Hispanics/Latinos' Cigarette and E-cigarette Use: Behavioral and Self-rated Health

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Abstract

Objective: To examine if serious psychological distress (SPD), binge drinking, and self-rated health predicted dual use of tobacco cigarette and e-cigarette compared with no use or the use of only one product among Hispanics/Latinos (H/L). By increasing our understanding of determinants of dual use, we can identify the most vulnerable groups and intervention targets.

Methods: Data from H/L who were current tobacco/nicotine users in the Houston Health Survey 2018 (N = 188; representing 158,369 individuals). Descriptive, bivariate and multinomial logistic regression analyses were conducted, and moderation by age and sex.

Results: H/L with SPD were more likely to be dual-users than non-users (Odds Ratio [OR]= 1.97), cigarette users (OR= 1.12), or e-cigarette users (OR= 2.44). Individuals who binge drank were more likely to be dual-users than non-users (OR= 2.66) or e-cigarette users (OR= 9.30); but more likely to be cigarette users compared to dual-users (OR= 2.05). Poorer self-rated health predicted an increased likelihood of being non-users (OR= 1.19), cigarette users (OR= 1.36), and e-cigarette users compared to dual-users (OR= 1.04).

Conclusions: Behavioral health and self-rated health are important predictors of tobacco cigarette, e-cigarette, and dual use among H/L. These relationships differ by age and sex.

Keywords

Hispanics/Latinos; tobacco-related disparities

The United States is anticipated to become more racially and ethnically diverse by 2060. Contributing to this projection in diversity is the Hispanic/Latino (H/L) population in the U.S., as it is expected to continue growing exponentially. In 2014 the H/L group comprised 17.4% of the U.S. population and by 2060 will account for 28.6% of the population,

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Humans Subject Statement
This project utilizes a publicly available dataset; thus, is exempt from Internal Review Board oversight.

which is a 114.8% increase.[1] Nationally among H/L, approximately 13.8% report using any tobacco product and 9.8% report smoking cigarettes, which is the most utilized tobacco product within this group.[2] However, the percentage of H/L individuals in Texas who smoke cigarettes is 12%.[3]

Although the prevalence of smoking is lower among H/L compared to other racial/ethnic groups in the U.S.,[4] they experience negative health consequences of tobacco use (ie, their 3 principal causes of mortality are related to smoking), [5–6] and disparities in cessation aid. [7] For instance, although H/Ls' smoking patterns (ie, light and intermittent smoking) [8–9] may suggest lower physiological dependence to nicotine, their quit rates are similar (not lower or higher) than non-Latino White smokers. [10–11] Little is known about the predictors of cessation success among H/L. Existing research has shown that despite motivation to stop smoking, H/L receive scant advice to quit and endorse low usage of evidence-based cessation treatment. [7, 11–13] Furthermore, the generalizability of known determinants of smoking to H/L is far from being conclusive. [14] Hence, research examining factors associated to smoking behavior in this priority population may contribute to create tailored approaches to increase cessation and in turn, reduce disparities.

There has been a globally rapid increase in the utilization of electronic cigarettes (e-cigarettes), in particular among young adults, males, and tobacco users.[15] Numerous components within e-cigarettes have been reported as harmful, including carcinogens, heavy metals and volatile organic compounds,[16–17] all of which have been linked to an increased risk of respiratory disease.[18] E-cigarettes' safety as a substance and their reduced risk in comparison to utilizing traditional cigarettes remains inconclusive.[19,20] Nonetheless, a recent systematic review concluded that e-cigarettes are perceived to be less harmful than traditional cigarettes irrespective of an individual's current smoking status.[21] Similarly, some current tobacco smokers believe that e-cigarettes are a safer option in comparison to traditional cigarettes,[22] and may have the intention to use e-cigarettes as a tool to cease and/or reduce tobacco smoking.[23] However, dual use of tobacco cigarettes and e-cigarettes is common, including among young adult samples,[24,25] and may indeed reduce the probabilities of successfully quitting smoking.[26] Further, another review noted several studies pointing to higher e-cigarette use among women and younger individuals compared to men and older adults, respectively.[27]

In a multiethnic sample, current smokers were more than 3 times likely to plan continuing using e-cigarettes relative to former smokers.[28] Specifically among H/L, researchers found that among ever smokers, 71% of individuals reported ever-using e-cigarettes and 35% reported currently using daily or some days. Nonetheless, there is a lack of research documenting health related factors associated with dual use of tobacco cigarettes and e-cigarettes among H/L. Behavioral health and overall health are some of the factors that warrant attention.

Serious Psychological Distress and Tobacco and E-cigarette Use

Akin to the general U.S. adult population, depression and anxiety are 2 common mental health conditions among H/L[29,30] and some research has documented their association

with daily smoking.[30,31] In particular, H/L female smokers have been found to endorse higher symptoms of depression in comparison to H/L male smokers irrespective of their age group.[32,33] Further, current and former adult H/L smokers have been shown to have an increased risk for endorsing anxiety compared to those who have never smoked.[33] However, a recent review of existing research [14] points out the inconsistent significant associations between depression and smoking status among H/L.

