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Tobacco use in cardiac patients: Perceptions, use, and changes after a recent myocardial infarction among US adults in the PATH study (2013–2015)

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Abstract

Smoking status following cardiac events strongly predicts future morbidity and mortality. Using a nationally representative sample of United States adults, aims of this study were (1) to estimate use of, and attitudes towards, tobacco products as a function of level of cardiac risk, and (2) to explore changes in attitudes and tobacco use among adults experiencing a recent myocardial infarction (MI). Data were obtained from the first and second waves of the Population Assessment of Tobacco and Health (PATH) study. Use and attitudes towards tobacco products were examined at Wave 1 among adults with no chronic health condition ($n = 18,026$), those with risk factors for heart disease ($n = 4593$), and those who reported ever having had an MI ($n = 643$). Changes in perceived risk of tobacco and use between the two waves and having an MI in the last 12 months ($n = 240$) were also examined. Those who reported lifetime MI were more likely to believe that smoking/using tobacco was causing/worsening a health problem. Having had a recent MI event increased perceived tobacco-related risk and attempts at reduction/quitting, but did not

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Conflict of interest

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significantly impact combusted tobacco cessation/reduction or uptake of non-combusted tobacco products. Sociodemographic characteristics and use of other tobacco products were associated with change in use of tobacco products. Those who have an MI are sensitized to the harm of continued smoking. Nonetheless, having an MI does not predict quitting combusted tobacco use or switching to potentially reduced harm products. Intense intervention is necessary to reduce combusted use in this high-risk population.

Keywords

Myocardial infarction; Tobacco; Harm reduction

1. Introduction

Smoking status in those who have coronary heart disease (CHD) is a powerful predictor of future morbidity and mortality. For example, continued smoking after having a myocardial infarction (MI) substantially increases mortality rates. Patients with MI who quit smoking have markedly lower rates of major adverse cardiac events (Relative Risk = 0.61) and mortality (Relative Risk = 0.49) compared to those who continued smoking (Boggon et al., 2014), and persistent smoking following MI is associated with twice the likelihood of both having an additional cardiac event and early mortality (Booth et al., 2014; Wilson et al., 2000). When smoking outcomes are biochemically verified, results are similar or even more striking, with risk of recurrent cardiovascular disease events reduced by 40% and reductions in risk of early mortality reduced by 70–80% (Breitling et al., 2011; Twardella et al., 2004). CHD risk also increases with consumption levels and decreases with time since quitting in a dose-dependent manner; even over a follow-up period of 30 years in a sample of over 500,000 adults (Mons et al., 2015). Unfortunately, although smoking rates have decreased considerably over the last several decades in the general population (US Department of Health and Human Services, 2014), these gains have been significantly less pronounced among those with CHD (Stanton et al., 2016). Given the robust and clinically substantive gains accrued by those with CHD who quit smoking, these steady rates of smoking are concerning, and understanding use and change in use of tobacco in this population is of great importance.

Patients with CHD or risk factors for CHD are generally well aware of the effects of continued smoking on their health, and smoking is one of the most recognized modifiable risk behaviors by the general public (Christian et al., 2007; McDonnell et al., 2014; Mosca et al., 2004). Additionally, patients who have experienced a major medical event, such as an MI or a cancer diagnosis, are often motivated to quit smoking (Tofler et al., 2015; Westmaas et al., 2015). However, even though most smokers who have been hospitalized are required to abstain from smoking while in the hospital (Williams et al., 2009), continued abstinence is challenging and most patients with CHD, or MI specifically, resume smoking shortly after hospitalization (Boggon et al., 2014; Prugger et al., 2013), with one study reporting a median time to relapse of only 19 days (Colivicchi et al., 2011).

Given knowledge of the dangers of continued smoking and the challenges of sustained abstinence, patients may seek out other ways to reduce their risk of future health events, such as trying tobacco products perceived as less harmful to their health (e.g., non-combusted tobacco products, such as e-cigarettes). While uncertainty about the effects of other constituents in e-cigarettes on cardiac health causes concern among cardiologists and other health professionals (Bhatnagar, 2016; Morris et al., 2015), use of e-cigarettes appears to have a lower cardiovascular risk profile than cigarettes (Benowitz and Fraiman, 2017) and may appeal to patients attempting to reduce their risk.

