.53%	
	Latino	451	47.00%	8.61%	
	Asian	101	10.59%	5.79%	
	Other	105	9.61%	5.74%	
Citizenship Status	US Citizen	916	86.43%	11.44%	**
	Naturalized Citizen	68	5.32%	5.68%	
	Non-Citizen	68	8.26%	1.46%	
Language Spoken at Home	Not English Only	501	50.3%	6.76%	*
	English Only	551	49.7%	13.89%	
Secondary Education	High School	600	59.82%	12.42%	
	Middle School or Lower	339	33.09%	7.40%	
	Not Attending School/Other	113	7.09%	6.01%	
	Male	558	51.11%	12.31%	
Gender	Female	494	48.89%	8.21%	
		1,052	14.5	15.13	*
Age	200% FPL	591	51.09%	13.69%	*
	<200% FPL	461	48.91%	6.77%	
Poverty Level	No	963	93.01%	7.54%	***
	Yes	89	6.99%	47.09%	

¹ Percentages and means represent the percent of each sub-population that has ever used e-cigarettes and mean values among e-cigarette ever users.

N represents unweighted sample size

FPL=Federal Poverty Level

* .05

** .01

100

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Table 2
Logistic Regression Models Predicting E-Cigarette Use, CHIS 2014 (N=1,052)

Independent Variable	Level	Model 1 Unadjusted		Model 2 Adjusted		Model 3 Adjusted and Simultaneous	
		OR	95% CI	AOR	95% CI	AOR	95% CI
Race	White	--	--	--	--	--	--
	Latino	0.51	(0.27 - 0.96)	0.75	(0.40 - 1.41)	1.18	(0.60 - 2.31)
	Asian	0.33	(0.33 - 1.99)	0.45	(0.08 - 2.56)	0.76	(0.11 - 5.20)
	Other	0.33	(0.11 - 1.00)	0.40	(0.14 - 1.19)	0.37	(0.12 - 1.11)
Citizenship Status	US Citizen	--	--	--	--	--	--
	Naturalized Citizen	0.47	(0.16 - 1.35)	0.64	(0.21 - 1.96)	0.85	(0.26 - 2.74)
	Non-Citizen	0.11	(0.04 - 0.37)	0.16	(0.05 - 0.50)	0.21	(0.06 - 0.72)
Language Spoken at Home	Language Other than English	--	--	--	--	--	--
	English Only	2.22	(1.22 - 4.05)	1.97	(1.05 - 3.72)	2.10	(0.97 - 4.53)

Note: OR= odds ratio; AOR= adjusted odds ratio

Model 2 controls for conventional smoking, age, gender and poverty level.

Model 3 introduces race, citizenship status and language spoken at home, while also controlling for conventional smoking, age, gender and poverty level.

Table 3
Logistic Regression Models Predicting Cigarette Use, CHIS 2014 (N=1,052)

Independent Variable	Level	Model 1 Unadjusted		Model 2 Adjusted		Model 3 Adjusted and Simultaneous	
		OR	95% CI	AOR	95% CI	AOR	95% CI
Race	White	--	--	--	--	--	--
	Latino	0.54	(0.22 - 1.32)	0.49	(0.14 - 1.67)	0.32	(0.09 - 1.17)
	Asian	0.20	(0.05 - 0.74)	0.25	(0.06 - 1.02)	0.21	(0.05 - 0.93)
	Other	0.86	(0.19 - 3.78)	1.70	(0.29 - 6.53)	1.44	(0.31 - 6.81)
Citizenship Status	US Citizen	--	--	--	--	--	--
	Naturalized Citizen	0.17	(0.03 - 0.98)	0.16	(0.03 - 1.02)	0.15	(0.02 - 1.17)
Language Spoken at Home	Non-Citizen	0.35	(0.09 - 1.31)	0.48	(0.12 - 1.89)	0.49	(0.11 - 2.18)
	Language Other than English	--	--	--	--	--	--
	English Only	1.32	(0.61 - 2.85)	1.18	(0.40 - 3.43)	0.48	(0.16 - 1.42)

Note: OR= odds ratio; AOR= adjusted odds ratio

Model 2 controls for e-cigarette use, age, gender and poverty level.

Model 3 introduces race, citizenship status and language spoken at home, while also controlling for e-cigarette use, age, gender and poverty level.