

**Psychosocial Drivers of Racial/Ethnic Disparities in Tobacco and Cannabis Use
Among Youth and Adults in the United States**

by

Delvon Mattingly

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Doctoral Committee:

Associate Professor Nancy L. Fleischer, Chair
Professor Michael Elliott
Associate Professor Briana Mezuk
Professor Harold W. Neighbors

Delvon Mattingly

delvon@umich.edu

ORCID iD: 0000-0002-2039-7311

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Dedication

To my father, thank you for teaching me the value of an education, how to overcome adversity, and to—importantly—dream big. To the rest of my family, thank you for standing by my side throughout my decade-long pursuit of higher education. Finally, to my partner, thank you for believing in me and celebrating my successes, holding me accountable every day, and always supporting me when times are tough. I dedicate this dissertation to our newborn son, Emmett, who will (hopefully) reap the rewards of our continuous efforts to promote racial/ethnic health equity.

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List of Abbreviations

ACASI	Audio computer assisted self-interviews
ADHD	Attention deficit/hyperactivity disorder
AI/AN	American Indian/Alaskan Native
AIC	Akaike Information Criteria
ANOVA	Analysis of variance
APA	American Psychological Association
AUDADIS-5	Alcohol Use Disorder and Associated Disabilities Interview Schedule-5
AvePP	Average latent posterior probabilities
BF	Bayes Factor
BIC	Bayesian Information Criteria
CAIC	Constant Akaike Information Criteria
CBD	Cannabidiol
CI	Confidence interval
Co-use	Concurrent use
cmP	Approximate correct model probability
CUD	Cannabis use disorder
Distress	Psychological distress
DSM-5	Diagnostic and Statistical Manual of Mental Disorders 5th Edition
E-cigarette	Electronic cigarette
EFA	Exploratory factor analysis
EMBRace	Engaging, Managing, and Bonding through Race intervention
ENDS	Electronic nicotine delivery systems
EOD	Experiences of discrimination
EVP	Electronic vaping product
FDA	Food and Drug Administration
GAIN-SS	Global Appraisal of Individual Needs Short Screener
H&H Study	Happiness & Health Study
KMO	Kaiser-Meyer-Olkin measure of sampling accuracy
LA	Los Angeles
LCA	Latent class analysis
LGB+	Lesbian, gay, bisexual, or something else
LRT	Likelihood ratio test
NESARC-III	National Epidemiologic Survey on Alcohol and Related Conditions-III
NH	Non-Hispanic

NH/OPI	Native Hawaiian and other Pacific Islander
NIAAA	National Institute on Alcohol Abuse and Alcoholism
OC	Other combustibles
OR	Odds ratio
PATH Study	Population Assessment of Tobacco and Health Study
Ref	Referent group
RiSE	Resilience, Stress, and Ethnicity program
ROA	Route of administration
SABIC	Sample-Size Adjusted Bayesian Information Criteria
SLT	Smokeless tobacco
SD	Standard deviation
SES	Socioeconomic status
THC	Tetrahydrocannabinol
TUD	Tobacco use disorder
US	United States
USC	University of Southern California
VLMR	Vuong-Lo-Mendell-Rubin likelihood ratio test
YA	Young adult

Abstract

Racial/ethnic disparities in substance use, including tobacco and cannabis use, have persisted in the United States (US) for centuries. To fully understand these disparities, it is necessary for public health professionals and clinicians to move beyond attributing them to individual behaviors alone and to begin interrogating broader psychosocial factors that induce stress and psychological distress and potentially shape inequities in substance use and misuse. This dissertation investigated whether psychosocial determinants of health drive racial/ethnic disparities in tobacco and cannabis use, focusing on racially/ethnically salient determinants (e.g., discrimination) and among youth and adults, including emerging adults.

In Chapters 2 and 3, using data from the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III), I examined the relationship between racial/ethnic discrimination and tobacco and cannabis use and use disorders among adults living in the US and explored whether these associations were modified by race/ethnicity. I found that racial/ethnic discrimination was associated with patterns of tobacco and cannabis use (e.g., dual/poly tobacco and cannabis) and joint tobacco and cannabis use disorders. These associations were stronger for non-Hispanic (NH) White adults, followed by NH Black adults.

In Chapters 3 and 4, using data from the Population Assessment of Tobacco and Health (PATH) Study, I employed latent class analysis (LCA) to identify subgroups of tobacco and cannabis use, with consideration of various routes of administration (ROA), among US emerging adults and identified racial/ethnic differences. With this, I also estimated associations between mental health problems (i.e., internalizing/externalizing problems) and latent use classes overall

and by race/ethnicity. I found that mental health problems were associated with tobacco and cannabis use and concurrent use (co-use) among youth and young adults (YAs), with associations varying by certain racial/ethnic groups.

Finally, in Chapter 5, I used data from the University of Southern California (USC) Happiness & Health (H&H) Study to conduct exploratory factor analysis (EFA) and determine whether nine indicators of concern, worry, and stress about societal discrimination, societal shootings/violence, and community police brutality (i.e., social problems) at baseline represented latent factors. I examined associations between each factor developed by the EFA and tobacco and cannabis use among a racially/ethnically-diverse cohort of YAs living in Los Angeles (LA), California. I found that factors representing concern, worry, and/or stress about social problems at baseline were associated with exclusive cannabis use and dual tobacco and cannabis use at follow up.

Using a racial/ethnic health equity lens, this dissertation examined potential drivers of racial/ethnic disparities in tobacco and cannabis use. My findings provide insight into the ways in which public health professionals, clinicians, and policymakers can intervene to prevent and reduce the prevalence of psychosocial determinants of health that will, in turn, mitigate inequities in tobacco and cannabis use.

Chapter 1 Introduction

1.1 The Epidemiology of Tobacco and Cannabis Use

Despite years of successful public health efforts that reduced cigarette smoking in the United States (US), tobacco use remains the leading cause of preventable morbidity and mortality.^{1,2} From the early 1960s to 2014, cigarette smoking caused more than 20 million premature deaths.¹ While recent trends data have demonstrated that cigarette smoking prevalence is at an all-time low in the US,³ the rise in use of other tobacco products raises alarm for public health.⁴ In several populations, such as among late adolescents/emerging adults (ages 15-24), reductions in prevalence and incidence of cigarette use have been offset by increases in use of electronic nicotine delivery systems (ENDS)/electronic vaping products (EVPs).^{2,5,6} ENDS use can lead to nicotine dependence and possibly respiratory and cardiovascular health outcomes.⁷⁻¹⁰ In addition, despite reductions in cigarette use at the population level, deaths from combustible tobacco products, such as cigars and pipe, still occur at rates that warrant public health attention.^{1,11}

Use of tobacco products usually begins during adolescence. For example, approximately 9 out every 10 people who smoke cigarettes had first smoked by 18 years old, and about 98% of people who smoke cigarettes first try one by 26 years old.¹ Nowadays, youth (ages 12-17) and young adults (YAs) (ages 18-24) are initiating with products like ENDS, complicating our understanding of the tobacco use continuum.^{12,13} The national prevalence of any current tobacco use, often defined as any use in the past 30 days, was 16.2% for youth and 19.0% for adults in 2020.^{14,15} Among youth in 2020, the prevalence of current ENDS, cigarettes, cigars, and

smokeless tobacco use was 13.1%, 3.3%, 3.5%, and 2.3%, respectively.¹⁴ These patterns varied slightly for adults, with the prevalence of ENDS, cigarettes, cigars, and smokeless tobacco being 3.7%, 12.5%, 3.5%, and 2.3%, respectively.¹⁵ It is noteworthy to mention that the prevalence of ENDS and cigarette use among YAs aged 18-24 were 9.4% and 7.4%, higher relative to each other adult age group.¹⁵

Tobacco use patterns also vary by race/ethnicity. Non-Hispanic (NH) White (17.8%) and Hispanic (17.2%) youth had higher prevalence of any current tobacco use compared to NH Black (13.2%), and NH other (10.1%) youth in 2020.¹⁴ NH American Indian or Alaska Native (AI/AN) (34.9%) and adults who identified as another race/ethnicity (29.1%) had the highest prevalence of any current tobacco use relative to NH White (21.1%), NH Black (19.4%), Hispanic (11.7%), and NH Asian (11.5%) adults in 2020.¹⁵ Disparities in tobacco use depend on the specific types of products. For example, the prevalence of cigar use is highest among NH Black adults (4.6%) compared to other adult racial/ethnic groups.¹⁵ In addition, racial/ethnic minoritized groups such as NH Native Hawaiian and other Pacific Islander (NH/OPI) are often underrepresented in tobacco use research yet have higher prevalence of tobacco use than NH Asian youth and adults whom they are sometimes paired with.^{16,17}

The tobacco industry has an inequitable history of marketing and promoting tobacco products to certain racial/ethnic minoritized groups. As an example, the industry has targeted African American/NH Black populations for decades to encourage the use and public endorsement of menthol cigarettes.¹⁸⁻²⁰ Additional efforts have recently burgeoned to promote ENDS use among youth and sexual minority populations.^{21,22} These marketing and advertising tactics suggest that, while the tobacco's industry best interest is to encourage tobacco use among as many people as possible, some products are deemed more appropriate for certain

sociodemographic groups according to a marketing standard. Disparities in patterns of tobacco use are shaped by these targeting strategies, along with other factors such as accessibility,^{23,24} flavor availability and preference,²⁵ peer/community influence,^{24,26} and stress or distress.^{27,28}

The social environment affects patterns of cannabis use similarly to tobacco. For example, perceptions of the social acceptability of using cannabis and its potential harm or benefit have varied over time, potentially influencing use patterns.^{29,30} Frequency of cannabis use has grown over the past decade due to recent decriminalization efforts, increased social acceptability, and legalization mandates in numerous states.³¹⁻³⁵ Movements to decriminalize cannabis began in the late 1960s and resulted in lower penalties for possession charges,³⁶ yet US cannabis legalization first occurred in 1993.³¹ California was the first state to legalize medical cannabis in 1996, and by 2023, 37 states have approved or passed medical cannabis laws and 21 states have approved or passed both medical and recreational cannabis laws, with seven other states only legalizing cannabidiol (CBD) oil.³⁷⁻³⁹ The scientific literature on US cannabis use reveals varying prevalence estimates and time trends by youth and adults, and race/ethnicity.⁴⁰ Approximately one in every six (17.9%) US youth and adults aged 12 and older used cannabis in the 2020.⁴⁰ The prevalence was lowest among youth aged 12 to 17 (10.1%) and highest among YAs aged 18 to 25 (34.5%). In addition, between 2016 and 2019, the past 30-day prevalence of cannabis use was 10.0% among US adults 18 years or older.⁴¹

Prevalence of cannabis use varies by routes of administration (ROA), or the ways in which cannabis can be consumed, such as by smoking, vaping, or ingesting.⁴²⁻⁴⁴ For example, a recent study found that youth cannabis smoking has decreased while youth cannabis vaping has increased from 2017 to 2019.⁴⁵ Another ROA, blunting, occurs when someone discards the tobacco in a cigar and replaces it with cannabis to be smoked, and mulling occurs when someone

mixes cannabis with tobacco in cigars.^{46,47} Blunt use is found to be more prevalent among NH Black populations, relative to other racial/ethnic groups.^{48,49} Recent studies on cannabis vaping suggest that the prevalence is higher among Hispanic and NH Black youth and adults compared to NH White youth and adults.^{50,51} Furthermore, other forms of cannabis consumption, such as dabbing (i.e., inhalation of concentrated forms of cannabis) and ingesting (i.e., eating or drinking edibles), are prevalent among youth and adults who currently use cannabis.^{52,53} For example, the prevalence of lifetime cannabis edible use (61%) was higher than lifetime cannabis vaping (44%) among youth.⁵³ Understanding different ways in which cannabis can be administered is important in addressing racial/ethnic disparities in use, and to understand how these use patterns intersect with tobacco use.