E-cigarettes have become increasingly popular in the general population (King et al., 2015) as well as among those with medical co-morbidities (Borderud et al., 2014; Harrington et al., 2014) and commonly cited reasons for use are as a smoking cessation aid or for harm reduction through cigarette substitution (Coleman et al., 2017; De Genna et al., 2017; Farsalinos et al., 2014; Patel et al., 2016; Rutten et al., 2015). Within the cardiac population specifically, initial studies suggest that at least some patients with CHD are trying e-cigarettes as a harm reduction approach (Kalkhoran et al., 2017), with potentially some use being driven by having a new cardiac event (Busch et al., 2016). However, these preliminary results needed to be tested in larger, longitudinal samples.

Recently the first two waves of a large, national, longitudinal study on tobacco use have been completed (Population Assessment of Tobacco and Health, PATH). The public availability of these data provides a novel opportunity to examine changes in tobacco use and perceptions of use as a function of change in health status (e.g., cardiac event) in a general population sample. This includes exploring whether cardiac patients are able to quit combusted use or engage in other attempts at harm reduction such as switching to non-combusted products. Accordingly, the aims of this study are: (1) to estimate use of and attitudes towards tobacco products as a function of level of CHD risk and (2) to explore change in attitudes about and use of tobacco products among adults who report a recent MI, using a nationally representative sample of U.S. adults.

2. Methods

2.1. Data source

Data were obtained from the Public Use Files of Wave 1 (W1) and Wave 2 (W2) of the PATH study (US Department of Health and Human Services, National Institutes of Health, National Institute on Drug Abuse, Food and Drug Administration, & Center for Tobacco Products, 2017a). The PATH study W1 (n = 45,971) target population consisted of civilian, non-institutionalized youth (aged 12 to 17) and adults (aged 18 and older) in the U.S. W1 data were collected from September 12, 2013 through December 14, 2014, using a four-stage probability sampling design. W2 data were collected from October 23, 2014 through October 30, 2015 following the same procedures, and included all W1 respondents who continued living in the U.S. and were not incarcerated at the time of the survey (n = 40,534). Weighting procedures adjusted for varying selection probabilities and differential non-response rates, while appropriately accounting for the complex study design. The overall weighted response rate for W1 was 74.0% with a weighted retention rate of 83.1% at W2.

Previous reports provide additional details on sampling and weighting procedures (Hyland et al., 2016; Kasza et al., 2017).

2.2. Measures

Information examined in the present study included socio-demographic characteristics, health conditions, use of tobacco products, and perceived harm of tobacco use.

Sociodemographic information included respondents' age, sex, race/ethnicity, and educational attainment, levels defined as can be seen in Table 1.

2.3. CHD risk level

For initial characterization by CHD risk level, W1 respondents were categorized based on their response to the question: "Has a doctor or other health professional ever told you that you had any of the following health conditions?" Individuals were placed in three categories, (1) those who selected "heart attack," (the common term for MI) (2) those who selected "high blood pressure", "high cholesterol", or both, but no MI, and (3) those who did not endorse any of the previous categories. The comparison group for the analytic sample was limited to individuals who did not endorse having a serious health condition expected to influence tobacco use or perception (i.e., chronic obstructive pulmonary disease, chronic bronchitis, emphysema, asthma, other lung disease, diabetes, or cancer).

When examining changes over time from W1 to W2, respondents were categorized by their answer to the previous health question as well as to the new question at W2 "In the past 12 months, has a doctor, nurse, or other health professional told you that you had any of the following health conditions?" "Based on the responses to the W1 and W2 health status questions, respondents were divided into two subgroups: (1) individuals who did not develop a new health condition (i.e., all health conditions reported had already been reported in W1), and (2) individuals reporting an MI (or MI plus another condition) between survey waves. Respondents reporting a new health condition and no new MI at W2 were similarly not included in the analysis sample.

2.4. Tobacco product use

Cigarette smoking status was defined as current, former, or never smoking. Current smokers included individuals who (a) had smoked 100 cigarettes or more in their lifetime and now smoked daily or some days (i.e., current established smokers), or (b) had smoked at least all or part of a cigarette but < 100 cigarettes and now smoked daily or some days (i.e., current experimental smokers). Former cigarette smokers were defined as respondents who reported (a) having smoked at least 100 cigarettes in their lifetime but not smoking at the time of the survey (i.e., former established smokers), or (b) having smoked at least all or part of a cigarette but < 100 cigarettes and were not smoking at all when they completed the survey (i.e., former experimental smokers). Never cigarette smokers were respondents who did not fall into any of the above categories. Current cigarette smokers also reported their average number of cigarettes smoked daily.