Serious psychological distress (SPD) is a term used to encompass clinically significant distress (based on depression and anxiety symptoms) and has been found to affect 3.8% of H/L adults compared to 3.7% Non-Hispanic Blacks and 3.3% Non-Hispanic Whites. [34] SPD has been linked to smoking status. For instance, individuals who endorsed SPD have been found to smoke more frequently compared to those without SPD.[35] In particular, middle-aged and older women who smoked heavily have exhibited higher levels of SPD compared to men.[36] Although these studies included H/L in their sample, the proportions were small or unknown, and the differential effects of SPD on smoking status across ethnic groups were not the focus of the studies.

The aforementioned findings extend beyond cigarettes to include e-cigarettes. Data from nationally representative studies have documented that individuals with adverse mental health conditions, including SPD, are likely to have used e-cigarettes in their lifetime and to be current users,[37,38] A recent population based study found that exclusive current cigarette users, e-cigarette users, and dual users independently and significantly endorsed increased levels of psychological distress.[39] The aforementioned findings hold for the subsample of individuals between 18–34 years old. In addition, within a sample of smokers with serious mental illness, e-cigarette use was higher among young adults ages 18–25, although H/L in particular were less likely to use e-cigarettes compared to other ethnicities.[40] Although the reported relationships between e-cigarette use and adverse mental health are noteworthy, when studies have included H/L representation in their sample, the proportions were small and/or analyses were not conducted stratified by ethnicity, limiting the applicability of results to H/L populations and warranting further investigation. [38,39,41]

At-risk Alcohol Use and Tobacco And E-cigarette Use

Although H/L are less likely to consume alcohol in their lifetime (ie, 78.7% versus 91.2%), and within the past month (ie, 46.9% versus 60.4%), compared to Non-Hispanic Whites,[42] when they do consume alcohol they do so at a higher rates.[43] At-risk alcohol use, as defined by the National Institute of Alcohol and Alcoholism [44], is characterized by frequent binge drinking and/or chronic moderate or high levels of alcohol use, and is linked to numerous negative health and social outcomes.[45] The likelihood of at-risk alcohol use is higher among tobacco cigarette users, even among those who do not smoke daily. [46–47] Cox and colleagues[48] found that H/L who reported currently smoking were also more likely to consume alcohol compared to non-Hispanic smokers. This co-occurrence of smoking and hazardous alcohol use among H/L individuals is a strong indicator of chronic disease and mortality.[5]

Research focusing on the relationship between at-risk alcohol use and e-cigarette use is limited; however, extant literature has pointed to an increased rate of alcohol use among both adult[49] and young adult samples[50] whom utilize e-cigarettes compared to non e-cigarette users. Within the young adult sample, Cohn and colleagues[50] found current alcohol use to be a stronger predictor of e-cigarette use in comparison to current cigarette use. Data from the National Epidemiologic Survey on Alcohol and Related Conditions-Wave III found that individuals who reported usage of e-cigarettes had a heightened risk of hazardous alcohol use and binge drinking frequency compared to individuals who did not utilize e-cigarettes.[51] Of note, dual use of tobacco cigarettes and e-cigarettes is linked to further probability of hazardous alcohol use. However, to the current authors' best knowledge, research delineating associations of e-cigarette use with at-risk drinking among H/L has not been documented.

Self-rated Health And Tobacco Cigarette And E-cigarette Use

Self-rated health is a proxy of overall health status and has been adopted as a metric of progress toward clinical practice outcomes and public health in the US.[52–53] Research has documented that H/L report lower self-rated health when compared to Whites [54–56] and women tend to rate their health as poorer compared to men. [54, 57,58] On the other hand, findings about the differences of self-rated health across age groups are less consistent. [53,54, 57, 59]

Data from national datasets in the U.S. have indicated that non-smokers report overall higher self-rated health compared to current smokers and current tobacco use is strongly associated with suboptimal self-rated health.[54,60] Similar associations were reported in a sample of predominantly white women attending a family medicine clinic where smokers were 4 times more likely to report suboptimal health.[59] However, these aforementioned findings have not been stratified by ethnicity, although one of the studies reported that patients rating their health as "fair or poor" were more likely to be non-white.[59] Further, limited research among H/L recently documented the significant associations between self-rated health and current smoking status among women in a Latin American country. [61]

Furthermore, a systematic review found that e-cigarette users have positive perceptions of e-cigarette use compared to their perceptions of traditional tobacco cigarettes.[27] In particular, e-cigarette users reported improvements in their health including their respiratory functioning, overall health, and fitness. Taken together, although self-rated health has been negatively linked to cigarette smoking status, research examining its relationship with e-cigarette and dual use is still warranted, including among H/L groups. These associations are important because self-rated health is a good indicator of objective health and could signal perceived susceptibility to disease among individuals, which in turn, can influence their tobacco use behaviors.

Summary Of Gap In Literature And Research Questions

H/L living in the U.S. face significant tobacco-related health disparities, from smoking related health concerns to cessation outcomes and services.[6,7,14] Although emerging

research has started to document associations between dual use of tobacco cigarette and e-cigarette with behavioral and overall health, there is relatively little known about these relationships among H/L. By increasing our understanding of factors related to dual use, we can identify the most vulnerable groups and develop interventions designed to improve health outcomes and in turn, advance health equity. To contribute to this gap in knowledge, our study aims to answer the following questions: Does SPD, binge drinking, and overall self-rated health predict dual use of tobacco cigarette and e-cigarette compared with no usage or the use of only one product? Do these relationships differ by age and sex? We hypothesize that each predictor will be individually and significantly related to dual use compared to the other categories of tobacco/nicotine use. In addition, we will explore the moderation effects of age and sex, although no specific hypotheses were proposed.