Cannabis use also induces several adverse health effects. While some research suggests that cannabis provides benefits in treating certain health conditions,^{54,55} cannabis use has been linked to four health outcomes: 1) impaired cognitive growth, 2) adverse respiratory and cardiovascular health effects, 3) the use of other substances, and 4) cannabis use disorders, which are the most common illicit substance use disorders in the US (in states that criminalize use).⁵⁶⁻⁶⁰ Since cannabis vaping is a newer use modality, its associated health consequences are not fully understood.⁶¹ Nevertheless, vaping both nicotine and cannabis are public health concerns in the US, as EVPs are beginning to be recognized as convenient sources of concurrent use (co-use) of nicotine (additive psychoactive constituent in tobacco products) and tetrahydrocannabinol (THC, additive psychoactive constituent in cannabis products).^{62,63}

Before vaping became popular, tobacco and cannabis co-use was deemed a problematic form of substance use.^{42,57} Concerns about co-use originated in the context of smoking combustible tobacco products and cannabis. To date, according to public health and addiction

researchers, tobacco and cannabis co-use remains a “public health emergency.”⁶⁴ The health consequences of co-use, relative to exclusive or no use, include increased risk of tobacco or cannabis use disorders, additive toxicant exposure linked to cancer, and greater difficulty quitting either substance.^{42,44,46} Since tobacco and cannabis use share several ROA, use of one substance may encourage or reinforce use of the other.^{42,46} With the emergence of ENDS/EVP use, co-use of tobacco and cannabis may harm public health as vaping provides yet another ROA.⁶³

Understanding the patterns of tobacco and cannabis use, including co-use, is important in unveiling associated downstream health consequences and racial/ethnic health disparities. The social environment gives rise to inequitable phenomena that shape the ways in which people consume tobacco and cannabis. In addition, mental health problems might also be associated with tobacco and cannabis use and are likely interrelated with the social environment. In the following section, I provide a conceptual model for understanding tobacco and cannabis use disparities in the US. This section breaks down the conceptual model by part, beginning with psychosocial determinants of health and ending with tobacco and cannabis use-related outcomes.

1.2 Conceptual Model for Understanding Tobacco and Cannabis Use Disparities

In the section below, I display the public health consequences of psychosocial determinants of health on tobacco and cannabis use through a conceptual model that helps guide this dissertation (see Figure 1.1). I illustrate the steps by which psychosocial exposures lead to substance use through previously hypothesized stress-coping mechanisms.⁶⁵⁻⁶⁹ In this model, the term “substance use” refers to tobacco and cannabis use for simplicity but can also be used to describe alcohol use, prescription drug misuse, and the use of other drugs (e.g., opioids), none of which are the focus of this dissertation.

Box 1 describes the psychosocial determinants used in this dissertation, which include racial/ethnic discrimination, internalizing and externalizing mental health problems (hereafter, internalizing/externalizing problems), and negative affect about social problems. Box 2 details stress and psychological distress (hereafter, distress), which fall on the causal pathway between experiencing these psychosocial exposures and developing health outcomes. When people are exposed to racial/ethnic discrimination, internalizing/externalizing problems, or negative affect about social problems such as violence/shootings, they exert physiological and psychological demands on the body that lead to stress, chronic stress, or distress.^{65,66} Stress and distress require appraisal, or the process by which people assess stressful events and their available coping resources.⁶⁵⁻⁶⁷ This particular mechanism is identified as a behavioral coping response (Box 3). Coping responses differ by the individual and depend on each person's social environment and availability of psychosocial resources.^{65,66,68-70} In a substance use framework, theories of general stress reduction and self-medication (e.g., alleviating negative affect such as distress) describe the processes by which people resort to substances (Box 4) to manage stressful/distressful experiences.^{68,71,72}

The pathway between behavioral responses or coping mechanisms and substance use can result in several substance use states (Box 5). These states include current substance use, or the use of a particular substance within a recent timeframe; substance use initiation, or the uptake of a particular substance for the first time; substance use relapse, or using a particular substance again after successfully quitting; and co-use, or the use of more than one substance at a time in a designated timeframe, also referred to as dual (use of two substances) and poly (use of three or more substances) use. Overall, the idea is that greater exposure to stress and distress may cause substance use by encouraging initiation and relapse or influencing recent and more frequent or

intense use.⁶⁵ Reinforcement of this pathway and changes in the ways in which people use substances may occur numerous times; however, for simplicity, the conceptual model depicting these pathways are visualized once. For example, youth may uptake ENDS to mitigate distress, while adults may relapse and use cigarettes, both of which can eventually lead to the use of multiple substances, or co-use.

These scenarios differ by individual factors as well, such as race/ethnicity, emphasized by the content below Box 4 with arrows leading into the pathways between Boxes 3 and 4 and Boxes 4 and 5. One focus of this dissertation is to identify psychosocial drivers of racial/ethnic disparities in tobacco and cannabis use. Given that stress-coping mechanisms vary by race/ethnicity,⁷³⁻⁷⁷ it is important to further our understanding of what contributes to these differences. As such, tobacco and cannabis use vary by race/ethnicity,^{14,15,40,41} warranting research that explores potential determinants that shape these disparities. The remaining pathways in the conceptual model depict self-medicated substance use to regulate stress and distress (between Box 6), with implications for deleterious health outcomes over the short- and long-term (Box 7). These outcomes include increased risk for dependence symptoms such as tobacco and cannabis use disorders, other health consequences such as respiratory or cardiovascular effects or cancer, and poorer cessation outcomes as reinforced by dependence.^{1,42,58} Lastly, the cycle in the middle of the conceptual model represents the life course, demonstrating that these mechanisms can function at any given point in time from youth through adulthood.

The following sub-sections of this Introduction provide more detail for each component of the model that guides this dissertation. I discuss racial/ethnic discrimination, internalizing/externalizing problems, and negative affect about social problems (i.e., societal

discrimination, societal shootings/violence, community police brutality) as psychosocial determinants of health. I provide an overview of the stress process, how it relates to distress, and how both lead to poor health. I provide additional description of the stress-coping frameworks that inform the research questions in this dissertation. To conclude, I lay out my specific aims and hypotheses corresponding to three research projects that inform my overall dissertation research question.

1.3 Psychosocial Determinants of Health

In this section, I describe racial/ethnic discrimination, internalizing/externalizing problems, and negative affect about social problems. I also discuss the sources of each psychosocial determinant of health and how they individually affect health.

1.3.1 Discrimination

Inequitable treatment based on negative assumptions about people or groups belonging to certain identities, or discrimination, is a stressor plaguing minoritized populations today.^{69,78,79} Many US youth and adults will experience some form of discrimination in their lifetimes.⁸⁰⁻⁸² This source of stress has been linked to poor physical and mental health among various minoritized (e.g., racial/ethnic, gender, sexual) groups.⁸³⁻⁸⁷ Discrimination comes in many forms that originate from unique systems in place by a dominant group (e.g., White Americans) that marginalizes and oppresses their perceived subordinates (e.g., Black Americans).^{79,88} Since its advent in 1790, the US Census had explicitly discriminated against non-White populations by establishing a White-Black binary up until 1960, where racial/ethnic minoritized groups were first able to self-identify.⁸⁹ The original White-Black classification, which has since evolved to capture a more granular assessment of racial/ethnic identity in the US, in part shaped inequities by creating a racial/ethnic dichotomy.

Discrimination is a behavior, not an attitude (prejudice), stereotype (belief), or ideology (e.g., racism).^{78,85,86} For many people, the effects of discrimination lead to stress, distress, and poorer health.^{85,90} While it is difficult to quantify the amount of discrimination people face in their lifetimes, studies have reported that more than half of US adults have ever experienced discrimination.⁸⁰⁻⁸² To better capture the downstream health consequences of experiencing discrimination, it is imperative to understand its sources. One kind of discrimination, racial/ethnic discrimination, is a source of stress among and salient to racial/ethnic minoritized groups in the US.^{85,86}

Racial/Ethnic Discrimination

Racial/ethnic discrimination is rooted in racism. Racism in the US is a hierarchal ideology in which dominant White Americans rank other social or cultural groups into subordinate classes, or races.^{86,91-93} Racism manifests through three pathways: cultural racism, institutional/structural racism, and individual-level racism.^{86,91} Cultural racism is a high-level ideology that perpetuates negative stereotypes, prejudices, and stigma based on individuals' race or ethnicity.^{86,91} Institutional/structural racism, also called systemic racism, include systems that provide benefit to the dominant race through policies and allocation of resources.^{86,91} Racial/ethnic discrimination is a form of individual-level racism and includes inequitable treatment directed at racial/ethnic minoritized groups or individuals by social institutions or individuals.^{86,91} Racial/ethnic discrimination functions downstream from cultural and institutional/structural racism.

Cultural and institutional/structural racism provide a framework that allows racial/ethnic discrimination to exist. Social structures that are the products of racism, such as residential segregation and unjust immigration policies, give rise to stressful experiences.⁹¹ This is a key

foundations of social stress theory, which describes a process for how socially minoritized people are affected by systemic forms of oppression.⁹⁴ The theory that racism is a primary source of stress defining health inequities between racial/ethnic groups has existed in the literature for decades.^{85,95-97} With any given stressor, there comes physiological and psychological consequences,⁹⁵ thus, researchers have posited that racism is one of the main sources of racial/ethnic intergroup variability underlying health disparities and leading to poorer health outcomes for racial/ethnic minoritized groups.^{93,95,98} As a corollary, racism-related stress may occur over the life course due to its pervasive nature in the United States.⁸⁶ This concept suggests that racism, and the resulting stress and distress, is not experienced at one point in time, but rather persistently throughout one's lifetime.^{99,100}

1.3.2 Internalizing/Externalizing Problems

In the 1960s, Achenbach et al. proposed a psychopathological taxonomy for adolescents that describes mental health disorders occurring during the developmental period.^{101,102} Their initial model categorized mental health problems into four distinct groups: internalizing problems, externalizing problems, other problems, and mixed problems.¹⁰¹⁻¹⁰⁴ Since the conception of these groups, other researchers such as Krueger (1998), have used similar statistical methods to unravel the structure of mental health problems, including if and how they coexist (i.e., mental health comorbidity).^{105,106} For years, frameworks for characterizing broad distinct groups of mental health problems or disorders have relied on the internalizing/externalizing problems dichotomy.^{104,107,108} The dichotomy is a useful tool for guiding research that aims to investigate associations between risk factors of mental health problems or comorbidity. The dichotomy, however, provides broad characterizations of mental health problems and is less helpful for identifying individual disorders.¹⁰⁴

Internalizing/externalizing problems are broad groupings of emotional, behavioral, and social problems.^{103,104,107,108} In other words, internalizing problems are psychiatric phenomenon in which people express distress inward, while externalizing problems are psychiatric phenomenon in which people express distress outward.^{103,104,107-109} Examples of internalizing problems include the presence of mood, anxiety, and somatic problems that may later lead to disorders through diagnosis.^{103,107} In contrast, externalizing problems include problems related to aggressiveness and delinquency that may lead to diagnosed disorders such as attention-deficit/hyperactivity (ADHD) disorder and conduct disorder.^{103,108} People with internalizing/externalizing problems share two attributes: an expression of negative affectivity and poor coping mechanisms.¹⁰³ These attributes are related to the urge to mitigate the negative effects of associated distress and can implicate changes in behavior, such as the uptake of substances that usually begins during adolescence.¹⁰³ However, internalizing/externalizing problems have been found to also persist into adulthood.¹¹⁰⁻¹¹²

1.3.3 Negative Affect About Social Problems

In this dissertation, social problems encapsulate the range of negative stressors people might experience at the systemic level. I focus on three types of social problems, 1) hostility and discrimination (based on any identity) in society (i.e., societal discrimination), 2) shootings or violence in society (i.e., societal shootings or violence), and 3) police brutality in communities (i.e., community police brutality), and whether people experience negative affect, such as being concerned, worried, and stressed, about each of these stressors.