Current, former, or never use of e-cigarettes, hookah, traditional cigars, filtered cigars, cigarillos, snus, smokeless tobacco (i.e., moist snuff, dip, spit, or chewing tobacco), pipe,

and dissolvable tobacco was also determined. For these products, current users were defined as respondents who (a) have used the tobacco product fairly regularly and currently are using some days or every day (i.e., current established users), or (b) have used the product in question, even once or twice, but never regularly, and now are using some days or every day (i.e., current experimental users). Former users were defined as those who reported (a) having used the tobacco product regularly but are currently not using at all (i.e., former established users), or (b) having used the product at least once but never fairly regularly, and not using at all now (i.e., former experimental users). Individuals were identified as never users if they did not fall into any of the other categories.

2.5. Change in use and harm perception

To identify general patterns of harm reduction respondents were also classified as current, former, or never users of combusted and non-combusted tobacco products at W1 and W2. Cigarettes, traditional cigar, cigarillo, filtered cigar, pipe, and hookah were combined to produce a “combusted” category while e-cigarettes, smokeless, snus, and dissolvables composed the category “non-combusted.” Cessation was defined as current combusted user at W1 and not current user at W2, uptake as current combusted user (and not current non-combusted users) at W1 who were current combusted and non-combusted users at W2, and switching as current combusted users (and not current non-combusted users) at W1 and current non-combusted user (but not current combusted user) at W2. Respondents indicating current use of tobacco products were also asked if, in the past 12 months, they had attempted to quit completely or reduce their use of each product.

Two outcome variables related to harm perceptions were explored. The first, harm perceptions of smoking/tobacco use at W1, was assessed by a single item: “Smoking/using tobacco products is causing/caused a health problem or made it worse? (yes/no).” The second outcome of interest was change in harm perceptions of cigarettes. Participants were asked at W1 and W2: “How harmful do you think cigarettes are to health?” with the response options varying from “not at all harmful” to “extremely harmful”. Responses between waves were compared and collapsed into two categories: “increased” or “decreased/no change” in perception of harm.

2.6. Statistical methods

To characterize the three groups varying in CHD risk at W1, frequencies and weighted percentages with their respective 95% confidence intervals (CIs) were generated for demographics and tobacco use variables, and differences on these variables of interest by CHD risk were explored using chi-square tests. Frequencies and weighted percentages were also generated for those respondents who reported having experienced a new MI in the 12 months prior to W2.

Multiple logistic regression modeling was used to examine the association between respondents’ sociodemographic characteristics and health status (i.e., no health condition, high blood pressure/cholesterol, and MI) with their perceived harm of smoking/using tobacco products at W1.

A series of logistic or linear regression models, for dichotomous or continuous variables, respectively, identified correlates of changes in harm perceptions in the overall sample, as well as changes in tobacco use among users of combusted products at W1.

Sociodemographics, harm perception at W1, and health status at W2 (i.e., new MI) were included in the analyses to identify variables associated with an increased perception of harm of cigarettes between waves. Multiple regression models for changes in tobacco use (attempted to quit/reduce combusted tobacco products, changes in cigarettes per day (CPD), uptake of or switching completely to non-combusted tobacco products, and cessation of combusted products) included sociodemographics, new MI, use of combusted products at W2 and non-combusted tobacco products at W1 and W2. Baseline CPD was included for analyses examining changes in CPD, which was limited to individuals identifying as cigarette smokers in both waves. For the remaining analyses of changes from W1 to W2, respondents were identified as current users or non-users (former and never) to facilitate the interpretation of regression coefficients.

All regression analyses were done in two steps. First, simple regression analyses were conducted to investigate associations between potential predictors and the dependent variable of interest. Second, multiple regressions were conducted to calculate adjusted odds ratios (AOR) or regression coefficients and 95% CI. Statistical significance was set at $p = 0.05$ for all tests. Analyses were conducted using SAS 9.4 software (SAS Institute, Cary, NC). Analyses incorporated replicate weights and a variant of balanced repeated replication known as Fay's method (Judkins, 1990) to account for the complex survey design. Missing data on any variable resulted in case-wise deletion of that observation. All analyses conform to requirements for weighting and subgroup analyses recommended for use with this data set (US Department of Health and Human Services, National Institutes of Health, National Institute on Drug Abuse, Food and Drug Administration, & Center for Tobacco Products, 2017b).

