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Perceived Harms of and Exposure to Tobacco Use and Current Tobacco Use among Reproductive-Aged Women from the PATH Study

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Abstract

Data for this study were obtained from reproductive-aged women (age 18 to 44 years, at wave 1) from waves 1 (2013–2014) and 2 (2014–2015) of the Population Assessment of Tobacco and Health Study (n = 13,241). Bivariate and multinomial regression analyses were performed associating past 30-day use of cigarettes only, e-cigarettes only, and dual use with perceptions of harm, exposure to tobacco product use, and sociodemographic variables. Cross-sectional and longitudinal analyses were conducted. Of all reproductive-aged women included in the analyses, 75.5% reported no tobacco use, 16.9% reported cigarette use only, 1.5% reported e-cigarette use only, and 6.1% reported dual use within the past 30 days. Perceived harm, tobacco exposure, pregnancy status, age, race/ethnicity, income, education, and sexual orientation were associated with past 30-day use, cross-sectionally at wave 1. Similar associations were found for longitudinal analyses using wave 2 data, except for income and education, which were no longer associated. Results of this study contribute to knowledge regarding prevalence and correlates of tobacco use across exclusive cigarette, exclusive e-cigarette, and dual use among reproductive-aged women.

Keywords

Cigarette; E-Cigarette; Tobacco Use; Smoking; Risk Factors

Introduction

Cigarette smoking among women of reproductive age is a public health problem. Women who smoke are at higher risk of developing osteoporosis, early menopause, and cervical

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Declaration of Interest Statement

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cancer (Roth and Taylor 2001). In 2016, 7.2% of women who gave birth reported smoking cigarettes during pregnancy (Drake, Driscoll, and Mathews 2018). Smoking by women of reproductive age during pregnancy is the leading preventable cause of many adverse outcomes including maternal, fetal, and infant morbidity and mortality (U.S. Department of Health and Human Services 2014). Specifically, maternal smoking during pregnancy increases risk for birth complications, including preterm birth, low birth weight, and sudden infant death (Berlin 2017) and has long-term effects on the child, including behavioral problems and chronic health conditions in adulthood (Dietz et al. 2010; England et al. 2015).

Recently, alternative tobacco products, such as electronic cigarettes (or e-cigarettes) have been gaining popularity (Schoenborn and Gindi 2015; Liu et al. 2019). E-cigarettes have been marketed as safer alternatives to conventional cigarettes (Berg et al. 2015). However, available data indicates that use of e-cigarettes is not without risk. E-liquids used in e-cigarettes have been found to contain detectable levels of carcinogens, such as formaldehyde and nitrosamines, and toxins such as diethylene glycol (Cheng 2014; Jensen et al. 2015). Using these e-liquids have been associated with a number of health risks, including: throat and mouth irritation, coughing, nausea, vomiting, and pulmonary health risks, related to pulmonary inflammation and reduced functioning (Grana, Benowitz, and Glantz 2014).

Although use of e-cigarettes may help to reduce harms caused by cigarette smoking among smokers (Caponnetto et al. 2013; Farsalinos and Polosa 2014), there is currently no evidence to suggest that e-cigarettes are a safe alternative to maternal smoking during pregnancy. Like traditional cigarettes, e-cigarettes contain nicotine, which can pose danger to pregnant women and their developing fetuses (Kennedy et al. 2017; Spindel and McEvoy 2016). E-cigarettes are a heterogeneous product class, with significant variability in the nicotine delivery from different e-cigarette devices (Voos, Goniewicz, and Eissenberg 2019). This is concerning, as the amount of nicotine consumed by e-cigarette users has been found to be comparable to, or sometimes greater than, the amount consumed by cigarette smokers (Whittington et al. 2018).

Currently, cigarettes are the main source of tobacco used by women of reproductive age in the United States, though e-cigarettes are quickly growing in popularity (Berg et al. 2015; Kurti et al. 2018). It is estimated that 10% of women smoke three months prior to pregnancy (Curtin and Matthews 2016). More than half of women in the United States who smoke will continue to do so during pregnancy (Orleans et al. 2000) and only 25% will successfully quit during pregnancy (Curtin and Matthews 2016). Given that many women who smoke prior to pregnancy continue to do so during their pregnancy (Shoff and Yang 2013) and that the use of e-cigarettes to quit smoking may be common in women of reproductive age, including those who are pregnant (Oncken et al. 2017; Whittington et al. 2018), understanding patterns of tobacco product use among reproductive-aged women is critical in addressing the problem of maternal smoking during pregnancy. Thus, the current study objective was to examine cross-sectional and longitudinal associations between perceived harms, exposure to tobacco product use, and sociodemographic variables with current exclusive cigarette, current exclusive e-cigarette, and current dual use among reproductive-aged women.

Methods

Study Population.

The Population Assessment of Tobacco and Health (PATH) Study is a household-based, nationally representative, longitudinal cohort study of adults and youth in the United States. Adult tobacco users, young adults (18–24 years) and African-Americans were oversampled relative to population proportions. Weights adjust for non-response bias and oversampling and yield representative estimates of the non-institutionalized, civilian US population. Data were obtained from the Public Use Files of wave 1 (collected September 2013 to December 2014) and wave 2 (collected October 2014 to 2015) (Hyland et al. 2017). Of the total wave 1 adult respondents (n=32,320), we limited analyses to reproductive-aged women who had not used any other form of tobacco besides cigarettes or e-cigarettes in the past 30 days (18 to 44 years at wave 1; n=13,241) who completed waves 1 & 2. Details on adult sampling and weighting procedures are briefly described below, and in more detail elsewhere (Kurti et al. 2018; Hyland et al. 2017).

Sampling procedures.