Societal Discrimination

In the sections above, I described discrimination and racial/ethnic discrimination in the US. I also described above how discrimination can occur in multiple forms and for various

attributions, or the reasons why people feel discriminated against.^{113,114} These reasons vary from individual identities (e.g., sex, gender, race/ethnicity) to intersecting identities (e.g., African American women).¹¹⁵ Societal discrimination can refer to population-level discrimination experienced based on any attribution, or combination of attributions, including age, sex, gender, race/ethnicity, sexual orientation identity, and likely occurs vicariously more often than directly.

Direct discrimination on the interpersonal level describes the phenomena in which someone mistreats someone else based on their association to a specific identity.^{85,86} Vicarious discrimination, which is also a significant source of stress, describes the phenomena in which someone learns of or hears about someone else experiencing discrimination irrespective of the reason that discriminatory experience occurred.^{116,117} To the person who experiences vicarious discrimination, the victim of discriminatory experiences can be random, someone in their community, or someone close to them like a friend, sibling, or spouse. Perceptions of societal discrimination are like vicarious experiences and can cause stress irrespective of whether direct discrimination occurs.

Societal Shootings or Violence

Shootings, or gun violence, and violence in general are threatening to public health, especially today in the US.^{118,119} For example, gun violence in the US today is nearly 12 times higher than that of other high-income countries.¹²⁰ Youth are most susceptible to the harmful effects of violence (e.g., sibling assault, witnessing assault), as most of them experience at least one instance of violence before they turn 18 years old.^{121,122} Area-level exposure in which people are exposed to any type of violence, such as gun or neighborhood violence, have health consequences via common stress responses.^{123,124} These stress responses are likely similar to the stress generated by experiencing discrimination, from the standpoint of experiencing these

instances vicariously and not directly.¹²⁵⁻¹²⁷ Some researchers refer to these phenomena as vicarious (violent) victimization, or hearing about or witnessing others' experiencing violence and fearing personal experiences in the future.¹²⁷ Thus, vicarious victimization to violence is akin to vicarious experiences of discrimination from a stress-response standpoint.

Community Police Brutality

Another social phenomenon that has been declared a national public health problem is police brutality.^{128,129} Police brutality is characterized by acts of physical, psychological, and sexual violence by law enforcement on civilians that is often unwarranted and illegal.^{130,131} It is an exposure with direct ties to structural racism, historically affecting Black Americans and Indigenous people dating back to the American slavery era when police recaptured and punished runaway slaves.^{132,133} Many people might not directly experience police brutality in their lifetimes,¹³⁴ but each incident of police brutality in one's community, such as high-profile killings that garner national attention, comes with an emotional toll.^{134,135} Several studies have linked exposure to policing, including police brutality, to mental health problems.¹³⁶⁻¹³⁸ The pathway through which policing induces mental health problems may function through a stress-response mechanism such as fear of future victimization.^{128,131} With recent high-profile killings by law enforcement officials in the US, national attention and discourse surrounding police brutality has increased.^{139,140} With that, associated stress or fear of future victimization has also increased.^{139,141}

The Common Links Between Each Exposure

Vicarious exposure to societal discrimination, societal shootings or violence, or community police brutality can elicit a stress response through two main pathways. First, personal affiliation and attachment to the victim of discrimination, shootings or violence, or

police brutality is a strong predictor of negative affectivity.¹¹⁶ Second, fear of future victimization is a predictor of stress and distress.^{126,127} These two factors are not mutually exclusive, meaning that vicarious exposure to any of these social problems can cause stress through both pathways. In addition, these exposures are best conceptualized as race-related stressors,¹⁴² which is explained further later in this Introduction.

1.4 Stress, Psychological Distress, and Health

A common theme in previous sections is that psychosocial determinants of health can induce stress responses. In this section, I describe the stress process, how it relates to distress, and how both stress and distress effect health.

1.4.1 The Stress Process

Stress is a silent killer.¹⁴³ Characterized by Selye (1976), “all living beings are constantly under stress and anything, pleasant or unpleasant, that speeds up the intensity of life, causes a temporary increase in stress, the wear and tear exerted upon the body.”¹⁴³ Stress occurs when the internal or external environment produces stressors that are taxing and lead to worsened physical and mental health.^{98,143-147} A stressor can be perceived as negative and cause negative affect or positive and cause motivations.¹⁴⁵ Acute stress responses are generally adaptive and can lead to marginal health benefits while chronic stress responses are harmful.^{145,148} The biological mechanisms through which stress impacts the body involve direct physiological reactions, damage to the immune system, and increased susceptibility to the onset of chronic disease.^{145,148} Moreover, stress is regulated through responses by organ systems, such as the body’s natural propensity to maintain homeostasis (i.e., allostasis).^{146,149}

Since the early twentieth century, scientists have worked to better understand the processes by which stress occur.^{98,143,146} The stress-process model posits that stress derives from

a person's position in the social environment.¹⁴⁶ It also describes that the link between a source of stress and its manifestation as health damaging is determined by social and psychological resources such as coping and social support.¹⁴⁶ Three domains compose the process by which social stress occurs: the source, the mediator, and its manifestation.^{146,147} Sources of social stress derive from structures and cultures that produce them. On the individual level, they originate from two broad circumstances: 1) the occurrence of discrete events, and 2) the presence of relatively continuous problems.^{146,147} Factors such as coping that mediate the relationship between stress and its manifestation vary by the individual.^{146,147} Coping mechanisms are heterogeneous in that they differ by their effectiveness and method of implementation, such as whether coping, or the act of coping, is perceived as necessary.^{146,147} The concept that individual variability plays a role in determining coping mechanisms, including differences in availability of coping resources, impacts behavioral responses has existed in the scientific literature for decades.^{146,147} Recent scholars have extended these ideas to form frameworks that help explain the mechanisms outlining stress and health outcomes.^{66,67,70,83}

Chronic stress affects allostasis,⁸⁴ or the human body's ability to maintain homeostasis (i.e., bodily equilibrium) through adaptation to its environment.^{149,150} Chronic stress disrupts allostasis through organ overstimulation or activation, leading to allostatic load, or the "wear and tear" on the body.^{149,150} The link between chronic stress and allostatic load is widely recognized and has important implications for research in medicine and public health.¹⁴⁹⁻¹⁵¹ Repeated exposures to stress can sustain a cumulative stress response and lead to bodily deterioration through a process called weathering.^{152,153} As this process occurs, people might develop mental health problems and chronic diseases, lowering their life expectancies and implicating them for future substance use to mitigate long-term stress and distress.¹⁵⁴

Related to chronic stress, distress is described as “an unpleasant subjective state” and is directly tied to the stress process.^{147,155,156} The stress-process manifests in three tiers of social structure: social stratification, social institutions providing roles and statuses, and interpersonal relationships.^{147,157} The expression of distress can be attributed to the structures that give rise to it. These structures, such as institutions that perpetuate racist prejudices or the changing social environment, are not only responsible for the ways in which people are exposed to stressors including how they cope with them,^{147,157} but also how they affect people’s subjective state of mind.¹⁵⁶ In addition, distress is associated with tobacco and cannabis use.^{158,159}

Stress is directly linked to distress, but the two concepts must be differentiated from a conceptual standpoint.¹⁵⁷ Stressful life events may not only induce stress, or the physiological and psychological demands on the body, but also distress, by leading to more severe emotional disturbance.^{156,157} However, in this dissertation, such differentiation is not as important, as the presence of either stress or distress can impact coping mechanisms via similar pathways, and the focus is on how they influence tobacco and cannabis use outcomes. Nevertheless, it is important to understand the context of stress and distress as outcomes of psychosocial determinants of health, and how they drive racial/ethnic disparities in tobacco and cannabis use.

1.4.2 Race-Related Stress

Race-related stress is stress generated through processes involving interpersonal and systemic inequitable treatment toward racial/ethnic groups.^{86,142,160} Race-related stress derives from racism, or stress generated by behaviors or policies established to enforce a racist agenda. These sources of stress are separate from everyday stress experienced by all individuals and are defined as additional instances of stress stemming from racism.^{86,160} Each type of psychosocial determinant of health in this dissertation can be conceptualized as a form of, or directly tied to,

race-related stress. That is, structural racism drives and perpetuates the incidence of each exposure. For example, racial/ethnic discrimination is a direct source of racism.^{85,86} If an individual experiences discrimination based on their race or ethnicity, then that was due to racism. Internalizing/externalizing problems, while salient to all racial/ethnic groups, can develop and worsen due to race-related stress.^{86,161,162} Societal discrimination, while relevant to all forms of marginalized identities, can pertain to racial/ethnic discrimination at the institutional and systems levels.⁹¹ Shootings and violence in society often disproportionately plague racial/ethnic minoritized populations¹⁶³ and are, in many cases, influenced by structural racism.¹⁶⁴ Policing derives from racist practices developed during the US slavery era.^{132,133} Now, racial/ethnic minoritized populations are the targets of interpersonal and community-level policing, whether violent or not, more so than White Americans.^{131,132,134,135} For the sake of simplicity, I conceptualize each exposure in this dissertation as race-related stressors while acknowledging the nuances that exists for each experience and the variability in experiences by person, place, and time. Although this dissertation does not explicitly examine structural racism and its relationship with tobacco and cannabis use outcomes, it provides the foundation for examining racial/ethnic differences in the relationships between the psychosocial determinants and tobacco and cannabis use.

1.5 Stress-Coping Frameworks

While this dissertation focuses on psychosocial determinants of health and how they relate to racial/ethnic disparities in tobacco and cannabis use in the US, it is important to understand the processes by which these factors may lead to substance use. In this section, I describe the Transactional Model of Stress and Coping, developed by Lazarus and Folkman in 1984,⁶⁶ and how this model helped set up the framework for other theories to come. I also

discuss stress-coping models salient to substance use research.⁶⁷⁻⁶⁹ These frameworks elucidate causal mechanisms by which stress leads to adverse behavioral health outcomes such as tobacco and cannabis use. I end by detailing the Environmental Affordances Model by Mezuk et al. (2013),⁷⁰ which provides additional understanding of health disparities from a stress-coping lens, and why it is important to consider the impact of sociodemographic status (e.g., race/ethnicity) on coping abilities and styles.