3. Results

3.1. Respondent characteristics

Table 1 displays respondents' sociodemographic and tobacco use characteristics at W1 by CHD risk factor level. Adults who experienced an MI were more likely to be older, male, White, and have less than a high school education (Table 1). Tobacco use status at W1 also differed significantly by CHD risk; prevalence of current cigarette smoking, current use of pipe, and current use of any combusted tobacco products were higher among individuals reporting lifetime MI. Adults who did not have a chronic condition had higher rates of current use of e-cigarettes, smokeless tobacco, snus, hookah, and non-combusted tobacco products relative to the other groups.

Table 2 shows sociodemographics, as well as prevalence of current, former, and never use of combusted and non-combusted tobacco products among individuals who experienced a new MI in the 12 months prior to W2. Sociodemographics of this subsample echoed the subsample from W1 who reported lifetime heart attack with comparable rates of combusted and non-combusted tobacco product use.

3.2. Perceived harm of tobacco products

Respondents with lifetime MI and those with CHD risk factors respectively had 2.5 (95% CI 1.9–3.3) and 1.2 (95% CI 1.1–1.4) higher odds of perceiving that smoking/using tobacco products caused/worsened a health problem than adults with no chronic condition, after controlling for sociodemographic variables. Changes in cigarette harm perception was also associated with health status, with respondents who experienced a new MI being 2.1 (95% CI 1.1–4.1) times more likely to report an increase in perceived harm from cigarette use (Table 3).

3.3. Changes in tobacco use

Patterns in change of tobacco use between waves reflective of potential harm reduction (i.e., attempted to quit/reduce, cessation of combusted tobacco products, change in CPD, uptake of non-combusted tobacco products, switching from combusted to non-combusted), can be seen in Table 3. Individuals who experienced a new MI had 2.1-fold higher odds (95% CI 1.4–3.2) of attempting to quit/reduce combusted use. However, recent MI was not a significant predictor of cessation of combusted tobacco products at W2 (Table 3). A recent MI was also not significantly associated with change in CPD (Table 3).

With respect to uptake of non-combusted tobacco products at W2, cardiac status was again not a significant predictor (Table 3). Among those who had an MI in the prior year, 15.5% added a non-combusted tobacco product while still using combusted products, compared to 13.6% of those with no change in health status ($p = 0.20$). However, cardiac status was significantly negatively associated with switching completely from combusted to non-combusted products. While 9.2% of those with no change in health status switched to non-combusted use, none of those experiencing a new MI switched ($p = 0.0015$, not shown in table due to 0 value). Sociodemographic characteristics were significant predictors in all patterns of tobacco use change.

4. Discussion

This is the first examination of change in use of a variety of tobacco products among those who have reported a recent MI drawn from a U.S. nationally-representative sample. Not surprisingly, those who have an MI or increased CHD risk (high blood pressure and/or high cholesterol) were more likely to report current or former smoking status and believe that smoking is causing or worsening a health condition, in line with previous research reporting that cardiac patients are well aware of the risk of continued smoking on their health (Christian et al., 2007; McDonnell et al., 2014; Mosca et al., 2004).

The most critical finding from this analysis was that having a recent MI promoted limited change in tobacco use either towards harm avoidance (smoking cessation) or harm reduction (switching to non-combusted products). While those with a recent MI had an increased perception of the harm of continued smoking and were more likely to report an attempt to reduce or quit their combusted use, a recent MI did not predict combusted product cessation, CPD reduction, or uptake of non-combusted tobacco product use. Moreover, having a recent MI was a predictor of not switching from combusted to non-combusted products. In sum,

having a recent heart attack was not predictive of any harm reduction success. This pattern of initial quitting/reduction with no significant longer-term changes is consistent with the quick and high rates of relapse observed among patients with CHD following hospital discharge (Colivicchi et al., 2011).

Other reports in the literature have suggested that cardiac patients may try to mitigate harm by quitting smoking or pursuing alternative sources of nicotine promoted as less harmful (Busch et al., 2016; Kalkhoran et al., 2017). However, in this study, where cardiac patients can be compared within the context of a general population sample, we found that demographic and tobacco use status were predictive of harm avoidance and harm-reduction over time whereas the occurrence of an MI did not independently predict any change. The patients changing their tobacco use patterns are those who express interest in a reduced harm tobacco product even without the occurrence of a major health event (e.g., younger adults, Pearson et al., 2018).

Possible reasons for lack of changes in tobacco use following a cardiac event are multi-fold. One challenge may lay in reluctance to try new strategies to improve health behaviors. A common pattern, at least among hospitalized men, is repeating the same unsuccessful attempts at reducing tobacco use that failed in the past (Elshatarat et al., 2013). These failures may also have a cumulative effect. As treatments for cardiac conditions improve, patients live longer, and live through more acute cardiac events. As having a previous hospitalization for a cardiac issue can significantly reduce the probability of smoking abstinence following hospital discharge (Berndt et al., 2012), repeated failed cessation attempts after each additional cardiac event may snowball and further suppress quit attempts.