Briefly, a four-stage stratified area probability sample design was used, with a two-phase design for sampling the adult cohort at the final stage. During the first stage, a stratified sample of 156 geographical primary sampling units (PSUs, generally counties or groups of counties) was selected. Within each PSU, the second stage formed and sampled small geographical segments. The third-stage sampled residential addresses in the US Postal Service Computerized Delivery Sequence Files, with coverage enhancement procedures used to include addresses not listed in those files. The fourth stage selected individuals from the sampled households, with a roster constructed by interviewing one adult household member to list the household members and collect information about each one for use in sampling adults (up to two per household) and children (aged 9–11 years and separately for those aged 12–17 years). A two-phase sampling procedure was used to select adults within the sampled households, with the first phase using higher selection probabilities for young adults, African Americans, and tobacco users, and the second phase relying on self-reported age, race, and tobacco use status to correct any errors in classification. This sample was to be representative of the 2013 civilian, non-institutionalized United States population aged 12 and over (Hyland et al. 2017).

Data collection protocols.

PATH Study protocol included four main data collection components: (1) a CAPI household screening questionnaire administered by an interviewer, (2) self-administered ACASI questionnaires for the adult and youth interviews, (3) a CAPI questionnaire administered by an interviewer to the parent or guardian of each youth, and (4) collection of biospecimens from consenting adults (Hyland et al. 2017). For wave 1, the weighted overall response rate for the Household Screener was 54.0% and weighted overall response rate for the adult interview was 74.0%. Weighted retention rates were 84.3% for continuing adults (Conway 2015). The Westat Institutional Review Board (IRB) approved the study design and protocol to safeguard the rights, welfare, and well-being of all humans involved in the PATH Study. Informed consent was provided by all participating adults. The Office of Management and

Budget approved the data collection protocol (Hyland et al. 2017). Informed consent was obtained from participants following the initial eligibility screening. The protocol for secondary data analysis using de-identified data was reviewed and approved as exempt by the Virginia Commonwealth University IRB.

Measures.

The main outcomes of interest in wave 1 and 2 was current tobacco use, categorized as no current tobacco use (if the participant had not used cigarettes or e-cigarettes within the past 30 days), current exclusive cigarette use (if the participant had only used cigarettes within the past 30 days), current exclusive e-cigarette use (if the participant had only used e-cigarettes within the past 30 days), and current dual use (if the participant indicated that she had used both cigarettes and e-cigarettes in the past 30 days). Perceptions of harm related to cigarettes were measured in wave 1 by the following question: “How much do you think people harm themselves when they use cigarettes?” Participants could respond to this question with: not at all harmful, slightly harmful, somewhat harmful, very harmful, and extremely harmful. The response categories not at all harmful and slightly harmful were combined into one category. Perceptions of harm related to e-cigarettes were measured by the following question: “How much do you think people harm themselves when they use electronic cigarettes?” Potential responses included: more harmful than cigarettes, as harmful as cigarettes, and less harmful than cigarettes. Exposure to tobacco product use, included two measures: one for household smokers and another measuring general smoke exposure in the past 7 days. Both measures were coded as binary (yes or no) variables.

Potential covariates.

Pregnancy status was defined as not pregnant in any wave or pregnant at any wave. Ever cigarette use and ever e-cigarette use were binary variables (yes or no). Other covariates included wave 1 measures of: age (18–24 years; 25–34 years; or 35–44 years), race/ethnicity (White; Black; or Other, including Hispanic), income (<\$10000; \$10000 to \$24999; \$25000 to \$49999; \$50000 to \$99999; or \$100000), education (less than high school; GED/high school diploma; some college; or bachelor’s degree or higher), and sexual orientation (heterosexual or lesbian, gay, bisexual, other). Marital status (married; divorced, widowed, or separated; or never married) at wave 2 was used since this information was not available in wave 1.

Statistical Analysis.

Weighted descriptive analyses and bivariate associations were performed on current use outcome variables, perceptions of harm, tobacco use exposure, and sociodemographic variables both cross-sectionally (wave 1) and in longitudinal analyses (wave 1 characteristics associated with measures of tobacco use at wave 2). Weighted multivariate logistic regressions, adjusted for by potential covariates, were fit to the data to evaluate associations between perceptions of harm, tobacco use exposure, and outcomes. Potential covariates were included as a means to control confounding and to obtain unbiased estimates. Variable selection for covariates was determined from a review of the existing literature (Walter and Tiemeier 2009). Separate multinomial regression models were conducted for wave 1 and wave 2. Analyses for wave 2 are adjusted for current tobacco use in wave 1 (e.g. current

exclusive cigarette use, current exclusive e-cigarette use, and current dual use vs. no tobacco use at wave 1). The reference group for these models were those who did not report current cigarette, e-cigarette, or dual use. All potential covariates were included in each of these separate models. All analyses were performed using SAS 9.4 (Cary, NC).

Results

Over half (59.3%) of our sample indicated that they had ever used cigarettes and 23.1% had indicated that they had ever used e-cigarettes in their lifetime. Approximately 16.9% of our sample reported past 30-day exclusive cigarette use, 1.9% reported past 30-day exclusive e-cigarette use, and 6.1% reported past 30-day dual use. A majority of the sample reported that they were not pregnant at either wave (94.9%), between 35–44 years old (53.0%), White (75.3%), earning at least \$25,000 in annual household income (62.7%), obtaining at least some college education (65.3%), straight (92.1%), married (50.4%), based on data from both waves. In unadjusted bivariate analyses of wave 1 data, differences across each of these variables were found to be statistically significant across each current use outcome variable, except for pregnancy status (Table 1). Generally, in adjusted analyses, lower perceived harms of cigarettes and e-cigarettes, greater exposure to tobacco product use (within household and generally), and older age were associated with increased odds of reporting current use (exclusive cigarette, exclusive e-cigarette, and dual use). Pregnancy, higher income, higher education, and self-reported Black race/ethnicity were associated with decreased odds of current tobacco use. Many of these associations remained significant in longitudinal analyses, except for reported income and education categories, which were no longer significant at wave 2. Current use at wave 1 was strongly associated with current use outcome variables at wave 2 (Table 2).