1.5.1 The Transactional Model of Stress and Coping

Lazarus and Folkman's (1984) model explains why people who experience stress turn to risky health behaviors to cope.^{66,165} Through this framework, stressors are thought of as person-environment transactions.⁶⁶ These transactions are mediated by primary and secondary cognitive appraisals and coping mechanisms. Cognitive appraisals occur when the person identifies and deeply considers the stressor.⁶⁶ A primary appraisal occurs when the person who is confronting a stressor evaluates its significance and potential harm or benefit, while a secondary appraisal occurs when the person analyzes their ability to manage the stressor, such as through accepting or altering the situation, or anticipating positive or negative affect.⁶⁶ Evaluation of the accessibility of coping resources occurs during secondary appraisals.⁶⁶

Two goals are achieved through coping: emotional regulation (i.e., emotion-focused) and problem solving (i.e., problem-focused).⁶⁶ Both forms of coping are used in most stress transactions,¹⁶⁶ but the use of one over the other largely depends on how the stressor is appraised, such as whether the stressor is threatening or manageable.^{66,166,167} Problem-focused coping strategies are more used when the transaction is more manageable and emotion-focused coping strategies are more used when the transaction is less manageable.^{166,167} That is, people who use problem-focused coping do so to regulate their stressors, while people who use emotion-focused

cope do so to regulate their emotional responses to stressors.^{166,167} A common theory is that people turn to substances to cope with the stress through emotion-focused coping strategies.^{67,68,71,168} These decisions to use substances are conceptualized as a coping strategy or style,^{165,168} and this form of coping is most relevant to this dissertation.

1.5.2 Stress-Coping Models in Substance Use Research

Models of stress and coping with substances extend Lazarus and Folkman's ideas by further emphasizing adverse behaviors to reduce stress or distress, or to self-medicate.^{67,71,72,168,169} The slight distinction between stress reduction and self-medication is an important one. The former refers to the use of substances to lower stress, and the latter was first proposed in the context of psychiatric comorbidity in which people resort to substances to tolerate and modify their negative affect, in extreme cases, distress.^{72,169} These affective states can be painful and overt, or difficult to recognize and subtle.^{72,169} Stress responses often times include negative affectivity but not in every case.^{66,146} Distress, however, is an affective state but does not encompass all forms of negative affect. Nevertheless, there is overlap between using substances to reduce stress and using substances as a form of self-medication, or to reduce negative affect or distress.

The distinction between stress-reduction and self-medication theories is relevant for describing the relationships of interest in this dissertation. Both pathways can lead to substance use. Stress-coping models in substance use research help lay the foundation that describes why exposure to racial/ethnic discrimination, internalizing/externalizing problems, and negative affect about social problems lead to substance use as coping mechanisms. Variations of the stress-coping model build on Lazarus and Folkman's transactional model,⁷⁰ such as a version of a stress-coping framework in the context of social stigma^{170,171} and structural racism.^{77,172-174} These

models focus on stigma and racism as predictors of cognitive appraisals of stress.^{77,172-174} The stress-coping with racism framework can be applied to coping with race-related psychosocial determinants, such as racial/ethnic discrimination, internalizing/externalizing problems, and negative affect about social problems. Racism is a pervasive and continuous stressor for many racial/ethnic minoritized groups,^{86,93} and, as such, the downstream determinants of interest in this dissertation might occur at any time across the life course.

The pervasiveness of a stressor raises consequences for downstream coping strategies.¹⁰⁰ Coping patterns are recognized as adverse when they are ineffective, such as patterns strengthening the relationship between stress or distress and substance use.^{67,68} Highly pervasive stressors have been found to be more associated with ineffective or inactive coping, such as not directly dealing with the problem.¹⁰⁰ This strengthens the argument that exposure to race-related psychosocial determinants of health might lead to substance use through a coping framework, and perhaps lead to racial/ethnic disparities in tobacco and cannabis use.

Substance use is considered an adverse form of coping with grave implications for health consequences, such as dependence, chronic health effects (e.g., cardiovascular disease), and difficulty quitting.^{1,42,58} While this dissertation focuses on tobacco and cannabis use as a result of problematic coping strategies, other sources of coping exist and differ by key sociodemographic groups, such as race/ethnicity.⁷³⁻⁷⁷ I defined coping strategies above as problem-focused or emotion-focused, but research has emphasized two additional categories: meaning-focused and social coping.¹⁷⁵ These coping mechanisms can co-exist with the former two during the personal appraisal process. That said, substance use can arise from any stressor depending on the individual. Examples of coping strategies that might result in less problematic health outcomes include seeking support from peers or family (i.e., social support),^{172,176} religion or

religiosity,^{172,177} self-reliance or resilience to pervasive stressors,^{77,178} or in the context of race-related stressors, a strong sense of racial identity or empowerment.^{172,179} No matter the coping strategy, for at least a substantial proportion of US youth and adults, psychosocial determinants of health may lead to substance use, calling for research that helps explain these relationships.

1.6 Specific Aims and Hypotheses

To conclude the Introduction section, I provide aims and hypotheses for each research question in this dissertation. I examine psychosocial drivers of racial/ethnic disparities in tobacco and cannabis use among US youth and adults, focusing on stressors that can be conceptualized as race-related and on associated racial/ethnic disparities in use patterns. Each determinant (i.e., racial/ethnic discrimination, internalizing/externalizing problems, negative affect about social problems) corresponds to a specific research question. Findings from this dissertation will provide insight into how race-related stressors are associated with problematic use patterns of tobacco and cannabis overall, and whether these associations differ by race/ethnicity. This investigation is important to inform efforts aimed to promote racial/ethnic health equity, with important implications for reducing disparities in the health consequences of tobacco and cannabis use. Below is each specific aim and hypothesis.

1.6.1 Specific Aim 1 (Chapters 2-3)

To examine the associations between racial/ethnic discrimination and patterns of tobacco use (i.e., exclusive, dual (two products), poly (three or more products)) and patterns of tobacco and cannabis use and co-use (i.e., individual tobacco, dual tobacco, poly tobacco with or without cannabis) among US adults, and to explore the extent to which these relationships are modified by race/ethnicity.

Sub Aims

- A. To evaluate the associations between past-year racial/ethnic discrimination and past 30-day (i.e., current) patterns of tobacco use (Chapter 2), and current patterns of tobacco and cannabis use and co-use (Chapter 3).
- B. To investigate the modifying roles of race/ethnicity on both associations.

Hypotheses

- A. Supported by previous research examining relationships between racial/ethnic discrimination and individual use of tobacco products,¹⁸⁰⁻¹⁸² I hypothesize that US adults who experience more racial/ethnic discrimination will have higher odds of current tobacco use, including forms of dual/poly use, functioning through a stress-coping framework.^{67,68} Racial/ethnic discrimination will also be associated with cannabis use, corroborating prior work that has examined these relationships.¹⁸³ While not previously examined, experiencing more racial/ethnic discrimination will additionally be associated with current dual/poly tobacco use outcomes with cannabis. These relationships will also function through a stress-coping framework, possibly representing more severe stress responses that lead to more problematic substance use outcomes (e.g., current tobacco and cannabis co-use).
- B. I hypothesize that associations between racial/ethnic discrimination and current tobacco and cannabis use will be greater for Hispanic and NH Black adults than NH White adults. While experiencing racial/ethnic discrimination leads to poorer health outcomes overall,^{84,85,93} associations will be stronger among racial/ethnic minoritized groups that are historically disadvantaged in the US and are exposed to more race-related psychosocial determinants of health. This hypothesis is based on an interplay of factors, such as structural racism, that gives rise to discriminatory experiences,^{86,92} and predatory

and aggressive targeting efforts by the tobacco industry toward certain groups that results in greater use of products, such as cigarettes and cigars.¹⁸⁻²⁰

1.6.2 Specific Aim 2 (Chapters 4-5)

To evaluate associations between severity of internalizing/externalizing problems and tobacco and cannabis use and co-use separately for US emerging adults, and to determine whether race/ethnicity modifies these relationships.

Sub Aims

- A. To identify latent classes of current tobacco use of multiple products and current cannabis use via different ROA among separate samples of youth and YAs and explore whether use class patterns vary by key sociodemographic characteristics, including race/ethnicity.
- B. To examine the extent to which severity of internalizing/externalizing problems are associated with current tobacco and cannabis use classes.
- C. To investigate whether race/ethnicity modifies the associations between severity of internalizing/externalizing problems and current tobacco and cannabis use classes.

Hypotheses

- A. I hypothesize that distinct patterns of tobacco product-specific and cannabis ROA-specific use classes exist by race/ethnicity. For example, Hispanic and NH Black youth and YAs will have higher prevalence of cannabis vaping use classes than NH White youth and YAs.
- B. Former studies have established an interrelationship between internalizing/externalizing problems and substance use among youth and adult populations.¹⁸⁴⁻¹⁸⁷ Thus, I hypothesize that high severity of both types of problems will be associated with tobacco and cannabis use classes. For internalizing problems, these associations will function

through the self-medication mediating pathway to reduce distress.^{72,169} Associations with externalizing problems will be hypothesized to function through stress-reduction factors, such as deviance or exclusion from prosocial peers (and, alternatively, inclusion of deviant peers), encouraging substance use.¹⁸⁸ In addition, I hypothesize that high severity of externalizing problems will be associated with tobacco and cannabis use classes more strongly than associations with high severity of internalizing problems, as observed in prior research.¹⁸⁷

The extent to which internalizing/externalizing problems are associated with current use of specific classes of tobacco and cannabis is up for inquiry. I hypothesize that associations between internalizing/externalizing problems and current use will differ by classes defined by tobacco product-specific and marijuana ROA-specific use combinations. An investigation by Conway et al. (2017) found that associations between internalizing problems and tobacco use were strongest for cigarette use, while associations between externalizing problems and tobacco use were strongest for cigar use, suggesting that there is variation in mental health problems across the tobacco product use spectrum.¹⁸⁶ Given that there is limited understanding of the relationship between internalizing/externalizing problems and current use of newer products (e.g., ENDS),^{185,189,190} prior work leads me to theorize that associations will be similar for ENDS use if the products are sought to be used to reduce stress and distress. In addition, ENDS are common among youth and YAs, more so than cigarettes.^{14,15}

I further hypothesize that associations between internalizing/externalizing problems and current cannabis use classes will be similar to associations with current tobacco use. A study among youth found that externalizing problems were strongly

related to cannabis use while internalizing problems were associated with lower frequencies of use.¹⁸⁷ Like tobacco product-specific associations, I predict that internalizing/externalizing problems will be related to specific cannabis use modalities. This hypothesis is not fully supported by previous literature as, to my knowledge, studies examining relationships between internalizing/externalizing problems and blunting and vaping cannabis separately, for example, do not exist. In addition, certain ROAs are more salient to certain racial/ethnic groups,^{41,48} making these investigations important.

C. Associations between internalizing/externalizing problems and tobacco and cannabis use will be modified by race/ethnicity. NH Black and Hispanic populations are disproportionately afflicted by internalizing/externalizing problems,^{24,25} which may contribute to racial/ethnic disparities in tobacco and cannabis use. NH Black and Hispanic groups may be more susceptible to engaging in adverse coping strategies due to the lack of problem-focused coping resources.^{66,70} Thus, these groups may be more prone to using substances to self-medicate.^{72,169} Considering these factors, I hypothesize that the association between internalizing/externalizing problems and tobacco and cannabis current use classes will be more profound among NH Black and Hispanic youth and YAs, compared to NH White youth and YAs.