The characteristics of patients with CHD may also reduce the probability of switching to other, potentially less harmful products. For example, cardiac patients tend to be older and have lower educational attainment than the general tobacco-using population, both characteristics that have significant associations with the likelihood of using newer products such as e-cigarettes (Pericot-Valverde et al., 2017; Vardavas et al., 2015). Indeed, younger age was a powerful predictor in the current study of uptake of non-combusted products and other research shows that patients in primary care who smoke e-cigarettes tend to be younger and more educated (De Genna et al., 2017; Kalkhoran et al., 2017). Cardiac patients may also dislike the chemical nature of the e-cigarette liquids, a common concern among current cigarette smokers considering e-cigarette use (McKeganey and Dickson, 2017).

Overall, this study paints a picture of a high-risk comorbid population aware of the dangers of continued smoking and making initial attempts to reduce or quit combusted use, but unsuccessful at changing their tobacco use. Given the seemingly intractable nature of smoking in patients with CHD, successful interventions to reduce combusted use may prove incredibly difficult. Policy change targeting the root of the problem of persistent smoking in this vulnerable population may be more fruitful. One such approach is to adopt a nicotine reduction policy. Such a policy, which is currently within the FDA's purview (Gottlieb and Zeller, 2017), would reduce the nicotine content of cigarettes below levels that sustain addiction. With reduced levels of nicotine in cigarettes, those who wished to discontinue

smoking (such as patients with CHD who face dire health consequences for continued smoking) should be able to do so more easily (Benowitz and Henningfield, 1994).

Several limitations of this study merit mention. First, both tobacco use and health status were self-reported and the term “heart attack” may not have perfect correspondence with MI. Second, the survey was not tied to when the reported MI happened; thus, time between the event and follow-up survey will have varied between individuals. Third, while data for this study was drawn from a national sample, the number of people experiencing a new cardiac event between the two waves was relatively low, preventing examination of changes in use of individual products in detail. Despite these limitations, given the unique opportunity of examining changes in tobacco use among those reporting a MI, in a large, longitudinal study, these findings represent an important update on the continued health challenge of tobacco use in cardiac patients and individuals at high risk of developing CHD.

5. Conclusions

The present study contributes new knowledge regarding prevalence of use and attitudes towards tobacco products among those differing in cardiac risk level as well as changes in use among those who have experienced a recent MI. These results underscore that use of tobacco products among patients with CHD remains high and recent cardiac events do not precipitate changes in tobacco use behavior beyond an initial quit/reduction attempt. Overall, this study suggests that there is an urgent need for intensive tobacco interventions targeting patients with CHD or policy change to facilitate harm reduction.

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Sociodemographics and prevalence of tobacco products use across varying cardiac risk level groups. Population Assessment of Health and Tobacco (PATH) Study Wave 1, United States, 2013–2014.