Discussion

The current study sought to determine whether perceived harms and exposure to tobacco product use is associated with current use (as measured by no current tobacco use, exclusive cigarette use, current exclusive e-cigarette use, and current dual use) both cross-sectionally and longitudinally, among a sample of reproductive-aged women. As has been previously reported, the prevalence of current use was highest for current exclusive cigarette use, followed by current dual use, and current exclusive e-cigarette use (Kurti et al. 2018; 2017). Results demonstrated that perceived harm, tobacco exposure, pregnancy status, age, race/ethnicity, income, education, sexual orientation were associated with current exclusive cigarette, current exclusive e-cigarette, and current dual use, cross-sectionally at wave 1. Similar associations were found in longitudinal analyses at wave 2, except for income and education, which were no longer associated with current exclusive cigarette and current dual use at wave 2. Marital status was also found to be associated with current dual use at wave 2. Sensitivity analyses removing the effect of marital status was conducted, indicating that results were not sensitive to including or excluding this variable. Further research is needed to examine associations between marital status and current dual use of cigarettes and e-cigarettes.

The associations that we found between pregnancy status, higher income, higher education, and self-reported Black race/ethnicity and decreased odds of current tobacco use is consistent with prior research using cross-sectional data (Kandel, Griesler, and Schaffran 2009; Lopez et al. 2018). Specifically, our estimated prevalence of past 30-day exclusive cigarette (16.9%), exclusive e-cigarette (1.9%), and dual use (6.1%) among reproductive-aged women is comparable to rates found across a nationally representative sample of adult employees in the US workplace (Kava, Hannon, and Harris 2020). According to data from the 2017 Behavioral Risk Factor Surveillance System, approximately 17.0% of US adult employees were current smokers, 5% were current e-cigarette users, and 2% were dual users. Women were less likely than men to use tobacco in any form. Though, similar to our study, exclusive e-cigarette use and dual use were associated with younger age, lower education, and race/ethnicity such that those who identified as Black, Asian, or Hispanic were less likely to report e-cigarette use (Kava, Hannon, and Harris 2020). Despite having lower odds of current tobacco use, racial/ethnic minorities and those with low socioeconomic status experience tobacco-related disease and illness, such as cancer, at a disproportionate rate. These individuals may experience unique social and environmental challenges, such as greater environmental cues to smoke and greater levels of perceived stress and social discrimination that may make it more difficult to quit once they start using tobacco (“Race/Ethnicity” 2017; Simmons et al. 2016).

Perceived harms of cigarettes were the greatest among non-current users of any tobacco product, suggesting that perceived harms of substances are a strong deterrent for use. These findings align with previous research conducted using a sample of young adult, sexual and gender minorities, which found an association between low tobacco harm perceptions and past 30-day tobacco use (Ganz et al. 2018). We also found that perceived harms of e-cigarette use in wave 1 was associated with current exclusive e-cigarette use in wave 1, but not associated with current exclusive cigarette and current dual use in wave 2. Thus, perceived risk of e-cigarettes might be useful for determining the odds risk for e-cigarette use, but may not be as useful for determining the odds risk for exclusive cigarette or dual use among reproductive-aged women.

The reason for this could be that perceived harms of e-cigarettes are changing. One recent study using data from two US National Surveys found that the proportion of US adults who perceive e-cigarettes to be harmful or more harmful than cigarettes increased from 2012 to 2017. Huang and colleagues (2019) also found that some smokers were deterred from using or switching to e-cigarettes, due to growing perceptions that e-cigarettes are equally harmful or more harmful than cigarettes. Specifically, a higher proportion of e-cigarette users perceived e-cigarettes as less harmful than cigarettes, when compared to never, former, and current smokers (Huang et al. 2019). In line with these findings, other studies have demonstrated that lower levels of perceived harm of e-cigarettes relative to cigarettes were associated with endorsement of ever trying and current use of e-cigarettes among adults (Pokhrel et al. 2015; Wackowski and Delnevo 2016; Baeza-Loya et al. 2014) and exclusive use of e-cigarettes among smokers who switched to e-cigarette use from cigarettes (Farsalinos, Romagna, and Voudris 2015). Results from the current study demonstrate that perceived risk of e-cigarettes at wave 1 have a differential effect on current exclusive cigarette, current exclusive e-cigarette, and current dual use at wave 2, thereby providing

justification for further research related to the investigation of the effects that perceived harms of cigarettes and e-cigarettes have on tobacco use, longitudinally, as more information on the long-term effects of e-cigarette use becomes available.

Study limitations included the use of self-reported data, which have the potential to introduce recall and social desirability biases, leading to possible under-reporting (Dietz et al. 2011). Additionally, this study did not control for measures of substance use history or impulsivity, which have been previously associated with cigarette and e-cigarette use among reproductive aged women (Chivers et al. 2016). Despite these limitations, this is one of only a few studies that have focused on risk factors for tobacco use among reproductive-aged women, both cross-sectionally and longitudinally.

Conclusions

Results of this study contribute to knowledge regarding prevalence and correlates of tobacco use across current exclusive cigarette, exclusive e-cigarette, and dual use among reproductive-aged women, cross-sectionally and longitudinally. Factors associated with current use include perceived harm, tobacco exposure, pregnancy status, age, race/ethnicity, income, education, sexual orientation, and marital status. Future studies should control for these factors, as a means to control for confounding and to obtain unbiased estimates for associations. Furthermore, results demonstrate differential longitudinal associations between perceived harm of e-cigarettes and current exclusive cigarette, exclusive e-cigarette, and dual use. These results underscore the importance of public health messaging, which needs to appropriately balance emphasis on potential reductions in harm from completely switching to e-cigarette use from cigarettes and the absolute harms of e-cigarette use. This is especially important within reproductive aged women, who are current tobacco users that may be thinking about becoming pregnant. Future research examining tobacco use patterns among reproductive-aged women should require longer follow-up periods to allow for assessment of association trends over time, in efforts to better understand the long-term impacts of the risk factors associated with current tobacco use as identified in the current study. Conducting this future research will help to explain why certain groups of women continue to use and how pregnancy influences these patterns over time.