1.6.3 Specific Aim 3 (Chapter 6)

To assess the extent to which negative affect (i.e., concern, worry, and stress) about social problems predict longitudinal tobacco and cannabis use and co-use among a racially/ethnically diverse cohort of YAs living in Los Angeles (LA), California, and whether race/ethnicity modifies these relationships.

Sub Aims

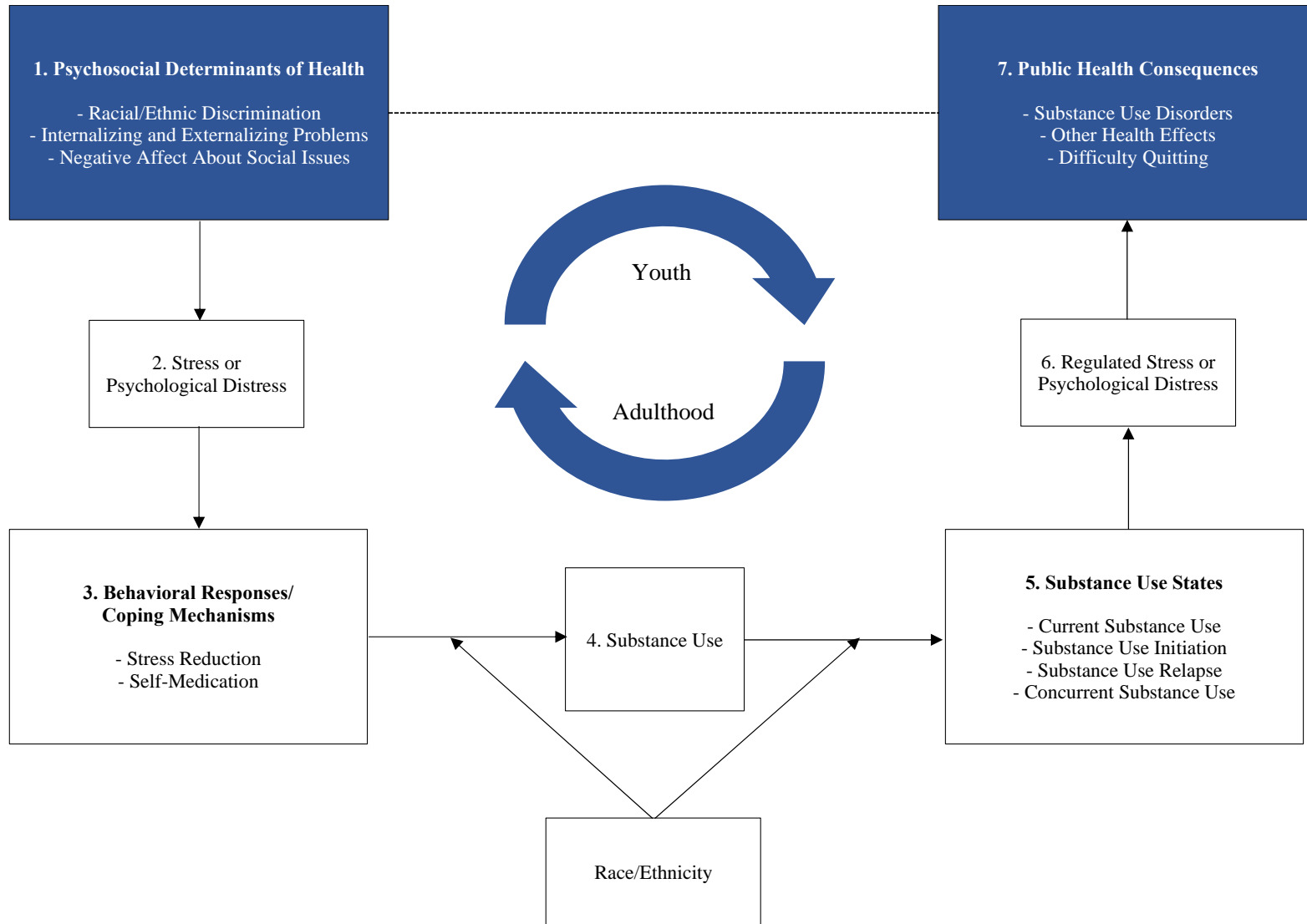
- A. Using exploratory factor analysis (EFA), explore whether there is an underlying factor structure of nine measures of concern, worry, and stress about societal discrimination, societal shootings or violence, and community police brutality.
- B. To examine associations between factor scores generated by the EFA at baseline and current tobacco and cannabis use and co-use at follow-up.

Hypotheses

- A. Based on the present understanding of race-related stressors,^{86,93} I hypothesize that there is an underlying factor structure representing patterns of concern/worry/stress about societal discrimination, societal shootings or violence, and community police brutality. These three social problems disproportionately affect racial/ethnic minoritized groups in the US,^{91,163,164} making it plausible that stressful and affective response to them pattern uniquely among US YAs. The EFA will help delineate patterns of concern-, worry-, and stress-related negative affectivity based on racially/ethnically-salient social problems. Specifically, I hypothesize that I will observe factors representing high levels of concern, worry, and stress (i.e., distress) about one or multiple social problems. Prior research using these measures has reported that subsamples of YAs in the same cohort have descriptively reported high levels of concern, worry, and stress about societal discrimination,¹⁹¹ societal shootings or violence,¹⁹² and community police brutality separately.^{139,141}
- B. I hypothesize that factor scores representing levels of high concern/worry/stress about societal discrimination, societal shootings or violence, and community police brutality will be associated with current tobacco and cannabis use and co-use. These relationships will function through the stress-reduction and self-medication pathways.^{68,71,72,169} In

addition, I hypothesize that relationships between factor scores representing high levels of concern/worry/stress and current use will be stronger for co-use, than exclusive or non-current use of tobacco or cannabis. This hypothesis is based on the theory that more stress or distress is associated with more substance use.^{67,68,168} Since tobacco and cannabis use pattern in many ways,^{42,46} it is plausible to hypothesize that co-use as a response to distress will occur.

Figure 1.1 Conceptual Model for Understanding Substance Use Disparities



Chapter 2 Discrimination and Tobacco Use Outcomes Among US Adults: Effect Modification by Race/Ethnicity¹

2.1 Introduction

Tobacco use remains the leading cause of preventable morbidity and mortality in the US today, despite previously successful efforts to reduce youth and adult cigarette smoking.^{15,193} While US cigarette use is at an all-time low in the past several decades,^{15,193} the use of other products, such as ENDS, has become more common, especially among younger populations.¹⁹³ Currently, nearly 1 in 10 YAs ages 18-24 and 1 in 20 adults ages 25 to 44 use ENDS, with prevalence being slightly lower among older adults.¹⁵ Although the introduction of ENDS in the market have implications for dual (two products) and polytobacco (three or more products) use, multiple tobacco product use (i.e., dual/poly tobacco use) was a public health concern even before ENDS became popular.¹⁹⁴

Research on dual/poly tobacco use has gained traction in recent years as scholars have explored patterns and determinants of use with ENDS in youth and adult populations.^{17,195,196} This research is motivated by needing to: 1) better understand how dual/poly tobacco use evolves over time, 2) determine if use of one product may influence the use of another, and 3) gain a better sense of the health effects associated with using more than one product at a time. Dual and polytobacco use may be more harmful than exclusive use of a single tobacco product. For example, combustible tobacco products are generally more harmful than ENDS, and dual use of

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cigarettes and cigars may lead to worsened health relative to dual use including ENDS.^{197,198}

Studies have found that dual/poly tobacco use is associated with greater nicotine dependence¹⁹⁹⁻²⁰¹ and higher frequency of use,^{201,202} which could lead to worse long-term health outcomes.^{201,203}

In addition to the potential health consequences of dual/poly tobacco use, another important consideration is differences in use by race/ethnicity, with consequences for downstream health inequities. Many studies have documented disparities in tobacco use by race/ethnicity. For example, NH AI/AN adults have the highest prevalence of tobacco product use, followed by adults of another race/ethnicity, NH White and NH Black adults, and Hispanic and NH Asian adults.¹⁵ In a study examining exclusive, dual, and polytobacco use patterns, NH White adults had higher prevalence of exclusive ENDS use compared to other racial/ethnic groups, and NH Black adults had higher prevalence of exclusive other combustibles (OC) use (i.e., cigars, pipes) and dual use of cigarettes and OC compared to other racial/ethnic groups.¹⁹⁵ Tobacco use patterns over time also vary by race/ethnicity. For example, a trends study using data from 2014-2019 found that polytobacco use with cigarettes decreased only among NH Black adults and remained constant for Hispanic, NH White, or adults from another race/ethnicity, while dual/poly tobacco use without cigarettes increased for all racial/ethnic groups.¹⁷

One determinant of disparities in tobacco use is discrimination, an exposure and psychological stressor that affects many populations in the US.^{86,204} Discrimination, or unequal treatment based on phenotypical characteristics or group identity, is detrimental to physical and mental health.^{85,86,204,205} One form of discrimination is racial/ethnic discrimination, or discrimination that occurs against racial/ethnic groups based on characteristics such as skin color

or racial/ethnic identity.^{86,206} This form of discrimination is experienced by at least half of racial/ethnic minoritized individuals living in the US in their lifetimes.⁸¹

Racial/ethnic discrimination is a direct result of structural racism and is a key social determinant of racial/ethnic health inequities in the US.^{84-86,92,205,206} Social determinants of health rooted in systemic marginalization may elicit stress responses that predispose some individuals to problematic methods of coping, such as the use and misuse of substances.^{68,207} To date, racial/ethnic discrimination has been examined as a risk factor for tobacco use outcomes.^{181-183,208-210} Most studies focused on tobacco use have found racial/ethnic discrimination to be associated with use of cigarettes,^{181-183,208,209} while a few recent studies have linked racial/ethnic discrimination with individual use of ENDS, cigars, pipe tobacco, and hookah.^{181,182} Racial/ethnic discrimination has also been associated with lower odds of tobacco cessation among NH Black compared to NH White adults.²¹⁰ In addition, a handful of studies have examined the relationship between racial/ethnic discrimination on polysubstance use,^{208,211} but it is difficult to extrapolate these results to tobacco use or the use of multiple tobacco products.

The extent to which racial/ethnic discrimination is associated with dual/poly tobacco use is not known. This is important to study because dual/poly tobacco use can lead to nicotine dependence,¹⁹⁹⁻²⁰¹ and potentially worse physical health outcomes, although the literature is scarce.²⁰² In this study, I examined associations between past-year racial/ethnic discrimination and 1) exclusive, dual, and polytobacco use, and 2) tobacco use disorder defined by DSM-5 criteria. I also evaluated effect modification of these relationships by race/ethnicity, since racial/ethnic discrimination quantitatively differs by race/ethnicity in the US,⁸¹ and thus its relationship with tobacco use may vary for each racial/ethnic group.