METHOD

Procedures And Sample

Data were drawn from the 2018 Health of Houston Survey (HHS), which surveyed a population of non-institutionalized adults 18 years and older in the City of Houston and Harris County in Texas. The study focused on individuals' health behaviors and health care access. A wide range of sociodemographics were examined including age, sex, income level, education, race, and ethnicity. For H/L, information about their ancestry (eg, Mexican, Puerto Rican, etc.) was also gathered. The aforementioned target data collection began in June 2017 via Random-Digit Dialing sample design of landlines and cell phones; however, the survey was forced a hiatus due to hurricane Harvey until February 2018 during which data collection restarted. The final data collection gathered 5,500 telephone interviews conducted in both English and Spanish, which ultimately included health and environmental conditions post-Harvey. Eligibility criteria included subjects' self-reports of living in a private residence (excluding group homes and institutions) and a minimum age of 18. Subjects were provided with a $5 amazon online code, and those with pre-paid cell phones were provided with a $10 amazon online code at the time of survey completion. For the purpose of this study, we focused on the H/L adult sample (ie, those who responded "yes" to the following question: "*Are you of Hispanic, Latino, or Spanish origin*"?), who were current tobacco cigarette smoker, e-cigarette users, or both (N =188). This sample was 32% female, 41% were between 18 and 24-years-old and were married or living with a partner, and 48% had a household income of less than $50,000. The majority were of Mexican ancestry (65.9%) and responded to the interview in English (89%). Other ancestries represented in the sample were Salvadoran (3.4%), Other Central American (1.7%), Other Caribbean Hispanic (4.5%), South American (5.0%), Other Hispanic (10.6%), Multiple Hispanic ancestries (8.9%). Out of the 188 individuals, 9 were missing ancestry information.

Variables And Measures

Predictor variables in this study were reported SPD, binge drinking, and self-rated health. The outcome variable was tobacco/nicotine product use, which was created from existing variables in the dataset. Moderators were age and sex. Education was controlled for in all analyses. Table 1 provides a breakdown of each included variable and how they were individually measured.

Statistical Analyses

Survey weights were implemented in order to compensate for the effects of disproportionate sampling probabilities introduced by the sampling design (eg, Asian oversample) and to correct for differences in demographic characteristics of the sample relative to the population. Applying weights to the analyses reduces biases in estimates. Weighted analyses in this study represent 158,369 individuals.

Statistical analyses began with descriptive statistics in order to describe the sample according to the variables of interest. Next, bivariate analyses were conducted in order to examine correlations between the variables of interest. Finally, multinomial (also known as polytomous) logistic regression analyses[62] were conducted to estimate the unique contribution (controlling for other variables in the model) of each predictor variable to the probability of being a current tobacco cigarette user, e-cigarette user, or dual user versus none-users. Multinomial logistic regression is used when the question under study is to explore the relationship between one or more risk factors to an outcome variable that has 3 or more qualitatively distinct categories (ie, the different tobacco users). One of the categories of the outcome variable is designated as the reference category and the odds of being in each of the other categories versus the reference category is predicted by a set of variables (ie, predictors). The choice of the reference category does not affect the results. Given the proposed research questions, 'dual users' was selected as the reference category; thus, the analyses provide 3 separate odds ratios (OR): non-users versus dual users; only tobacco cigarette users versus dual users; and only e-cigarettes versus dual users. This type of analysis has been previously employed in similar research. [50, 63]

First, a regression model including the main predictors (SPD, binge drinking, self-rated health), demographic variables (age, sex), and education level as predictors was fitted to the data. Then, interaction terms between the main predictors and age and sex were created and included in the regression model in order to study the moderation effects. Only self-rated health was treated as a continuous predictor. The other variables were treated as categorical predictors, which were dummy coded using the first category as the reference category (see Table 1 for details). Self-rated health was mean centered to facilitate interpretation and to avoid multicollinearity issues caused by including interaction terms in the model. Among the N = 188, 37 subjects (19.7%) were missing on the binge drinking variable. A multiple imputation method with 20 imputed datasets was employed to handle the missing data assuming missing at random.[64] Pooled estimates from the 20 datasets are reported in the Results section. All analyses were conducted using SPSS 26 software.

RESULTS

Descriptive Statistics

Unweighted descriptive statistics for the original data (N = 188) are reported in Table 2. Also, pooled descriptive statistics across the 20 imputed datasets after applying sampling weights are reported in Table 2. In the original data, 49.5% were currently not using any tobacco products, 23.9% were using only tobacco cigarettes, 16.5% were using only e-cigarettes, and 10.1% were dual-users. After applying sampling weights, 46.7% were

non-users, 28.4% were only tobacco cigarette users, 16% were only e-cigarette users and 9% were dual-users. Table 3 shows the bivariate correlations among the studied variables. The correlations for the original data are shown in the lower left diagonal and the upper right diagonal contains the pooled correlations from imputed datasets while applying the sampling weights.