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References

- Baeza-Loya Selina, Viswanath Humsini, Carter Asasia, Molfese David L., Velasquez Kenia M., Baldwin Philip R., Thompson-Lake Daisy G. Y., et al. 2014 "Perceptions about E-Cigarette Safety

- May Lead to e-Smoking during Pregnancy.” *Bulletin of the Menninger Clinic* 78 (3): 243–52. 10.1521/bumc.2014.78.3.243. [PubMed: 25247743]
- Berg Carla J., Stratton Erin, Schauer Gillian L., Lewis Michael, Wang Yanwen, Windle Michael, and Kegler Michelle. 2015 “Perceived Harm, Addictiveness, and Social Acceptability of Tobacco Products and Marijuana among Young Adults: Marijuana, Hookah, and Electronic Cigarettes Win.” *Substance Use & Misuse* 50 (1): 79–89. 10.3109/10826084.2014.958857. [PubMed: 25268294]
- Berlin Ivan. 2017 “Commentary on Niemelä et al. (2017): Maternal Smoking during Pregnancy—an Independent Risk Factor of Postnatal Health Disorders.” *Addiction* 112 (1): 144–45. 10.1111/add.13642. [PubMed: 27936503]
- Caponnetto Pasquale, Campagna Davide, Cibella Fabio, Morjaria Jaymin B., Caruso Massimo, Russo Cristina, and Polosa Riccardo. 2013 “Efficiency and Safety of an Electronic Cigarette (ECLAT) as Tobacco Cigarettes Substitute: A Prospective 12-Month Randomized Control Design Study.” *PLoS One* 8 (6): e66317. 10.1371/journal.pone.0066317.
- Cheng Tianrong. 2014 “Chemical Evaluation of Electronic Cigarettes.” *Tobacco Control* 23 (Suppl 2): ii11–17. 10.1136/tobaccocontrol-2013-051482.
- Chivers Laura L., Hand Dennis J., Priest Jeff S., and Higgins Stephen T.. 2016 “E-Cigarette Use among Women of Reproductive Age: Impulsivity, Cigarette Smoking Status, and Other Risk Factors.” *Preventive Medicine, Special Issue: behavior change, health, and health disparities* 2016, 92 (11): 126–34. 10.1016/j.ypmed.2016.07.029.
- Conway Kevin P. 2015 “Population Assessment of Tobacco and Health Study: Interim Report to the Office of Management and Budget on Wave 1 and Wave 2 Data and Biospecimen Collection” Interim Report. Rockville, Maryland: National Institute on Drug Abuse <https://www.reginfo.gov/public/do/DownloadDocument?objectID=56575601>.
- Curtin SC, and Matthews TJ. 2016 “Smoking Prevalence and Cessation Before and During Pregnancy: Data From the Birth Certificate, 2014.” *National Vital Statistics Reports : From the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System* 65 (1): 1–14. <https://europaemc.org/article/med/26905977>.
- Dietz Patricia M., England Lucinda J., Shapiro-Mendoza Carrie K., Tong Van T., Farr Sherry L., and Callaghan William M. 2010 “Infant Morbidity and Mortality Attributable to Prenatal Smoking in the U.S.” *American Journal of Preventive Medicine* 39 (1): 45–52. 10.1016/j.amepre.2010.03.009. [PubMed: 20547278]
- Dietz Patricia M., Homa David, England Lucinda J., Burley Kim, Tong Van T., Dube Shanta R., and Bernert John T.. 2011 “Estimates of Nondisclosure of Cigarette Smoking Among Pregnant and Nonpregnant Women of Reproductive Age in the United States.” *American Journal of Epidemiology* 173 (3): 355–59. 10.1093/aje/kwq381. [PubMed: 21178103]
- Drake P, Driscoll AK, and Mathews TJ. 2018 “Cigarette Smoking During Pregnancy: United States, 2016” Data Brief NCHS Data Brief No. 305. Atlanta, GA: Centers for Disease Control and Prevention <https://www.cdc.gov/nchs/products/databriefs/db305.htm>.
- England Lucinda J., Bunnell Rebecca E., Pechacek Terry F., Tong Van T., and McAfee Tim A. 2015 “Nicotine and the Developing Human: A Neglected Element in the Electronic Cigarette Debate.” *American Journal of Preventive Medicine* 49 (2): 286–93. 10.1016/j.amepre.2015.01.015. [PubMed: 25794473]
- Farsalinos Konstantinos E., and Polosa Riccardo. 2014 “Safety Evaluation and Risk Assessment of Electronic Cigarettes as Tobacco Cigarette Substitutes: A Systematic Review.” *Therapeutic Advances in Drug Safety* 5 (2): 67–86. 10.1177/2042098614524430. [PubMed: 25083263]
- Farsalinos Konstantinos E., Romagna Giorgio, and Voudris Vassilis. 2015 “Factors Associated with Dual Use of Tobacco and Electronic Cigarettes: A Case Control Study.” *The International Journal on Drug Policy* 26 (6): 595–600. 10.1016/j.drugpo.2015.01.006. [PubMed: 25687714]
- Ganz Ollie, Johnson Amanda L., Cohn Amy M., Rath Jessica, Horn Kimberly, Vallone Donna, and Villanti Andrea C.. 2018 “Tobacco Harm Perceptions and Use among Sexual and Gender Minorities: Findings from a National Sample of Young Adults in the United States.” *Addictive Behaviors* 81: 104–8. 10.1016/j.addbeh.2018.01.032. [PubMed: 29454177]
- Grana Rachel, Benowitz Neal, and Glantz Stanton A.. 2014 “E-Cigarettes: A Scientific Review.” *Circulation* 129 (19): 1972–86. 10.1161/CIRCULATIONAHA.114.007667. [PubMed: 24821826]