2.2 Methods

2.2.1 Data

I used data from the 2012-2013 National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III), sponsored by the National Institute on Alcohol Abuse and Alcoholism (NIAAA). NESARC-III is a nationally representative survey of the adult (18 years or older) noninstitutionalized, civilian population in the US designed to evaluate the mental health status of adults living in the US. It used a multistage probability sampling that randomly selected adults from the US population. Hispanic, NH Black, and NH Asian participants were oversampled, and racial/ethnic minoritized households with at least four eligible participants were oversampled; data were adjusted for oversampling. All data were collected via in-person interviews using Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5), a reliable semi-structured diagnostic interview process that assesses mental health disorders with DSM-5 criteria.^{212,213} The total response rate was 60.1%, resulting in a sample size of 36,309 US adults.^{213,214} The NESARC-III sampling design and weighting scheme are described in more detail elsewhere.²¹³

2.2.2 Participants

NESARC-III included 36,309 adults. All respondents were asked questions about racial/ethnic discrimination. Respondents who identified as Hispanic were asked about ethnic discrimination and respondents who identified as any race and not Hispanic were asked about racial discrimination. Respondents who had complete information on either discrimination measure, each tobacco use measure, and each relevant covariate were included in this study, resulting in an analytic sample size of 35,881. The process by which the analytic sample was selected is presented in Figure 2.1.

2.2.3 Measures

Experiences of Discrimination (EOD)

NESARC-III adopted six measures that can be used individually or combined into a summary scale. Each measure asked participants about their EOD in specific settings, with prior-to-past-year EOD and past-year EOD separately.²¹⁵ All respondents were asked, during the last 12 months, “(about) how often did you experience discrimination because you are Hispanic or Latino/because of your race or ethnicity in: 1) your ability to obtain health care or health insurance coverage, 2) how you were treated when you got care, 3) public, like on the street, in stores or in restaurants, 4) ANY other situation, like obtaining a job or on the job, getting admitted to a school or training program, in the courts or by the police,” and “(about) how often were you 5) called a racist name or 6) made fun of, picked on, pushed, shoved, hit, or threatened with harm.” Response options for each scenario included: 0) never, 1) almost never, 2) sometimes, 3) fairly often, and 4) very often. For past-year racial/ethnic discrimination, I summed the six experiences to create a summary scale (range 0-24), mirroring prior research using these measures.²¹⁶ The Cronbach’s alpha was 0.81 for the summary scale, demonstrating excellent internal reliability. For brevity, the EOD measure used in this study is referred to as “discrimination.”

Individual Tobacco Product Use

NESARC-III includes information on five types of tobacco products: cigarettes, cigars, pipe, smokeless tobacco (SLT; i.e., snuff, moist, dipping tobacco), and ENDS (i.e., electronic cigarettes (e-cigarettes) and e-liquid). Participants were asked to indicate which of the products they had used at least once in the past 12 months (yes or no). Those who indicated “yes” for each product were also asked to provide the most recent time they used a product in years, weeks, days, and hours. Using this information, I classified current use for each product as use in the

past 30 days. With these five variables, I created four broader classifications of tobacco product use: cigarette use, OC (cigars and/or pipe), SLT use, and ENDS use. Cigars and pipe were classified into the OC use group due to sample size limitations and to reduce the number of mutually exclusive tobacco use categories.

Exclusive, Dual, and Polytabacco Use (Patterns of Tobacco Use)

Using the four tobacco product use variables above, I created a 16-category variable of mutually exclusive tobacco product use groups. With the 16-category variable, I derived an additional variable that captures never/former (category 1), exclusive (categories 2-5), dual (categories 6-11), and polytabacco (categories 12-16) use (see Table A.1). Due to sample size limitations, I collapsed dual and polytabacco use categories to create an additional variable that captures never/former, exclusive, and dual/poly tobacco use for analyses that examined stratification by race/ethnicity.

Tobacco Use Disorder (TUD)

I examined TUD based on criteria developed by the American Psychological Association (APA) Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-5) using AUDADIS-5.²¹⁷ AUDADIS-5 operationalized TUD includes symptoms pertaining to all types of tobacco products. A past-year DSM-5 TUD is classified as having at least two of eleven symptoms presented in the DSM-5, and specified in Table A.2.²¹⁷ I created one variable that indicated whether participants had a past-year DSM-5 TUD (yes/no).

Covariates

I used the following sociodemographic characteristics as covariates: age (continuous), sex (male, female), race/ethnicity (Hispanic, NH White, NH Black, another race/ethnicity), highest educational attainment (high school/GED or less, some college, and college degree or

more), annual household income (\$25,000/year, \$25,000 to \$59,999/year, and greater than or equal to \$60,000/year), urbanicity (rural, urban), and geographic region (Northeast, North Central/Midwest, South, and West). Another race/ethnicity included participants who identified as NH AI/AN, NH Asian/Native Hawaiian/other Pacific Islander (A/NH/OPI), and NH multiracial (two or more races).

2.2.4 Statistical Analysis

This aim focused on two outcomes: 1) past-30-day patterns of tobacco use and 2) past-year DSM-5 TUD (outcome 2).

First, I calculated the prevalence of participant characteristics (i.e., sociodemographic, geographic characteristics, and the past-year discrimination scale) overall. I also show the prevalence of each individual tobacco use outcome in Table A.3. Second, I compared distributions of participant characteristics across the two outcome variables using chi-square tests for independence and analysis of variance (ANOVA) (see Tables A.4-A.5). To evaluate the associations between past-year discrimination and past-30-day patterns of tobacco use, I fit an unadjusted multinomial logistic regression model; the referent group (ref) was never/former tobacco use. For associations between past-year discrimination and past-year TUD, I fit an unadjusted logistic regression model; the referent group was never/former TUD. I fit an additional model for each outcome adjusting crude models for age, sex, race/ethnicity, highest educational attainment, annual household income, urbanicity, and geographical region. A quadratic age term was added to the model to account for the non-linear relationship between age and tobacco use; to minimize collinearity between the linear and quadratic terms, age was centered by subtracting its mean.

To investigate whether experiencing discrimination differed for each racial/ethnic group, I fit additional adjusted models for each outcome with two-way interaction terms between past-year discrimination and race/ethnicity. To determine whether the interactions were statistically significant, Wald tests were performed at an alpha level of 0.05. Since each p-value was highly statistically significant ($p < 0.001$), I stratified each model by race/ethnicity to explore effect modification by race/ethnicity of the associations between past-year discrimination and each outcome.

I conducted one supplementary analysis, three sensitivity analyses, and one post-hoc sensitivity analysis. The supplementary analysis examined associations between past-year discrimination and individual tobacco product use using adjusted logistic regression. This analysis aims to estimate whether strengths of associations differed by product. Among the sensitivity analyses, one analysis examined associations between prior-to-past-year discrimination, defined similarly to past-year discrimination, and the two tobacco use outcomes to investigate whether associations differed depending on when respondents experienced discrimination. These models were also stratified by race/ethnicity to examine effect modification. The second analysis examined associations between past-year discrimination and past-30-day patterns of tobacco use using exclusive tobacco use as the referent group to investigate whether associations differed for adults who used tobacco products exclusively to adults who used multiple products. The third analysis disaggregated the “another race/ethnicity” group into NH AI/AN and NH A/NH/OPI and reran stratified analyses to investigate heterogeneity of the association within these additional groups, as possible when models converged. The fourth post-hoc analysis examined whether categorizing and modeling past-year

discrimination scores (i.e., 0, 1-5, 6-10, 11-15, and 16+) maintained an approximate linear trend in the regression models, given the skewedness of the continuous measure.

All analyses accounted for the complex sample design (stratification, clustering, and weighting) in the NESARC-III using Stata SE version 16.1 (StataCorp, College Station, Texas).

2.3 Results

2.3.1 Prevalence of Participant Characteristics

Table 2.1 shows the characteristics of the analytic sample (N=35,881). The mean past-year discrimination scale was 1.0 (standard deviation (SD): 2.3, range: 0-24), meaning that, on average, respondents reported “almost never” experiencing one of six scenarios of discrimination. About three-fourths of the respondents never/formerly used tobacco, 21.3% used tobacco exclusively, 2.7% used dual products, and 0.2% used three or more products. Lastly, 19.9% of respondents had a past-year TUD.

2.3.2 Discrimination and Patterns of Tobacco Use

In adjusted models, the odds of tobacco use (vs. never/former use) monotonically increased as the number of tobacco products used (i.e., exclusive, dual, poly) increased (see Table 2.2). For example, each one-unit increase in discrimination (0-24) was associated with higher odds of exclusive (odds ratio (OR): 1.06, 95% confidence interval (CI): 1.04-1.07), dual (OR: 1.10, 95% CI: 1.06-1.14), and polytobacco use (OR: 1.18, 95% CI: 1.09-1.27), respectively, each compared to never/former use and adjusted for sociodemographic and geographic characteristics.

2.3.3 Discrimination and DSM-5 Tobacco Use Disorder

Experiencing past-year discrimination was associated with past-year DSM-5 TUD (Table 2.3). Specifically, each one-unit increase in discrimination (0-24) was associated with 9% higher odds (95% CI: 1.07-1.10) of TUD.

2.3.4 Effect Modification by Race/Ethnicity

Past 30-Day Patterns of Tobacco Use

The two-way interaction between past-year discrimination and race/ethnicity in the model estimating the association of past-year discrimination on past 30-day patterns of tobacco use was statistically significant ($p < 0.001$). When examining the statistical significance of the interaction term with specific levels of the outcome, the terms were statistically significant for exclusive use ($p < 0.001$) and dual/poly tobacco use ($p < 0.001$) (see Table 2.4). In stratified models, past-year discrimination was associated with exclusive tobacco use among all racial/ethnic groups. Specifically, each one-unit increase in discrimination (0-24) was associated with 3% higher odds (95% CI: 1.002-1.06) of exclusive tobacco use among Hispanic respondents, 9% higher odds (95% CI: 1.07-1.12) among NH White respondents, 4% higher odds (95% CI: 1.02-1.06) among NH Black respondents, and 8% higher odds (95% CI: 1.03-1.13) among respondents who identified as another race/ethnicity. Discrimination was associated with dual/poly tobacco use among NH White and NH Black respondents only, with NH White respondents having 18% higher odds (95% CI: 1.13-1.22) of use with each one-unit increase in discrimination, while NH Black respondents had 5% higher odds (95% CI: 1.002-1.11).

Past-Year DSM-5 Tobacco Use Disorder

The two-way interaction between past-year discrimination and race/ethnicity in the model estimating the association of past-year discrimination with past-year DSM-5 TUD was statistically significant ($p < 0.001$). For TUD, each one-unit increase in discrimination (0-24) was

associated with 5% higher odds (95% CI: 1.02-1.07) among Hispanic respondents, 13% higher odds (95% CI: 1.11-1.16) among NH White respondents, 7% higher odds (95% CI: 1.05-1.09) among NH Black respondents, and 9% higher odds (95% CI: 1.04-1.14) among respondents who identified as another race/ethnicity.

2.3.5 Supplementary Analysis

Table A.6 shows results from the supplementary analysis estimating associations between past-year discrimination and individual tobacco product use. Each one-unit increase in discrimination was associated with 6% (95% CI: 1.05-1.08), 8% (95% CI: 1.05-1.11), and 5% (95% CI: 1.01-1.10) higher odds of cigarette, OC, and SLT use, respectively. The association for ENDS use was not statistically significant (OR: 1.03, 95% CI: 1.00-1.07).