After applying the sampling weights, most of the main predictor variables were significantly related with tobacco/nicotine use. SPD was significantly related to higher likelihood to be dual-user compared to non-user ($r = -.04$, $p < .05$) and only e-cigarette user ($r = -.06$, $p < .05$), and higher likelihood of being only cigarette user compared to dual-user ($r = .07$, $p < .05$). A similar pattern was found for the relationship between binge drinking and tobacco use. People who binge drank more than 10 days/year (compared to people who did not binge drink at all) were more likely to be dual-users versus non-users ($r = -.08$, $p < .05$), and only e-cigarette users ($r = -.15$, $p < .05$), but also they were more likely to be only tobacco cigarette users when compared to dual-users ($r = .17$, $p < .05$). Similarly, poorer self-rated health was related to higher likelihood to be dual-users compared to non-users and only e-cigarette users ($r = -.05$ and $r = -.08$, $ps < .05$). However, individuals who reported poorer self-rated health showed higher likelihood to use only cigarettes compared to dual-users ($r = .17$, $p < .05$). Given that bivariate correlations do not capture the holistic view of controlling for the relationship with other variables and cannot study moderation effects, multinomial logistic regression analysis was conducted.

Multinomial Regression

Pooled estimates and significance tests based on multiple imputed datasets are reported here. Table 4 summarizes the results for the multinomial regression with just the main effects of each variable. There are 3 main columns, which represent the results for different focal groups that were compared to the dual-users. Regression coefficient estimates and 95% confidence intervals for the OR are given for each predictor in the model. The summary of findings below focus on the regression coefficients for SPD, binge drinking, and self-rated health since these were the main predictors of this study. Results for other covariates can be found in Table 4.

People with SPD were more likely to be dual-users than non-users (B = −0.68, $p < .001$), only cigarette users (B = −0.11, $p < .05$), or only e-cigarette users (B = −0.89, $p < .001$) after controlling for other variables in the model. Binge drinking also significantly predicted the likelihood of the tobacco/nicotine use variable. Compared to never binge drinkers, people reporting binge drinking 1–10 days/year were more likely to be dual-users than non-users (B = −0.61, $p < .01$) and more likely to be only tobacco cigarette users than dual-users (B = 0.49, $p < .05$) after controlling for all other variables in the model. There was no difference between individuals who were never binge drinkers and 1–10 days/year binge drinkers when comparing the e-cigarette users versus the dual-users (B = −0.39, n.s.). Individuals who binge drank more than 10 days/year compared to never binge drinkers, were more likely to be dual-users than non-users (B = −0.98, $p < .001$) or only e-cigarette users (B = −2.23, $p < .01$). Also, individuals who binge drank more than 10 days/year were more likely to be only cigarette users compared to the dual-users (B = 0.72, $p < .01$). After controlling for other

variables, poorer self-rated health predicted an increase in likelihood of being non-users (B = 0.17, p < .001), only tobacco cigarette users (B = 0.31, p < .001), and only e-cigarette users (B = 0.04, p < .05) compared to dual-users.

In order to study moderating effects of the main predictors (ie, SPD, binge drinking, and self-rated health,) by sex and age, interactions among the variables were included in the multinomial model. However, not all interaction terms could be included in the model because some interaction cells were empty (there were no cases for at least one of the cross-categories). [Note. The interaction between SPD and sex could not be added because there were no women who had dual use and SPD. The interaction between binge drinking and sex was not included because there were no women dual-users who reported their binge drinking status. The interaction between binge drinking and age was not included because there were no 18–24 years old who are cigarette only users and did not binge drink. Also, there were no older than 24 years old who were dual users and binge drank more than 10 days/year.]

The final interaction terms that were included in the model were SPD X age, self-rated health X sex, and self-rated health X age. Table 5 summarizes the results from the multinomial regression model including the interaction terms.

The majority of the interaction terms were significant for each of the focal categories that were compared to the dual-users. The only non-significant interaction was between SPD and age (B = −0.06, n.s.) for the regression model comparing non-users versus dual-users. In order to understand the interaction effects, simple slope analyses were conducted for the interaction terms that were significant. All coefficients were interpreted while holding other variables in the model constant (ie, controlling for other variables).

The simple slope analysis for the interaction between SPD and age indicated that the relationship between SPD and the likelihood of the tobacco/nicotine use categories were more strongly negative for those that were younger adults. For older adults, SPD was not a significant predictor of the likelihood of being only tobacco cigarette users versus dual-users (B = 0.06, n.s.), but SPD was a significant predictor of being dual-users compared to non-users (B = −0.52, p < .001) or only e-cigarette users (B = −0.54, p < .001) after controlling for all other variables. Compared to the older adults, younger adults who endorsed SPD were more likely to be dual-users compared to only tobacco cigarette users (B = −0.19, p < .05) or only e-cigarette users (B = −1.10, p < .001) after controlling for all other variables.

The simple slope of self-rated health on the likelihood of specific tobacco use categories was positively higher for men compared to women. For women, after controlling for other variables, the relationship between self-rated health and being non-users or being only e-cigarette users was negative (B = −0.28, p < .001 and B = −0.19, p < .001, respectively), indicating that women were more likely to be dual-users than non-users or e-cigarette users as their self-rated health was poorer. For women, self-rated health was not a significant predictor of the likelihood of being only cigarette users versus dual-users (B = 0.04, n.s.) after controlling for other variables. However, for men, the relationship between self-rated health and tobacco use status was positive for predicting non-users, only cigarette users, and

only e-cigarette users. That is, as self-rated health was poorer, men were more likely to be non-users (B = 0.66, p < .001), only cigarette users (B = 0.77, p < .001), or only e-cigarette users (B = 0.44, p < .001) compared to dual-users even after controlling for other variables.