- Huang Jidong, Feng Bo, Weaver Scott R., Pechacek Terry F., Slovic Paul, and Eriksen Michael P.. 2019 "Changing Perceptions of Harm of E-Cigarette vs Cigarette Use Among Adults in 2 US National Surveys From 2012 to 2017." *JAMA Network Open* 2 (3): e191047–e191047. 10.1001/jamanetworkopen.2019.1047.
- Hyland Andrew, Ambrose Bridget K., Conway Kevin P., Borek Nicolette, Lambert Elizabeth, Carusi Charles, Taylor Kristie, et al. 2017 "Design and Methods of the Population Assessment of Tobacco and Health (PATH) Study." *Tobacco Control* 26 (4): 371–78. 10.1136/tobaccocontrol-2016-052934. [PubMed: 27507901]
- Jensen R Paul Wentai Luo, Pankow James F., Strongin Robert M., and Peyton David H. 2015 "Hidden Formaldehyde in E-Cigarette Aerosols." *The New England Journal of Medicine* 372 (4): 392–94. 10.1056/NEJMc1413069. [PubMed: 25607446]
- Kandel Denise B., Griesler Pamela C., and Schaffran Christine. 2009 "Educational Attainment and Smoking among Women: Risk Factors and Consequences for Offspring." *Drug and Alcohol Dependence, Women and Smoking: An Interdisciplinary Examination of Socioeconomic Influences*, 104 (10): S24–33. 10.1016/j.drugalcdep.2008.12.005.
- Kava Christine M., Hannon Peggy A., and Harris Jeffrey R.. 2020 "Use of Cigarettes and E-Cigarettes and Dual Use Among Adult Employees in the US Workplace." *Preventing Chronic Disease* 17 10.5888/pcd17.190217.
- Kennedy Allyson E., Kandam Suraj, Rene Olivares-Navarrete, and Dickinson Amanda J. G. 2017 "E-Cigarette Aerosol Exposure Can Cause Craniofacial Defects in *Xenopus Laevis* Embryos and Mammalian Neural Crest Cells." *PLoS ONE* 12 (9). 10.1371/journal.pone.0185729.
- Kurti Allison N., Bunn Janice Y., Villanti Andrea C., Stanton Cassandra A., Redner Ryan, Lopez Alexa A., Gaalema Diann E., et al. 2018 "Patterns of Single and Multiple Tobacco Product Use Among US Women of Reproductive Age." *Nicotine & Tobacco Research* 20 (suppl_1): S71–80. 10.1093/ntr/nty024. [PubMed: 30125011]
- Kurti Allison N., Redner Ryan, Lopez Alexa A., Keith Diana R., Villanti Andrea C., Stanton Cassandra A., Gaalema Diann E., et al. 2017 "Tobacco and Nicotine Delivery Product Use in a National Sample of Pregnant Women." *Preventive Medicine*, 8 10.1016/j.ypmed.2017.07.030.
- Liu Buyun, Xu Guifeng, Rong Shuang, Santillan Donna A., Santillan Mark K., Snetselaar Linda G., and Bao Wei. 2019 "National Estimates of E-Cigarette Use Among Pregnant and Nonpregnant Women of Reproductive Age in the United States, 2014–2017." *JAMA Pediatrics*, 4 10.1001/jamapediatrics.2019.0658.
- Lopez Alexa A., Redner Ryan, Kurti Allison N., Keith Diana R., Villanti Andrea C., Stanton Cassandra A., Gaalema Diann E., et al. 2018 "Tobacco and Nicotine Delivery Product Use in a U.S. National Sample of Women of Reproductive Age." *Preventive Medicine, Behavior Change, Health, and Health Disparities 2018: Tobacco Regulatory Science*, 117 (12): 61–68. 10.1016/j.ypmed.2018.03.001.
- Oncken Cheryl, Ricci Karen A., Kuo Chia-Ling, Dornelas Ellen, Kranzler Henry R., and Sankey Heather Z.. 2017 "Correlates of Electronic Cigarettes Use Before and During Pregnancy." *Nicotine & Tobacco Research* 19 (5): 585–90. 10.1093/ntr/ntw225. [PubMed: 28403454]
- Orleans C Tracy Dianne C. Barker Nancy J. Kaufman, and Marx Joseph F. 2000 "Helping Pregnant Smokers Quit: Meeting the Challenge in the next Decade | Tobacco Control." *Tobacco Control* 9 (Suppl 3). https://tobaccocontrol.bmj.com/content/9/suppl_3/iii6.short.
- Pokhrel Pallav, Fagan Pebbles, Kehl Lisa, and Herzog Thaddeus A.. 2015 "Receptivity to E-Cigarette Marketing, Harm Perceptions, and e-Cigarette Use." *American Journal of Health Behavior* 39 (1): 121–31. 10.5993/AJHB.39.1.13. [PubMed: 25290604]
- "Race/Ethnicity." 2017 Smoking Cessation Leadership Center. September 11, 2017. <https://smokingcessationleadership.ucsf.edu/raceethnicity>.
- Roth Lindsay K., and Taylor Hugh S.. 2001 "Risks of Smoking to Reproductive Health: Assessment of Women's Knowledge." *American Journal of Obstetrics and Gynecology* 184 (5): 934–39. 10.1067/mob.2001.112103. [PubMed: 11303201]
- Schoenborn Charlotte A., and Gindi Renee M. 2015 "Electronic Cigarette Use Among Adults: United States, 2014." *NCHS Data Brief*, no. 217 (10): 1–8.