2.3.6 Sensitivity Analyses

Results from the first sensitivity analysis that examined associations between prior-to-past-year discrimination and tobacco use outcomes demonstrated that prior-to-past-year discrimination was associated with past 30-day patterns of tobacco use and past-year DSM-5 TUD at similar magnitudes as past-year discrimination (Tables A.7-A.9), in the main model and the models stratified by race/ethnicity. Results from the second sensitivity analysis that examined associations between past-year discrimination and past 30-day patterns of tobacco use using exclusive use as the referent group revealed that past-year discrimination was associated with 4% higher odds of dual use (95% CI: 1.01-1.07) and 11% higher odds of polytobacco use (95% CI: 1.03-1.21) (Table A.10). In stratified analyses, discrimination was associated with dual/poly tobacco use, compared to exclusive use, only among NH White respondents (Table A.11). Finally, the analysis that disaggregated the “another race/ethnicity” category into NH AI/AN (n=503) and NH Asian/NH/OPI (n=1782) found no associations between past-year

discrimination and exclusive or dual/poly tobacco use or TUD for NH AI/AN (Table A.12). However, discrimination was associated with past 30-day exclusive use (OR: 1.08, 95% CI: 1.02-1.15) and past-year TUD (OR: 1.10, 95% CI: 1.04-1.17) for NH Asian/NH/OPI respondents. The last sensitivity analysis that explored the effects of categorical discrimination on tobacco use outcomes revealed that the regression estimates for exclusive, dual, and poly use remained approximately linear (data not shown).

2.4 Discussion

Results from this study suggest that adults who experience more discrimination have higher odds of using tobacco products and experiencing TUD. Associations between discrimination and exclusive and dual/poly tobacco use, as well as TUD, were strongest for NH White respondents compared to respondents who identified as belonging to racial/ethnic minoritized groups. However, there was an association between past-year discrimination and exclusive use and TUD for all racial/ethnic groups, and an association between past-year discrimination and dual/poly tobacco use for NH White and NH Black respondents. These results suggest that racial/ethnic variation in the associations between discrimination and tobacco use outcomes among US adults is complex. Further insight on factors that might be driving mechanisms linking discrimination and tobacco use are needed, especially efforts that focus on what mechanisms might explain the stronger associations among NH White adults compared to adults from racial/ethnic minoritized populations.

My findings corroborate prior studies that have examined discrimination as a risk factor for tobacco use,^{181,183,208-210} and shed additional light on how these experiences may impact more complex tobacco use patterns. Discrimination is associated with individual tobacco product use,^{181,183} and in this study, dual/poly tobacco use. In addition, the strengths of associations

between discrimination and tobacco use increased as the number of tobacco products used increased, suggesting that a dose-response relationship between discrimination and tobacco used might exist. This potential dose-response relationship raises concern about the multitude of tobacco use patterns that result in adults who experience discrimination. Another consideration is whether more discrimination is associated with increased tobacco use frequency and initiation in a similar dose-response manner as it is associated with dual/poly tobacco use. Additional work detailing these relationships is needed to further understand the role recent or long-term exposure to discrimination plays on tobacco use outcomes. For example, more discrimination may lead to increased tobacco use intensity and less favorable cessation outcomes.

While prior scientific literature has established a relationship between race-related stressors and tobacco use, the mechanisms through which these stressors impact the use of multiple tobacco products are unclear. The common liability hypothesis suggests that any substance use is associated with additional substance use, and the sequence of substances used depends on individual/genetic or social factors and substance availability more so than the sole influence of the first substance used.^{218,219} In the context of dual/poly tobacco use, use of multiple tobacco products may be attributable to common liabilities. Thus, outside of estimating health effects, particular attention to the use of specific combinations of tobacco products may not be as germane as general use of two products (dual) and three or more products (poly), and factors that determine these use patterns. The common liability hypothesis also extends to TUD through similar mechanisms as nicotine exposure comes from many different tobacco products, and the type of products used in developing TUD may not be as relevant.²¹⁹ Addressing dual/poly tobacco use and TUD among populations that are disproportionately affected by race-related stressors may ultimately reduce tobacco use.

Because experiences of discrimination are rooted in structural racism, or systems that reinforce racial inequities by perpetuating differential access to resources and opportunities, they may be causes of racial/ethnic disparities in tobacco use.^{85,207} To help understand potential drivers of racial/ethnic disparities in tobacco use, I investigated stratum-specific associations of discrimination on tobacco use outcomes among four racial/ethnic populations in the US: Hispanic, NH White, NH Black, and respondents who identified as another race/ethnicity. I found that while discrimination was associated with tobacco use outcomes in all racial/ethnic groups, the associations were strongest for NH White respondents. Given that discrimination is a result of racism in the US, and that racism is defined as an ideology, or a hierarchy where the dominant race (i.e., White) subordinates and ranks other racial/ethnic groups (e.g., Black),^{85,92} it might not make conceptual sense that NH White respondents reported experiencing discrimination based on their race/ethnicity. However, in this study, NH White respondents reported experiencing discrimination, warranting discussion of the reasons why these adults felt discriminated against based on their race/ethnicity and how these mechanisms differ from racial/ethnic minoritized groups.

Several studies have shown that NH White Americans feel discriminated against based on their race.^{81,220} Some reasons NH White Americans have reported being discriminated against based on race are related to religion, politics, resource entitlement, and relative social mobility.²²⁰⁻²²² For example, the notion that more anti-White discrimination exists may stem from the idea that historically privileged groups (i.e., White Americans) experience drawbacks when historically minoritized groups (e.g., Black Americans) attain social mobility.²²² These factors might intersect with White racial/ethnic identity and lead these Americans to perceive

discriminatory experiences to be based on their race/ethnicity when, in fact, they are due to other attributes.

Factors explaining why discrimination may more detrimentally affect certain racial/ethnic groups than others are speculative. One factor is cultural resilience.^{223,224} Resilience against discrimination is generally protective against the effects of stress,²²³ and having a strong racial/ethnic identity can attenuate the mental detriments of discrimination.²²⁴ While resilience may help decrease the risk of health problems caused by discrimination,²²³ dismantling racism to eliminate discrimination is a better public health solution. Another factor is racial centrality, which has been shown to mediate associations between prior experiences of discrimination and cigarette use among Black adults.²²⁵ Lessening the incidence of discrimination at the individual and systemic levels will ultimately ameliorate racial/ethnic health inequities. Requesting that racial/ethnic minoritized groups who experience more discrimination to develop habits and behaviors that help reduce the effects of discrimination is inequitable. The better solution is to prevent discrimination from taking place rather than advising people to withstand it.

Another potential explanation that discrimination differentially affects racial/ethnic groups is that tobacco use as a psychosocial resource is not as salient to racial/ethnic minoritized adults as it is to NH White adults, as previously posited.⁶⁸ This does not imply that discrimination is more detrimental to NH White adults than racial/ethnic minoritized adults overall, but rather that, in terms of tobacco use, NH White adults might be at higher risk than racial/ethnic minoritized adults. The idea that the relationship between stress and psychosocial resources differ by identities such as age, sex, and race/ethnicity is highlighted in the stress process model.²²⁶⁻²²⁸ Models that help explain environmental influences on stress and coping emphasize the importance of considering differential availability of resources and how these

resources may impact tobacco use.^{70,207} These ideas are exemplified in this study through race/ethnicity, which represents a collection of various experiences. Through a cultural racism framework,²²⁹ I recognize that the degree to which interpersonal exposures are processed may differ by race/ethnicity, and are likely not consistent across space and time. It is possible that certain groups more often the target of discrimination are less susceptible to adverse coping behaviors over time. It also must be stated that interpersonal forms of discrimination do not capture all experiences of racism in the US, and that more macro-level experiences differentially effect racial/ethnic groups.^{229,230} Furthermore, associations between discrimination and tobacco use may differ at various points throughout the life course, calling for future work to explore these relationships more exhaustively.

2.4.1 Limitations

This study has several limitations. First, data used in this analysis were collected in 2012-2013 and given recent increases in social and political discourse on the legacy of racism in the United States, experiences of racial/ethnic discrimination may have shifted since then. Despite this limitation, to my knowledge, NESARC-III is the most recent collection of nationally representative data that contains indicators of racial/ethnic discrimination and tobacco use outcomes. Second, while this study examines past-year discrimination and past 30-day tobacco use outcomes, given the cross-sectional nature of the data, it is impossible to infer causal relationships. Third, related to survey design, all measures in NESARC-III are captured via self-report and subject to response biases. Fourth, I did not have enough statistical power to disaggregate dual and polytobacco use groups for every analysis. It is possible that discrimination differentially impacts specific tobacco use patterns, through factors such as product availability and personal endorsement, but a larger sample size or less restrictive

definitions of use (e.g., past-year use) are needed to analyze this further. A related fifth limitation is that I did not have the statistical power to disaggregate the sample of respondents who identified as another race/ethnicity further. Respondents who composed this category identified as NH American Indian/Alaska Native, NH Asian/Native Hawaiian/other Pacific Islander, or multiracial, and they likely experience discrimination differently. I was able to disaggregate this group into NH AI/AN and NH A/NH/OPI to investigate whether between-group heterogeneity exists and based on prior work that suggests advancing health equity requires sub-analyses that examine racial/ethnic differences despite statistical power limitations.²³¹ However, these results should be interpreted with caution given that data limitations prohibited us from disentangling which respondents were multiracial among these two groups.²¹³ Lastly, the discrimination measures in NESARC-III involve interpersonal accounts and thus fail to capture the association between structural racism on tobacco use outcomes.

2.5 Conclusions

This study examined associations between past-year discrimination and two tobacco use outcomes. Study findings suggest that experiencing more discrimination is associated with tobacco use and TUD. Findings also suggest that these associations vary by racial/ethnic identity; while associations were also present for Hispanic, NH Black, and respondents who identified as another race/ethnicity, they were strongest for NH White respondents. These results may not suggest that the detriments of discrimination are worse for NH White adults who experience them, but that NH White adults who experience discrimination might be at higher risk to use multiple tobacco products. Nevertheless, the scientific literature on discrimination and health provide insight into the life-long effects of discrimination on racial/ethnic minoritized groups, such that discrimination is more harmful for racial/ethnic minoritized groups than NH White

groups in the US for many health outcomes.^{84-86,92,207} It is important to continue to understand the differential effects of discrimination on tobacco use outcomes among US adults to gain a better understanding of the mechanisms that might explain why these associations are stronger for NH White adults in the present study. Likewise, it is important to understand what factors lead racial/ethnic minoritized groups to experience worse health outcomes associated with discrimination, and if any of these mechanisms function through tobacco use.