Age moderated the relationship between self-rated health and tobacco/nicotine use. For young adults aged 18–24, the relationship between self-rated health and the likelihood of tobacco/nicotine use categories compared to dual-users was more strongly negative. For adults over 24-years-old, poorer health predicted higher likelihood to be dual-users than being non-users (B = −0.28, p < .001) or only e-cigarette users (B = −0.19, p < .001) after controlling for other variables. Self-rated health was not a significant predictor of the likelihood of only tobacco cigarette users versus dual-users (B = 0.04, n.s.) for older than 24-years-old adults after controlling for other variables. For younger adults aged 18–24, poorer health predicted even higher likelihood of being dual-users compared to non-users (B = −1.21; p < .001), only tobacco cigarette users (B = −1.13; p < .001), or only e-cigarette users (B = −1.21, p < .001) after controlling for other variables.

Finally, although not a research objective of this paper, given the diverse rates of smoking among H/L of diverse national backgrounds, [9] we conducted post hoc descriptive analyses of the main variables by ancestry groups. As shown in Table 6, the sample size in most of the ancestry categories is very small, which precluded examination of moderation effects by subgroups.

DISCUSSION

The present study documented the associations between 2 indicators of behavioral health (SPD and binge drinking) and self-rated health with tobacco/nicotine use among H/L, emphasizing comparisons between dual use and the use of only one product. Findings demonstrated the complexity of these relationships and the relatively important role of demographics like age and sex in further understanding the supported associations. The discussion of findings is organized by predictor variable in the subsections below.

SPD

Consistent with our hypotheses, H/L individuals with SPD were more likely to be dual users compared to non-users or individuals who utilized only one tobacco/nicotine product. Previous research has indicated that dual users with SPD have high positive expectancies of the e-cigarette use, including the belief that these products may provide health benefits. [38, 41, 65] Interestingly, the finding from the multivariate model was the opposite from the pattern shown by the bivariate correlations pointing to SPD as significantly related to less likelihood of being dual user compare to cigarette only. This difference might have occurred because other variables were controlled for in the multivariate multinomial regression and/or the interaction effects. For instance, the moderation analyses by age demonstrated that younger adults from 18–24 years old were more susceptible than older adults to use both tobacco cigarettes and e-cigarettes (versus only one product) when they are experiencing SPD. However, both age groups were more likely to be dual-users than non-users when they have experienced SPD. These findings are generally consistent with previous research[40] indicating the vulnerability of young adults who use e-cigarettes to also use other tobacco

products, and the overall known comorbidity of SPD and smoking.[35,38] On the other hand, the inability to conduct analyses by sex is not surprising given the low rate of dual use of tobacco products among women, including H/L.[63] Although previous studies among the general population has not documented sex differences in the link between SPD and dual use,[38, 40,41] it would be important to oversample H/L women with SPD in future tobacco research and/or conduct qualitative interviews to better understand the patterns of dual use among them.

Binge Drinking

The hypothesis regarding binge drinking and tobacco/nicotine use was only partially supported in that individuals engaging in higher binge drinking (more than 10 binge drinking episodes a year) were more likely to be dual users relative to non-users or e-cigarette users, but less likely to be dual users compared to only tobacco cigarettes. Thus, the expectation that H/L dual users would binge drink more compared to non-users and individuals that consume only one product is not supported by this data, but indicates that the relationship is contingent to the specific product used. These patterns of associations were the same in bivariate and multivariate analyses, which speaks to the consistency of findings. Binge drinking is an at-risk alcohol use pattern known to co-exist with the consumption of cigarette use among H/L; thus, this finding replicates previous research highlighting this comorbidity[46,47] and provides new data regarding associations between binge drinking and dual and e-cigarette use among H/L.[51] Of note, a common factor associated with binge drinking is the use of tobacco cigarette, either alone or in conjunction with e-cigarettes.

There was insufficient data to conduct analyses stratified by sex when examining associations between binge drinking and tobacco/nicotine use. This was not surprising because the overall low prevalence of smoking[4,9] and dual tobacco use[63] among H/L women and also their potential lower rates of binge drinking compared to men [66], particularly among less acculturated women. Notably, a low number of women reported their binge drinking status, which may be consistent with underreporting or social desirability related to their social norms[67].

On the other hand, it was surprising to note the lack of cases of older adults who were dual users and binge drank at high rates. As suggested by previous research, it is possible that these individuals use e-cigarettes as a method of cessation instead of intending a dual use[68,69] or simply discontinued dual use overtime. [70] In any case, insufficient data to examine these moderation effects precluded us to shed light on the unexpected relationship between binge drinking and the likelihood of being a tobacco cigarette user or dual user. Additional research is warranted, including examining the role of acculturation in these relationships.

Self-rated Health

The examination of self-rated health and tobacco/nicotine use among H/L is relatively novel. Contrary to our hypothesis, poor self-rated health predicted the likelihood of being a non-user, an only tobacco cigarette user, and only e-cigarette user compared to dual users. This

finding is counterintuitive and differs from the results of the bivariate associations whereas poor self-rated health was predictive of being a dual user relative to being a non-user and only e-cigarette user. The difference in patterns suggests that there are other contributing variables in the model and/or that the examined relationships are influenced by other factors. For instance, our findings demonstrated that the associations between poor self-rated health and tobacco/nicotine use vary by sex and age groups. Specifically, H/L females and young adults endorsing poor self-rated health are at risk of being dual tobacco users, while poor self-rated health protects men and older adults from being dual users.