- Shoff Carla, and Yang Tse-Chuan. 2013 “Understanding Maternal Smoking during Pregnancy: Does Residential Context Matter?” *Social Science & Medicine* 78 (2): 50–60. 10.1016/j.socscimed.2012.11.027. [PubMed: 23246395]
- Simmons Vani Nath, Bárbara Piñeiro Monica Webb Hooper, Gray Jhanelle E., and Brandon Thomas H.. 2016 “Tobacco-Related Health Disparities Across the Cancer Care Continuum.” *Cancer Control : Journal of the Moffitt Cancer Center* 23 (4): 434–41. 10.1177/107327481602300415. [PubMed: 27842333]
- Spindel Eliot R., and McEvoy Cindy T. 2016 “The Role of Nicotine in the Effects of Maternal Smoking during Pregnancy on Lung Development and Childhood Respiratory Disease. Implications for Dangers of E-Cigarettes.” *American Journal of Respiratory and Critical Care Medicine* 193 (5): 486–94. 10.1164/rccm.201510-2013PP. [PubMed: 26756937]
- U.S. Department of Health and Human Services. 2014 “The Health Consequences of Smoking - 50 Years of Progress: A Report of the Surgeon General.”
- Voos N, Goniewicz ML, and Eissenberg T. 2019 “What Is the Nicotine Delivery Profile of Electronic Cigarettes?: Expert Opinion on Drug Delivery: Vol 16, No 11.” *Expert Opinion on Drug Delivery* 16 (11): 1193–1203. <https://www.tandfonline.com/doi/full/10.1080/17425247.2019.1665647>. [PubMed: 31495244]
- Wackowski Olivia A., and Delnevo Cristine D.. 2016 “Young Adults’ Risk Perceptions of Various Tobacco Products Relative to Cigarettes: Results From the National Young Adult Health Survey.” *Health Education & Behavior: The Official Publication of the Society for Public Health Education* 43 (3): 328–36. 10.1177/1090198115599988. [PubMed: 26304709]
- Walter Stefan, and Tiemeier Henning. 2009 “Variable Selection: Current Practice in Epidemiological Studies.” *European Journal of Epidemiology* 24 (12): 733–36. 10.1007/s10654-009-9411-2. [PubMed: 19967429]
- Whittington Julie R., Simmons Pamela M., Phillips Amy M., Gammill Sarah K., Cen Ruiqi, Magann Everett F., and Cardenas Victor M.. 2018 “The Use of Electronic Cigarettes in Pregnancy: A Review of the Literature.” *Obstetrical & Gynecological Survey* 73 (9): 544–49. 10.1097/OGX.0000000000000595. [PubMed: 30265741]

Table 1.

Baseline Characteristics By Current (Past 30-Day) Cigarette and E-Cigarette Use among Reproductive Aged Women (18–44 Years; Wave 1)

	Full Sample n = 13,241; Weighted N = 77696766 (100.0%)	No Cigarette or E- Cigarette Use n = 5525; Weighted N = 56993786 (75.5%)	Current Exclusive Cigarette Users n = 3222; Weighted N = 12753754 (16.9%)	Current Exclusive E- Cigarette Users n = 291; Weighted N = 1107838 (1.5%)	Current Dual Users n = 1185; Weighted N = 4602188 (6.1%)	Chi- Square, p-value
	Weighted N (%)	Weighted N (%)	Weighted N (%)	Weighted N (%)	Weighted N (%)	
Perceived Harm - Cigarettes						1426.1,
Not at all/slightly harmful	1412951 (1.9)	586680 (1.0)	613743 (4.8)	17742 (1.6)	189369 (4.1)	<0.0001
Somewhat harmful	3891299 (5.2)	968574 (1.7)	2120564 (16.6)	54731 (4.9)	739556 (16.1)	
Very harmful	16757215 (22.2)	10366782 (18.2)	4510254 (35.4)	337342 (30.5)	1483216 (32.3)	
Extremely harmful	53476407 (70.8)	45023450 (79.1)	5498718 (43.1)	698022 (63.0)	2179995 (47.5)	
Perceived Harm - E- cigarettes						408.5,
Less harmful than cigarettes	26429297 (41.5)	17012223 (36.6)	5350382 (46.5)	934987 (84.4)	3110279 (68.6)	<0.0001
About the same	3341380 (52.5)	26531169 (57.0)	5417984 (47.1)	167481 (15.1)	1322428 (29.2)	
More harmful than cigarettes	3871127 (6.1)	2996519 (6.4)	740930 (6.4)	5369 (0.5)	99250 (2.2)	
Household Smokers						1579.0,
No users in home	51777340 (73.6)	44623944 (83.4)	4649884 (40.3)	737296 (71.9)	1684224 (40.4)	<0.0001
Any user in home	18575453 (26.4)	8879068 (16.6)	6891126 (59.7)	278667 (28.1)	2485055 (59.6)	
General Smoke Exposure						2053.9,
No exposure in past 7 days	37696245 (50.2)	35676481 (62.8)	1255245 (10.0)	370188 (33.6)	313679 (6.9)	<0.0001
Any exposure in past 7 days	37449490 (49.8)	21164529 (37.2)	11271352 (90.0)	730844 (66.4)	4223297 (93.1)	
Current Pregnancy Status						4.0,
Not pregnant in any wave	73650017 (94.9)	53836922 (94.6)	12120407 (95.1)	1060161 (95.7)	4417808 (96.2)	0.1046
Pregnant at any wave	3969496 (5.1)	3099721 (5.4)	624401 (4.9)	47677 (4.3)	173217 (3.8)	
Age at Interview						46.6,
18 – 24 Years	15206404 (20.1)	11172538 (19.6)	2601617 (20.4)	410078 (37.0)	995048 (21.6)	<0.0001
25 – 34 Years	20309472 (26.9)	14897908 (26.2)	3626354 (28.4)	298960 (27.0)	1446651 (31.4)	
35 – 44 Years	40042938 (53.0)	30875456 (54.2)	6525784 (51.2)	398799 (36.0)	2160488 (46.9)	
Race/Ethnicity						63.6,
White	55329229 (75.3)	40955068 (74.3)	9585141 (76.1)	850428 (78.6)	3817284 (83.7)	<0.0001
Black	9716827 (13.2)	7182679 (13.0)	2002153 (15.9)	108768 (10.1)	414116 (9.1)	
Other, including Hispanic	8451000 (11.5)	6989969 (12.7)	1000274 (7.9)	122817 (11.4)	327973 (7.2)	
Income						532.7,