Table 1

Characteristics	No chronic condition (n = 18,026)			High blood pressure/cholesterol (n = 4593)			Heart attack (n = 643)			p value
	Unweighted sample size n	Weighted % (95% CI)		Unweighted sample size n	Weighted % (95% CI)		Unweighted sample size n	Weighted % (95% CI)		
Age (years)										< 0.0001
18–24	6965	20.4 (20.0, 20.7)		409	3.1 (2.7, 3.4)		9	0.5 (0.1, 0.8)		
25–34	4497	26.2 (25.3, 27.1)		562	8.4 (7.5, 9.2)		13	1.6 (0.3, 3.0)		
35–44	2831	20.1 (19.3, 20.9)		840	16.1 (14.9, 17.2)		30	2.3 (1.2, 3.2)		
45–54	2085	16.7 (16.0, 17.3)		1070	22.9 (21.2, 24.4)		132	13.6 (10.4, 16.7)		
55–64	1129	10.4 (9.7, 11.1)		978	24.6 (23.0, 26.2)		192	24.6 (20.1, 29.0)		
65 and older	511	6.2 (5.6, 6.7)		733	24.9 (23.0, 26.7)		267	57.4 (52.1, 62.6)		
Gender										< 0.0001
Women	8839	51.7 (50.9, 52.4)		1948	47.3 (45.2, 49.0)		205	28.9 (23.2, 34.6)		
Men	9164	48.3 (47.5, 49.0)		2644	52.7 (50.9, 54.5)		438	71.1 (65.3, 76.7)		
Race/ethnicity										< 0.0001
White, non-Hispanic	10,440	61.8 (60.9, 62.5)		2923	68.9 (67.2, 70.6)		461	78.8 (75.3, 82.2)		
Hispanic	3661	18.6 (17.9, 19.1)		587	11.7 (10.3, 13.0)		51	7.4 (4.9, 9.8)		
Black/African American, non-Hispanic	2405	10.6 (10.1, 11.0)		794	12.9 (11.7, 13.9)		88	10.0 (7.8, 12.1)		
Other	1472	9.0 (8.5, 9.5)		280	6.5 (5.3, 7.6)		43	3.8 (2.0, 5.5)		
Education										< 0.0001
Less than high school/GED	3369	15.6 (15.1, 16.0)		891	15.0 (13.7, 16.3)		204	29.4 (24.2, 34.6)		
High school graduate	4352	23.4 (22.7, 24.0)		1018	25.7 (24.0, 27.3)		145	28.4 (23.3, 33.3)		
Some college	6359	31.5 (30.8, 32.1)		1490	28.9 (27.4, 30.3)		206	28.1 (23.9, 32.3)		
Bachelor's and advanced degree	3793	29.5 (28.9, 30.2)		1173	30.4 (28.9, 31.9)		85	14.1 (10.9, 17.3)		
Cigarettes										< 0.0001
Current smoker	7303	22.5 (21.8, 23.2)		1860	18.0 (17.0, 18.9)		337	26.2 (22.1, 30.3)		
Former smoker	6006	39.2 (37.8, 40.4)		1903	52.7 (50.6, 54.8)		246	56.8 (51.4, 62.2)		
Never smoker	4633	38.3 (36.8, 39.8)		815	29.3 (27.0, 31.4)		56	16.9 (12.1, 21.5)		
E-cigarettes										< 0.0001
Current user	2076	6.2 (5.7, 6.5)		439	4.2 (3.7, 4.5)		81	6.0 (4.3, 7.5)		

Characteristics	No chronic condition (n = 18,026)			High blood pressure/cholesterol (n = 4593)			Heart attack (n = 643)			p value
	Unweighted sample size n	Weighted % (95% CI)	Unweighted sample size n	Weighted % (95% CI)	Unweighted sample size n	Weighted % (95% CI)	Unweighted sample size n	Weighted % (95% CI)		
Former user	4557	13.7 (13.1, 14.2)	943	9.2 (8.5, 9.8)	128	9.9 (7.7, 12.0)				
Never user	11,347	80.2 (79.4, 80.9)	3200	86.6 (85.7, 87.4)	433	84.1 (81.1, 87.0)				
Cigar									< 0.0001	
Current user	2753	8.3 (7.8, 8.6)	689	6.9 (6.3, 7.5)	92	7.0 (5.2, 8.7)				
Former user	6728	30.4 (29.1, 31.6)	1782	33.4 (31.4, 35.2)	282	41.1 (35.7, 46.3)				
Never user	8480	61.3 (60.0, 62.6)	2104	59.7 (57.7, 61.6)	263	51.9 (46.7, 57.6)				
Smokeless									< 0.0001	
Current user	1098	3.5 (3.2, 3.7)	304	3.1 (2.7, 3.5)	33	2.6 (1.4, 3.6)				
Former user	2376	11.2 (10.4, 11.8)	817	15.1 (13.5, 16.6)	123	17.9 (13.4, 22.4)				
Never user	14,378	85.3 (84.5, 86.1)	3430	81.7 (80.1, 83.3)	481	79.5 (74.8, 84.2)				
Snus									< 0.0001	
Current user	298	0.9 (0.7, 1.0)	59	0.6 (0.4, 0.7)	3	0.2 (0.0, 0.37)				
Former user	1466	4.9 (4.5, 5.1)	344	4.0 (3.4, 4.6)	33	2.9 (1.6, 4.1)				
Never user	16,178	94.2 (93.8, 94.5)	4164	95.4 (94.7, 96.0)	604	96.9 (95.7, 98.1)				
Pipe									< 0.0001	
Current user	373	1.1 (0.9, 1.3)	105	1.1 (0.8, 1.2)	21	1.5 (0.8, 2.2)				
Former user	2974	12.8 (12.0, 13.4)	1153	19.7 (18.2, 21.2)	261	41.6 (36.2, 47.0)				
Never user	14,636	86.1 (85.4, 86.4)	3324	79.2 (77.6, 80.6)	357	56.9 (51.3, 62.2)				
Dissolvables									-	
Current user	39	0.1 (0.0, 0.1)	9	0.1 (0.0, 0.1)	0	0 (0.0, 0.0)				
Former user	162	0.5 (0.3, 0.6)	35	0.3 (0.2, 0.4)	3	0.2 (0.0, 0.4)				
Never user	17,795	99.4 (99.2, 99.5)	4541	99.6 (99.4, 99.7)	640	99.8 (99.5, 100)				
Hookah									< 0.0001	
Current user	2200	5.9 (5.4, 6.3)	192	1.5 (1.2, 1.6)	11	0.8 (0.2, 1.4)				
Former user	4892	15.6 (14.8, 16.2)	816	8.5 (7.8, 9.2)	79	7.1 (5.0, 9.1)				
Never user	10,905	78.5 (77.5, 79.4)	3572	90.0 (89.2, 90.7)	552	92.1 (90.0, 94.0)				
Tobacco product use										
Combusted									< 0.0001	
Current user	9070	28.4 (27.5, 29.1)	2247	22.5 (21.4, 23.5)	365	29.0 (24.7, 33.3)				
Former user	5711	40.1 (38.8, 41.3)	1707	53.2 (51.2, 55.2)	231	57.8 (52.5, 62.9)				