The aforementioned outcomes raise the question about the directionality of findings, particularly given the cross-sectional nature of the data. Although speculative at this point, it is possible that individuals' report of poor self-rated health is influenced by their perception of tobacco use health risks [69] and/or that dual product consumption is a byproduct of or potential coping mechanism for co-existing behavioral health conditions,[68] which in turn, may affect self-rated health.[71] On the other hand, the lower likelihood of reporting being a dual user among older adults with poor self-rated health may suggest the tendency to reduce tobacco consumption with age. [58] These or additional explanations should be examined via further research, particularly longitudinal designs and qualitative studies.

The role of self-rated health in predicting tobacco/nicotine use among H/L may also be influenced by cultural and demographic factors related to baseline definitions of health. For instance, H/L reports lower self-rated health compared to Whites. [54–56] Importantly, as discussed by Jylha,[53] individuals from different cultures vary in their perceptions of health and in their willingness to disclose their health as positive or negative. Also, linguistic factors in the assessment of self-rated health may play a role in the endorsement of items as "fair", as they may mean something different across individuals. Similarly, age and sex also influence the assessment of health in likely complex ways, including the consideration of the comparison group and age-specific expectations.[53] For example, older people could compare their current health with their own former health and/or with others in the same age group or engaging in similar health behaviors. They also tend to assess their health more optimally than younger people, perhaps influenced by their expectation to have some health issues. Further, men tend to rate their health better than women, [54, 57, 58] which may directly and indirectly relate to tobacco use behaviors. Further research is needed to disentangle these relationships.

Strengths, Limitations And Directions For Future Research

This study has several strengths, both conceptual and methodological. This study was conducted in Houston, Texas which is the fourth largest city in the U.S.[72] and the most racially and ethnically diverse major metropolis in the country.[73] As such, it has a high population of H/L, which may represent the proportions in other areas of the country. Along this line, the study contributes to racial/ethnic disparities and tobacco-related disparities science by shedding light regarding behavioral health factors and self-rated health as predictors of tobacco/nicotine use in this priority population. Although preliminary at this point, our reports of the moderation effects of age and sex in predicting tobacco/nicotine use products are contributions to the literature. [74] Methodologically, this study was conducted

with data from the HHS, which utilized random sampling increasing the generalizability of the results. In addition, the definition of variables is consistent with other national surveys, like the Behavioral Risk Factor Surveillance System, which facilitates comparison of results across cities and states. Another strength is that the sampling weights were provided which allows for more accurate estimation of the model parameters. Finally, multiple imputation was utilized for analyses, which is the state-of-the-art method for dealing with missing data while assuming missing at random. [64]

Despite the noted study strengths, some limitations should be highlighted in order to better interpret the findings and for consideration in future studies. For instance, we acknowledge that the variables under study do not necessarily represent the unique or more central determinants of dual use among H/L as there are several other factors influencing smoking behaviors in this population, including unequal marketing exposure [75] and cultural factors. [14, 66] Additionally, disparities in social environments [77] may also be contributing factors, which warrant further investigation. Yet, given the role of behavioral health in tobacco use, [33,35,36,48] the relationships examined herein contribute to the understanding of tobacco-related health disparities among H/L, now with an extended focus on e-cigarette and dual use.

Data from this study is cross-sectional; thus, causality cannot be inferred. It is unclear whether psychological distress, binge drinking, and self-rated health have effects on tobacco use or if tobacco/nicotine use affects these variables. Also, most of the variables are categorical which might hinder the provision of abundant information. Future studies should use continued measures of the SPD and binge drinking as well as qualitative inquiries and longitudinal designs to collect more rich data. Additionally, the survey data was based on self-report; therefore, social desirability and/or bias recall may have played a role in the individual's responses. Another potential limitation is that there was insufficient data to conduct some moderation analyses and for the ones conducted, the results may have been underpowered given the sparseness of some of the interaction cells. Nonetheless, these preliminary results may spark the development and testing of specific hypotheses regarding the role of age and sex in H/L dual use of tobacco products, as well as the examination of these relationships by national subgroups. [9] Future research in these areas should use quota sampling methods and oversample H/L women who use both tobacco cigarette and e-cigarette, adults who binge drink, and H/L from ancestries other than Mexican to further investigate these moderations. Studies can also gather data from collaterals to compensate for none or underreporting. Lastly, we were not able to explore the study variables beyond self-identified sex. Data on sex identity or sexual orientation were not collected as part of the HHS; thus, we do not know the extent to which the findings are generalizable to sexual minorities. Given the smoking prevalence among the LGBTQ+ population,[77,78] we believe it is imperative that city and statewide surveys gather this important data so factors predicting tobacco cigarette and e-cigarette use can be studied among this vulnerable population.