	Full Sample n = 13,241; Weighted N = 77696766 (100.0%)	No Cigarette or E- Cigarette Use n = 5525; Weighted N = 56993786 (75.5%)	Current Exclusive Cigarette Users n = 3222; Weighted N = 12753754 (16.9%)	Current Exclusive E- Cigarette Users n = 291; Weighted N = 1107838 (1.5%)	Current Dual Users n = 1185; Weighted N = 4602188 (6.1%)	Chi- Square, p-value
	Weighted N (%)	Weighted N (%)	Weighted N (%)	Weighted N (%)	Weighted N (%)	
< \$10,000	11983696 (17.5)	7424611 (14.4)	3348565 (28.2)	247798 (24.2)	1020275 (23.9)	<0.0001
\$10,000-\$24,999	13575682 (19.8)	8938708 (17.4)	3133540 (26.4)	247798 (24.2)	1226379 (28.7)	
\$25,000-\$49,999	14616416 (21.3)	10560874 (20.6)	2663416 (22.5)	300383 (29.3)	1060864 (24.8)	
\$50,000-\$99,999	16557093 (24.2)	13670469 (26.7)	1971240 (16.6)	210600 (20.5)	704783 (16.5)	
>= \$100,000	11803183 (17.2)	10678024 (20.8)	739837 (6.2)	125277 (12.2)	260045 (6.1)	
Education						559.1,
Less than High School	6889667 (9.2)	4507266 (7.9)	1796630 (14.2)	89173 (8.0)	481217 (10.5)	<0.0001
GED/High School Diploma	19194836 (25.5)	12752652 (22.5)	4508764 (35.5)	257883 (23.3)	1605586 (35.1)	
Some College	26092345 (34.7)	18767547 (33.1)	4790339 (37.8)	545577 (49.2)	1953354 (35.1)	
Bachelor's Degree or higher	23022771 (30.6)	20682898 (36.5)	1589654 (12.5)	215204 (19.4)	528782 (11.6)	
Sexual Orientation						218.8,
Heterosexual	67504473 (92.1)	51864418 (93.9)	11071970 (88.9)	868650 (78.9)	3699434 (81.8)	<0.0001
Lesbian, Gay, Bisexual, Other	5812550 (7.9)	3372869 (6.1)	1383052 (11.1)	232566 (21.1)	824064 (18.2)	
Marital Status (Wave 2)						511.9,
Married	37926077 (50.4)	31793334 (55.9)	4222843 (33.2)	422701 (38.5)	1487198 (32.5)	<0.0001
Divorced, Widowed, Separated	12620089 (16.8)	7922336 (13.9)	3341729 (26.3)	173317 (15.8)	1182707 (25.8)	
Never Married	24706748 (32.8)	17148810 (30.2)	5144123 (40.5)	501977 (45.7)	1911839 (41.7)	

Table 2.

Multinomial Regression Models for Current (Past 30-Day) Tobacco Use among Reproductive Aged Women (18–44 Years, Wave 1 & Wave 2)

	Wave 1			Wave 2		
	Current Exclusive Cigarette Use n = 7645, Weighted N = 32962278	Current Exclusive E-Cigarette Use n = 7643, Weighted N = 52553573	Current Dual Use n = 4963; Weighted N = 42216844	Current Exclusive Cigarette Use n = 7642; Weighted N = 52531894	Current Exclusive E-Cigarette Use n = 7406; Weighted N = 51476364	Current Dual Use n = 4878; Weighted N = 41248008
	AOR (95 % CI)	AOR (95 % CI)	AOR (95 % CI)	AOR (95 % CI)	AOR (95 % CI)	AOR (95 % CI)
Tobacco Use (Wave 1)						
No Tobacco Use *				Reference	Reference	Reference
Current Tobacco User				29.7 (22.8, 38.6)	8.0 (5.3, 12.2)	28.8 (18.7, 44.2)
Ever Cigarette Use	15.0 (9.7, 23.1)	3.6 (2.0, 6.4)	12.8 (5.0, 33.3)	5.0 (3.2, 7.9)	2.5 (1.3, 4.6)	1.5 (1.2, 1.9)
Ever E-Cigarette Use	5.1 (4.2, 6.2)	11.4 (6.7, 19.2)	15.5 (11.9, 20.2)	1.5 (1.2, 1.8)	5.0 (3.0, 8.4)	4.4 (3.2, 5.9)
Perceived Harm - Cigarettes						
Not at all/slightly harmful	5.0 (2.9, 8.7)	2.2 (0.8, 6.1)	6.2 (3.5, 11.1)	1.9 (1.0, 3.6)	1.0 (0.3, 3.1)	2.5 (1.3, 4.9)
Somewhat harmful	5.5 (3.8, 8.0)	2.5 (1.1, 5.8)	6.9 (4.5, 10.7)	2.5 (1.5, 4.1)	1.4 (0.6, 3.4)	3.3 (1.9, 5.7)
Very harmful	2.0 (1.6, 2.7)	1.6 (1.1, 2.3)	2.1 (1.7, 2.7)	1.6 (1.3, 2.1)	1.4 (0.9, 2.0)	1.7 (1.3, 2.3)
Extremely harmful	Reference	Reference	Reference	Reference	Reference	Reference
Perceived Harm - E-cigarettes						
Less harmful than cigarettes	1.0 (0.6, 1.5)	4.7 (0.3, 64.9)	1.7 (1.0, 3.1)	0.9 (0.5, 1.5)	4.3 (0.3, 60.4)	1.6 (0.9, 2.8)
About the same	0.7 (0.5, 1.1)	1.7 (0.1, 23.4)	0.9 (0.5, 1.4)	0.8 (0.4, 1.3)	1.7 (0.1, 23.6)	0.9 (0.5, 1.6)
More harmful than cigarettes	Reference	Reference	Reference	Reference	Reference	Reference
Household Smokers						
No users in home	Reference	Reference	Reference	Reference	Reference	Reference
Any user in home	2.6 (2.2, 3.1)	1.6 (1.1, 2.3)	2.7 (2.2, 3.4)	2.1 (1.6, 2.7)	1.3 (0.9, 2.0)	2.2 (1.6, 2.9)
General Smoke Exposure						
No exposure in past 7 days	Reference	Reference	Reference	Reference	Reference	Reference
Any exposure in past 7 days	2.8 (2.3, 3.5)	1.3 (0.9, 1.9)	6.2 (1.2, 9.2)	1.4 (1.1, 1.9)	0.9 (0.6, 1.4)	3.2 (2.0, 4.9)
Current Pregnancy Status						
Not pregnant in any wave	Reference	Reference	Reference	Reference	Reference	Reference
Pregnant at any wave	0.4 (0.3, 0.7)	0.2 (0.1, 0.6)	0.3 (0.2, 0.5)	0.5 (0.3, 0.8)	0.3 (0.1, 0.7)	0.4 (0.2, 0.7)
Age at Interview						
18 – 24 Years	Reference	Reference	Reference	Reference	Reference	Reference