Characteristics	No chronic condition (n = 18,026)			High blood pressure/cholesterol (n = 4593)			Heart attack (n = 643)			p value
	Unweighted sample size n	Weighted % (95% CI)		Unweighted sample size n	Weighted % (95% CI)		Unweighted sample size n	Weighted % (95% CI)		
Never user	3038	31.5 (30.0, 33.0)		587	24.3 (22.2, 26.2)		38	13.2 (8.7, 17.6)		
Non-combusted										0.0009
Current user	3069	9.4 (9.0, 9.8)		741	7.4 (6.9, 7.9)		114	8.6 (6.6, 10.4)		
Former user	5313	20.0 (19.1, 20.7)		1353	20.5 (18.7, 22.1)		203	24.5 (19.6, 29.3)		
Never user	9553	70.6 (69.6, 71.5)		2477	72.1 (70.2, 73.9)		322	66.9 (61.8, 72.0)		

Note. 95% CI: 95% confidence interval; p value denotes results from chi-squared tests exploring differences in sociodemographics and tobacco products use between varying cardiac risk level groups; GED = general educational development; “.” = chi-squared tests could not be computed due to an absence of data in one of the groups.

Table 2

Sociodemographics and prevalence of use of combusted and non-combusted tobacco products among respondents who experienced a recent heart attack. Population Assessment of Health and Tobacco (PATH) Study Wave 2, United States, 2013–2015.

Characteristics	New heart attack (n = 240)	
	Unweighted sample size n	Weighted % (95% CI)
Age (years)		
18–24	25	3.0 (1.8, 4.2)
25–34	16	3.7 (1.5, 5.7)
35–44	12	2.3 (0.8, 3.7)
45–54	50	16.0 (10.7, 21.2)
55–64	67	26.8 (21.0, 32.7)
65 and older	70	48.1 (40.2, 56.0)
Gender		
Women	83	33.9 (24.5, 43.3)
Men	157	56.6 (50.9, 75.4)
Race/ethnicity		
White, non-Hispanic	144	72.9 (66.5, 79.2)
Hispanic	33	8.8 (4.1, 13.3)
Black/African American, non-Hispanic	49	16.0 (10.9, 21.1)
Other	14	2.3 (0.8, 3.7)
Education		
Less than high school/GED	81	29.2 (19.6, 38.8)
High school graduate	68	36.6 (24.6, 48.5)
Some college	69	28.6 (19.7, 37.4)
Bachelor's and advanced degree	16	5.6 (1.4, 9.8)
Tobacco product use		
Combusted		
Current user	156	32.7 (24.3, 41.0)
Former user	72	57.5 (48.1, 66.9)
Never user	11	9.8 (3.5, 16.0)
Non-combusted		
Current user	49	10.0 (6.6, 13.4)
Former user	71	23.3 (16.0, 30.4)
Never user	116	66.7 (59.3, 74.0)

Note. 95% CI: 95% confidence interval; GED = general educational development.

Table 3

Multiple regression analyses predicting changes in cigarette smoking harm perceptions and changes in tobacco use indicative of potential harm reduction. Population Assessment of Health and Tobacco (PATH) Study, Waves 1 and 2, 2013–2015.