Conclusion

Consistently, SPD, binge drinking, and self-rated health were significantly related to dual use of tobacco cigarette and e-cigarette when compared with non-users. However, the

relationships of these predictors with dual use versus only one product were not consistent for tobacco cigarette or e-cigarette use; rather, they were complex. In addition, age and sex demonstrated to be important moderators of the relationships examined, which speaks about the potential need for tailoring interventions according to subgroups. Furthermore, the strong relationships between SPD, binge drinking, and self-rated health with dual use speaks about the importance of assessing an array of tobacco/nicotine products in both research and clinical practice. Reducing the positive expectancies of the use of these products may increase the efficacy of tobacco control efforts targeting priority populations. [38,41] Along this line, the co-ocurrence of binge drinking with dual use and e-cigarette calls for the application and testing of evidence-based interventions focused on the reduction of multiple risk behaviors.[79]

Acknowledgements

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Table 1.

Measurement of Study Variables

Variable	Measurement	Categories
Predictor Variables		
Serious psychological distress (SPD)*	Kessler's scale of 6 questions assessing frequency of symptoms on a 0 to 4 scale. Score of 13 or greater indicated SPD. Example: *About how often during the past 30 days did you feel nervous-would you say all of the time, most of the time, some of the time, a little of the time, or none of the time?*	0= no 1= yes
Binge drinking	*In the past 12 months, about how many times did you have 5 (male)/4 (female) or more alcoholic drinks in a single day?*	0= no days binge drinking 1= 1–10 days/year 2= more than 10 days/year
Self-rated health	*Would you say your health in general is excellent, very good, good, fair, or poor?*	1= excellent 2= very good 3= good 4= fair 5= poor
Dependent Variable		
Tobacco/Nicotine Use	Combination of the variables current cigarette smoking pattern (i.e., *Do you now smoke cigarettes every day, some days, or not at all?*) and electronic cigarette smoking pattern (i.e., *Do you now use e-cigarettes every day, some days, or not at all?*)	0= non-users 1= only tobacco cigarettes 2= only e-cigarettes 3= dual users
Moderators		
Age	[Variable created from multiple survey questions]	1= 18–24 2= 25–69 3= 60 and over
Sex	*May I confirm your gender?*	1= male 2= female
Covariates		
Education		1= Less than High school 2= High school/some college 3= College and beyond

Table 2.

Descriptive Statistics of Study Variables for Unweighted and Weighted Sample

Variable	Descriptive statistics for original data without weights $n = 188$	Descriptive statistics for imputed data with weights (frequencies rounded to whole numbers) $n = 158,369$
Tobacco/nicotine use	Non-users = 93 (49.5%) Cigarette users = 45 (23.9%) E-cigarette users = 31 (16.5%) Dual-users = 19 (10.1%)	Non-users = 73,873 (46.7%) Cigarette users = 44,925 (28.4%) E-cigarette users = 25,348 (16.0%) Dual-users = 14,223 (9.0%)
Serious psychological distress	No = 164 (87.2%) Yes = 24 (12.8%)	No = 137,645 (86.9%) Yes = 20,724 (13.1%)
Binge drinking ($n = 151$)	None = 49 (32.5%) 1–10 days/year = 74 (49%) More than 10 days/year = 28 (18.5%)	None = 52,312 (33.0%) 1–10 days/year = 76,918 (48.6%) More than 10 days/year = 29,138 (18.4%)
Self-rated health (1=Excellent to 5=Poor)	Mean = 2.57 Standard Deviation = 1.15	Mean = 2.65 Standard Deviation = 1.24
Age	18–24 = 77 (41%) Above 24 = 111 (59%)	18–24 = 53,118 (33.5%) Above 24 = 105,251 (66.5%)
Sex	Male = 127 (67.6%) Female = 61 (32.4%)	Male = 119,159 (75.2%) Female = 39,210 (24.8%)
Education level	Less than high school = 24 (12.8%) High school/some college = 131 (69.7%) College and beyond = 24 (17.6%)	Less than high school = 33,240 (21.0%) High school/some college = 107,502 (67.9%) College and beyond = 17,627 (11.1%)

Table 3.

Bivariate Correlations among Study Variables

	1	2	3	4	5	6	7	8	9	10	11
1. Non-users[a]	1	N/A	N/A	-.04*	-.06	-.08*	-.05*	-.18*	.13*	.11*	-.04*
2. Cig. only[a]	N/A	1	N/A	.07*	.03	.17*	.17*	.25*	-.10*	-.11*	-.09*
3. E-cig. only[a]	N/A	N/A	1	-.06*	.07	-.15*	-.08*	-.04*	.06*	-.03*	.08*
4. Serious Psychological Distress	.04	.01	-.08	1	-.04*	.11*	.05*	-.05*	.14*	-.01*	-.10*
5. Binge drink 1–10 days/year[b]	-.08	.08	.02	-.05	1	N/A	-.01	.03	.20*	-.15*	.06*
6. Binge drink more than 10 days/year[b]	-.03	.12	-.11	.11	N/A	1	.08*	-.04	-.04	-.08*	.07*
7. Self-rated health	.01	.10	-.10	.05	-.01	.05	1	.19*	-.00	-.24*	-.09*
8. Age (18–24)	.15*	-.26*	.10	.07	-.10	.05	-.17*	1	-.03*	-.33*	.17*
9. Female	.11	-.10	.06	.04	.05	-.10	.01	-.05	1	-.01*	.08*
10. High School /some college[c]	.07	-.09	-.02	.01	-.08	.02	-.07	.31*	.01	1	N/A
11. College and beyond[c]	-.04	.00	.02	-.09	.14*	.00	-.10	-.27*	.01	N/A	1

[a]Reference group was dual-users;

[b]Reference group was no binge drinking;

[c]Reference group was less than high school education;

*
p < .05. Column numbers refer to the corresponding variables listed in the rows. N/As were entered for correlations between dummy variables for the same categorical variable. The numbers in the lower left diagonal indicate the bivariate correlations for the original data and the bold numbers in the upper right diagonal indicate the correlations for the sampling-weighted data.