	Wave 1			Wave 2		
	Current Exclusive Cigarette Use n = 7645, Weighted N = 32962278	Current Exclusive E- Cigarette Use n = 7643; Weighted N = 52553573	Current Dual Use n = 4963; Weighted N = 42216844	Current Exclusive Cigarette Use n = 7642; Weighted N = 52531894	Current Exclusive E- Cigarette Use n = 7406; Weighted N = 51476364	Current Dual Use n = 4878; Weighted N = 41248008
	AOR (95 % CI)	AOR (95 % CI)	AOR (95 % CI)	AOR (95 % CI)	AOR (95 % CI)	AOR (95 % CI)
25 – 34 Years	1.5 (1.2, 1.9)	0.7 (0.5, 1.1)	1.2 (0.8, 1.6)	1.4 (1.0, 1.9)	0.7 (0.4, 1.1)	1.3 (0.9, 1.9)
35 – 44 Years	1.2 (1.0, 1.5)	0.8 (0.5, 1.2)	1.5 (1.2, 1.9)	1.0 (0.7, 1.4)	0.7 (0.4, 1.1)	1.1 (0.8, 1.6)
Race/Ethnicity						
White	Reference	Reference	Reference	Reference	Reference	Reference
Black	1.2 (0.9, 1.6)	0.5 (0.2, 0.9)	0.5 (0.4, 0.7)	1.1 (0.8, 1.4)	0.4 (0.2, 0.9)	0.4 (0.3, 1.1)
Other	1.1 (0.8, 1.6)	0.6 (0.3, 1.5)	1.2 (0.8, 1.9)	1.1 (0.7, 1.8)	0.7 (0.3, 1.5)	1.2 (0.7, 2.0)
Income						
< \$10,000	Reference	Reference	Reference	Reference	Reference	Reference
\$10,000-\$24,999	0.7 (0.5, 0.9)	1.2 (0.6, 2.4)	0.6 (0.5, 0.8)	0.7 (0.5, 1.0)	1.2 (0.6, 2.4)	0.7 (0.5, 1.0)
\$25,000-\$49,999	0.6 (0.4, 0.7)	1.3 (0.7, 2.4)	0.5 (0.3, 0.6)	0.6 (0.4, 0.8)	1.4 (0.7, 2.5)	0.5 (0.4, 0.7)
\$50,000-\$99,999	0.5 (0.3, 0.8)	1.0 (0.6, 1.8)	0.4 (0.3, 0.6)	0.6 (0.4, 1.0)	1.2 (0.6, 2.1)	0.6 (0.4, 0.9)
>= \$100,000	0.4 (0.3, 0.6)	0.8 (0.4, 1.6)	0.5 (0.3, 0.8)	0.6 (0.4, 1.1)	1.0 (0.4, 2.1)	0.8 (0.4, 1.5)
Education						
Less than High School	Reference	Reference	Reference	Reference	Reference	Reference
GED/High School Diploma	1.0 (0.8, 1.4)	1.1 (0.5, 2.4)	1.1 (0.8, 1.6)	1.2 (0.9, 1.7)	1.3 (0.6, 2.7)	1.3 (0.9, 3.3)
Some College	0.7 (0.5, 1.0)	1.0 (0.5, 2.3)	0.9 (0.7, 1.3)	0.8 (0.6, 1.1)	1.2 (0.5, 2.5)	1.1 (0.7, 1.6)
Bachelor's Degree or higher	0.5 (0.4, 0.7)	0.6 (0.2, 1.3)	0.4 (0.3, 0.7)	0.7 (0.5, 1.0)	0.7 (0.3, 1.6)	0.6 (0.4, 1.0)
Sexual Orientation						
Heterosexual	Reference	Reference	Reference	Reference	Reference	Reference
Lesbian, Gay, Bisexual, Other	1.2 (0.9, 1.6)	1.8 (1.0, 3.2)	1.8 (1.4, 2.4)	1.2 (0.8, 1.8)	1.8 (1.0, 3.3)	1.7 (1.2, 2.6)
Marital Status (Wave 2)						
Married				Reference	Reference	Reference
Divorced, Widowed, Separated				1.2 (0.9, 1.5)	0.9 (0.5, 1.8)	1.5 (1.1, 2.1)
Never Married				1.2 (0.9, 1.6)	1.0 (0.6, 1.6)	1.5 (1.0, 2.1)

Note:

* No Tobacco Use = Reference Group; AOR = adjusted odds ratio; no tobacco use in the past 30 days is the outcome referent group, p-value < 0.05 is the threshold for statistical significance. Bold typeface indicates statistically significant associations.