Characteristics	Increased perception of harmfulness of cigarettes to health		Attempt to quit or cut down on tobacco products		Cessation combusted tobacco product		Change in cigarettes per day		Uptake non-combusted tobacco product	
	AOR (95% CI)		AOR (95% CI)		AOR (95% CI)		B (95% CI)		AOR (95% CI)	
Health status										
No new condition	Ref		Ref		Ref		Ref		Ref	
New heart attack	2.1 (1.1, 4.1)		2.1 (1.4, 3.3)		1.4 (0.8, 2.6)		0.5 (−2.5, 3.4)		1.7 (0.8, 3.7)	
Age (years)										
18–24	1.3 (1.0, 1.8)		1.1 (0.9, 1.5)		1.7 (1.2, 2.4)		−5.4 (−7.4, −3.3)		2.8 (1.9, 4.3)	
25–34	0.9 (0.7, 1.3)		1.5 (1.1, 2.0)		1.0 (0.7, 1.5)		−3.1 (−5.2, −1.0)		2.4 (1.5, 3.8)	
35–44	0.9 (0.6, 1.2)		1.6 (1.1, 2.1)		0.9 (0.6, 1.3)		0.7 (−2.0, 3.4)		2.0 (1.2, 3.2)	
45–54	0.7 (0.5, 1.0)		1.3 (0.9, 1.7)		0.7 (0.5, 1.0)		0.1 (−2.3, 2.4)		1.2 (0.7, 1.9)	
55–64	0.8 (0.5, 1.1)		1.4 (1.0, 1.9)		0.5 (0.3, 0.8)		−0.8 (−3.4, 1.7)		1.0 (0.6, 1.6)	
65 and older	Ref		Ref		Ref		Ref		Ref	
Gender										
Women	Ref		Ref		Ref		Ref		Ref	
Men	0.87 (0.74, 1.03)		0.8 (0.7, 0.9)		1.0 (0.9, 1.2)		0.9 (−0.0, 1.9)		1.1 (0.9, 1.2)	
Race/ethnicity										
White, non-Hispanic	Ref		Ref		Ref		Ref		Ref	
Hispanic	1.5 (1.3, 1.8)		0.9 (0.7, 1.0)		1.7 (1.5, 2.1)		−5.0 (−7.0, −3.0)		0.6 (0.5, 0.8)	
Black/African American, non-Hispanic	1.0 (0.8, 1.3)		1.2 (1.1, 1.4)		0.8 (0.7, 1.0)		−3.6 (−5.8, −1.4)		0.5 (0.4, 0.7)	
Other	1.0 (0.7, 1.4)		0.9 (0.7, 1.2)		1.1 (0.9, 1.5)		−2.6 (−3.6, −1.6)		1.2 (0.8, 1.7)	
Education										
Less than high school/GED	0.8 (0.6, 1.0)		1.8 (1.5, 2.2)		0.3 (0.2, 0.4)		5.4 (3.7, 7.1)		1.5 (1.1, 2.2)	
High school graduate	0.9 (0.7, 1.1)		1.8 (1.5, 2.2)		0.4 (0.3, 0.5)		4.2 (2.5, 5.8)		1.6 (1.2, 2.3)	
Some college	0.8 (0.7, 1.0)		1.7 (1.4, 2.0)		0.6 (0.6, 0.8)		2.7 (1.3, 4.0)		1.5 (1.1, 2.0)	
Bachelor's or advanced degree	Ref		Ref		Ref		Ref		Ref	
Perception of harmfulness of cigarettes to health (W1)	0.13 (0.12, 0.14)									
Non-combusted product use (W1)										

Characteristics	Increased perception of harmfulness of cigarettes to health	Attempt to quit or cut down on tobacco products	Cessation combusted tobacco product	Change in cigarettes per day	Uptake non-combusted tobacco product
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	<i>B</i> (95% CI)	AOR (95% CI)
Current user	–	–	–	–	–
Non-user	–	–	–	–	–
Non-combusted product use (W2)					
Current user	–	1.6 (1.4, 1.9)	0.7 (0.6, 0.8)	–0.3 (–1.2, 0.6)	–
Non-user	–	Ref	Ref	Ref	–
Combusted product use (W2)					
Current user	–	–	–	–	–
Non-user	–	–	–	–	–
Cigarettes per day (W1)	–	–	–	–0.9 (–0.9, –0.8)	–

Notes. AOR = adjusted odds ratio; *B* = standardized beta coefficient; ref = reference group; GED = general educational development; “–” = variable not included in the regression analyses; W1 = Wave 1; W2 = Wave 2.