Table 4.

Multinomial Regression Results for the Main Effects Model

	Focal group					
	Non-users		Only cigarettes		Only e-cigarettes	
Variables	B	95% CI for exp(B)	B	95% CI for exp(B)	B	95% CI for exp(B)
Intercept	4.89***		3.06***		3.91***	
Serious psychological distress	−0.68***	(0.48, 0.54)	−0.11*	(0.82, 0.98)	−0.89***	(0.37, 0.46)
Binge drinking 1–10 days[a]	−0.61**	(0.38, 0.79)	0.49*	(1.01, 2.67)	−0.39	(0.36, 1.28)
Binge drinking more than 10 days[a]	−0.98***	(0.25, 0.56)	0.72**	(1.31, 3.23)	−2.23**	(0.03, 0.40)
Self-rated health	0.17***	(1.15, 1.22)	0.31***	(1.31, 1.40)	0.04*	(1.00, 1.08)
Age 18–24 years old	0.29***	(1.24, 1.45)	−1.35***	(0.24, 0.29)	0.22***	(1.12, 1.40)
Male	−2.34***	(0.09, 0.11)	−1.25***	(0.24, 0.34)	−2.21***	(0.09, 0.13)
Education – High school/some college[b]	−0.81***	(0.40, 0.50)	−0.82***	(0.37, 0.52)	−1.10***	(0.28, 0.40)
Education – College and beyond[b]	−1.47***	(0.20, 0.27)	−2.28***	(0.09, 0.12)	−1.10***	(0.26, 0.43)

Note. Reference category for outcome variables was dual users; CI= confidence interval

*
p < .05.

**
p < .01.

***
p < .001.

[a]Reference category was no binge drinking.

[b]Reference category was less than high school education.

Table 5.

Multinomial Regression Results Including Interaction Terms

Variables	Focal Group					
	Non-users		Only cigarettes		Only e-cigarettes	
	B	95% CI for exp(B)	B	95% CI for exp(B)	B	95% CI for exp(B)
Intercept	4.48***		2.53***		3.53***	
Serious Psychological Distress	-0.52***	(0.53, 0.66)	0.06	(0.92, 1.22)	-0.54***	(0.51, 0.67)
Binge Drinking 1–10 days[a]	-0.51*	(0.41, 0.88)	0.61*	(1.08, 3.14)	-0.30	(0.39, 1.40)
Binge drinking more than 11 days[a]	-0.81**	(0.30, 0.67)	0.89**	(1.44, 4.10)	-2.07**	(0.03, 0.47)
Self-rated health issues	-0.28***	(0.70, 0.82)	0.04	(0.94, 1.14)	-0.19***	(0.75, 0.91)
Age 18–24 years old	0.05	(0.96, 1.14)	-1.52***	(0.19, 0.25)	0.05	(0.91, 1.21)
Male	-2.18***	(0.10, 0.13)	-1.00***	(0.31, 0.44)	-2.07***	(0.10, 0.16)
Education – High school/some college[b]	-0.38***	(0.61, 0.77)	-0.37**	(0.57, 0.84)	-0.71***	(0.40, 0.61)
Education – College and beyond[b]	-1.05***	(0.30, 0.41)	-1.82***	(0.13, 0.20)	-0.72***	(0.39, 0.61)
Age X Serious Psychological Distress	-0.06	(0.80, 1.10)	-0.25*	(0.61, 1.00)	-0.56***	(0.46, 0.71)
Male X Self-rated health	0.94***	(2.32, 2.80)	0.73***	(1.89, 2.30)	0.64***	(1.66, 2.15)
Age X Self-rated health	-0.93***	(0.37, 0.42)	-1.16***	(0.29, 0.34)	-1.02***	(0.32, 0.41)

Note. Reference category for outcome variables was dual users; CI= confidence interval

*
$p < .05$.

**
$p < .01$.

***
$p < .001$.

[a]Reference category was no binge drinking.

[b]Reference category was less than high school education.

Table 6.

Descriptive Statistics of the Main Variables by Ancestry Groups

Variables	Mexican	Salvadoran	Other Central American	Other Caribbean Hispanic	South American	Other Hispanic	Multiple Hispanic ancestries
N	118	6	3	8	9	19	16
Tobacco/Nicotine Use							
Non-users	66	3	0	2	3	9	8
Cigarette user	25	2	3	3	2	5	2
E-Cigarette user	17	1	0	2	1	4	4
Dual users	10	0	0	1	3	1	2
Serious Psychological Distress							
Yes	19	1	0	1	0	1	1
No	99	5	3	7	9	18	15
Binge Drinking							
No binge drinking	30	0	1	5	1	8	4
1–10 days	50	1	0	3	3	6	5
More than 10 days	16	0	2	0	3	3	2
Self-reported Health							
Mean	2.72	2.17	2.00	2.75	2.22	2.53	2.19
Standard Deviation	1.11	1.33	1.00	1.28	1.09	1.26	1.22

Note. Numbers in the cells represent actual counts. Frequencies are from the raw data. Difference in counts are due to missing data in the respective variable.