Figure 2.1 Flowchart Describing the Selection of the Analytic Sample

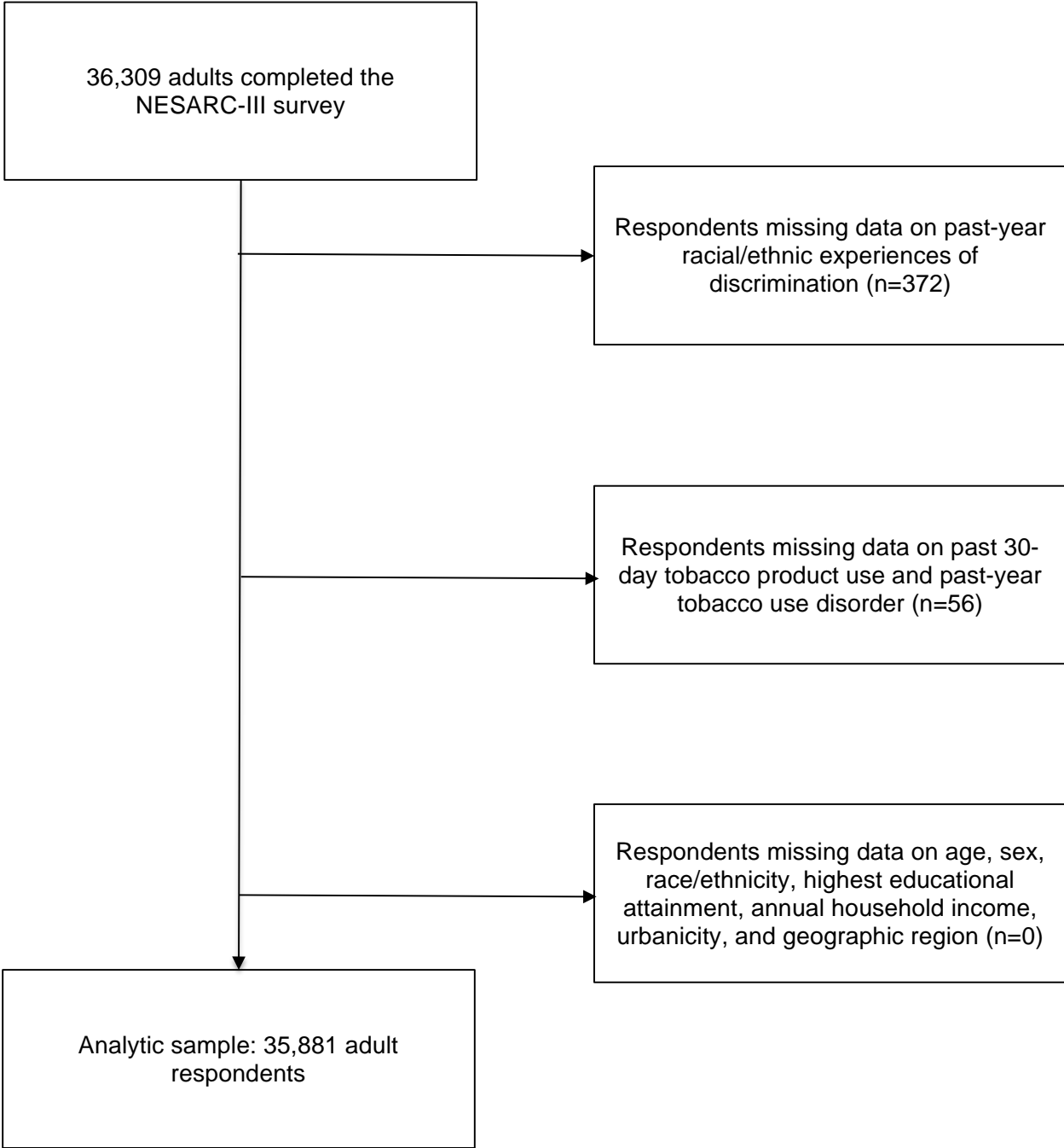


Table 2.1 Weighted Prevalence of Participant Characteristics Among the Analytic Sample

Participant Characteristics	
Age (mean \pm SD)	46.6 \pm 17.8
Sex, n (%)	
Female	20235 (52.0)
Male	15646 (48.0)
Race/ethnicity, n (%)	
Hispanic	6946 (14.7)
NH White	19008 (66.3)
NH Black	7642 (11.7)
Another race/ethnicity	2285 (7.3)
Highest educational attainment, n (%)	
High school graduate/GED or less	15096 (38.8)
Some college	11968 (33.1)
College graduate	8817 (28.1)
Annual household income, n (%)	
Less than \$25,000	12635 (27.3)
\$25,000 to \$59,999	12452 (33.2)
\$60,000 or more	10794 (39.5)
Urbanicity, n (%)	
Urban	29833 (78.7)
Rural	6048 (21.3)
Geographic region, n (%)	
Northeast	5144 (18.3)
Midwest	7487 (21.5)
South	14305 (36.9)
West	8945 (23.3)
Past-year discrimination scale (mean \pm SD)	1.0 \pm 2.3
Past 30-day patterns of tobacco use, n (%)	
Never/former use	26956 (75.8)
Exclusive use	7972 (21.3)
Dual use	894 (2.7)
Poly use	59 (0.2)
Past-Year DSM-5 tobacco use disorder, n (%)	
Yes/no	28703 (80.1)
Yes	7178 (19.9)

Table 2.2 Adjusted Associations Between Past-Year Discrimination and Past 30-Day Patterns of Tobacco Use

	Past 30-Day Patterns of Tobacco Use ^a					
	Exclusive		Dual		Poly	
	Unadjusted	Adjusted ^b	Unadjusted	Adjusted ^b	Unadjusted	Adjusted ^b
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Past-year discrimination scale	1.07 (1.05-1.08)	1.06 (1.04-1.07)	1.10 (1.06-1.13)	1.10 (1.06-1.14)	1.14 (1.07-1.23)	1.18 (1.09-1.27)
Age (continuous) ^c	0.86 (0.85-0.88)	0.86 (0.84-0.88)	0.74 (0.71-0.77)	0.70 (0.66-0.75)	0.52 (0.42-0.65)	0.41 (0.30-0.56)
Age, quadratic (continuous) ^c	0.90 (0.89-0.92)	0.87 (0.86-0.88)	0.91 (0.89-0.94)	0.86 (0.83-0.90)	0.98 (0.91-1.05)	0.78 (0.65-0.94)
Sex (ref: female)						
Male	1.58 (1.49-1.68)	1.65 (1.54-1.77)	3.07 (2.55-3.70)	3.16 (2.61-3.83)	11.62 (5.00-27.04)	12.19 (5.12-29.01)
Race/ethnicity (ref: NH White)						
Hispanic	0.60 (0.54-0.66)	0.33 (0.30-0.37)	0.51 (0.39-0.67)	0.25 (0.18-0.34)	0.10 (0.03-0.33)	0.03 (0.01-0.12)
NH Black	1.00 (0.92-1.10)	0.58 (0.52-0.64)	0.73 (0.58-0.92)	0.40 (0.31-0.51)	0.13 (0.03-0.62)	0.05 (0.01-0.27)
Another race/ethnicity	0.65 (0.56-0.75)	0.61 (0.53-0.71)	0.50 (0.35-0.72)	0.44 (0.31-0.63)	0.50 (0.16-1.53)	0.37 (0.14-0.98)
Highest educational attainment (ref: high school graduate/GED or less)						
Some college	0.71 (0.66-0.76)	0.65 (0.61-0.71)	0.83 (0.69-1.00)	0.76 (0.62-0.93)	0.98 (0.51-1.90)	0.88 (0.47-1.64)
College graduate	0.27 (0.24-0.29)	0.27 (0.24-0.29)	0.24 (0.19-0.32)	0.25 (0.19-0.34)	0.08 (0.03-0.24)	0.10 (0.03-0.32)
Annual household income (ref: less than \$25,000)						
\$25,000 to \$59,999	0.75 (0.71-0.81)	0.72 (0.67-0.78)	0.83 (0.67-1.01)	0.76 (0.61-0.95)	0.56 (0.29-1.08)	0.49 (0.25-0.95)
\$60,000 or more	0.44 (0.40-0.48)	0.46 (0.41-0.51)	0.50 (0.37-0.66)	0.51 (0.37-0.69)	0.26 (0.12-0.57)	0.27 (0.12-0.64)
Urbanicity (ref: urban)						
Rural	1.42 (1.25-1.62)	1.10 (0.99-1.22)	1.89 (1.49-2.40)	1.57 (1.25-1.98)	2.30 (1.38-3.83)	1.86 (1.04-3.32)
Geographic region (Northeast)						
Midwest	1.36 (1.18-1.57)	1.19 (1.05-1.34)	1.79 (1.27-2.51)	1.49 (1.04-2.12)	1.16 (0.52-2.57)	0.87 (0.39-1.96)
South	1.28 (1.12-1.48)	1.12 (0.98-1.28)	1.87 (1.36-2.57)	1.62 (1.17-2.25)	1.38 (0.73-2.62)	1.14 (0.60-2.19)
West	0.84 (0.73-0.97)	0.86 (0.75-0.99)	1.34 (0.97-1.86)	1.41 (1.00-2.01)	1.01 (0.38-2.67)	1.07 (0.41-2.81)

Bolded text indicates statistical significance (p<0.05)

^aThe outcome referent group: never/former use

^bOdds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, race/ethnicity, highest educational attainment, annual household income, urbanicity, and geographic region

^c Each one-unit increase in age is rescaled to represent 10 years

Table 2.3 Adjusted Associations Between Past-Year Discrimination and Past 30-Day Patterns of Tobacco Use

	Past-Year DSM-5 Tobacco Use Disorder	
	Unadjusted	Adjusted ^b
	OR (95% CI)	OR (95% CI)
Past-year discrimination scale	1.09 (1.08-1.10)	1.09 (1.08-1.10)
Age (continuous) ^c	0.83 (0.82-0.85)	0.82 (0.80-0.84)
Age, quadratic (continuous) ^c	0.91 (0.89-0.92)	0.87 (0.85-0.88)
Sex (ref: female)		
Male	1.48 (1.39-1.57)	1.49 (1.38-1.60)
Race/ethnicity (ref: NH White)		
Hispanic	0.48 (0.42-0.54)	0.24 (0.21-0.28)
NH Black	0.88 (0.80-0.98)	0.47 (0.42-0.53)
Another race/ethnicity	0.62 (0.53-0.74)	0.55 (0.47-0.65)
Highest educational attainment (ref: high school graduate/GED or less)		
Some college	0.76 (0.71-0.82)	0.69 (0.63-0.74)
College graduate	0.26 (0.24-0.29)	0.26 (0.23-0.29)
Annual household income (ref: less than \$25,000)		
\$25,000 to \$59,999	0.76 (0.70-0.82)	0.72 (0.67-0.78)
\$60,000 or more	0.43 (0.39-0.48)	0.45 (0.41-0.51)
Urbanicity (ref: urban)		
Rural	1.47 (1.30-1.67)	1.14 (1.02-1.26)
Geographic region (Northeast)		
Midwest	1.30 (1.14-1.47)	1.09 (0.96-1.24)
South	1.21 (1.06-1.39)	1.03 (0.90-1.18)
West	0.86 (0.74-0.99)	0.88 (0.75-1.03)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: no past-year DSM-5 tobacco use disorder

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, race/ethnicity, highest educational attainment, annual household income, urbanicity, and geographic region

^c Each one-unit increase in age is rescaled to represent 10 years

Table 2.4 Adjusted Associations Between Past-Year Discrimination and Past 30-Day Patterns of Tobacco Use

	Race/ethnicity ^a			
	Hispanic	NH White	NH Black	Another Race/Ethnicity
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past 30-Day Patterns of Tobacco Use ^{c, d}				
Exclusive use	1.03 (1.002-1.06)	1.09 (1.07-1.12)	1.04 (1.02-1.06)	1.08 (1.03-1.13)
Dual/poly use	1.01 (0.95-1.08)	1.18 (1.13-1.22)	1.05 (1.002-1.11)	1.04 (0.93-1.16)
Past-Year DSM-5 Tobacco Use Disorder ^{c, e}				
Meets criteria	1.05 (1.02-1.07)	1.13 (1.11-1.16)	1.07 (1.05-1.09)	1.09 (1.04-1.14)

Bolded text indicates statistical significance (p<0.05)

^a Each racial/ethnic category represents a separate model for each outcome

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, highest educational attainment, annual household income, urbanicity, and geographic region

^c P-value for the two-way interaction between discrimination and race/ethnicity for each level of patterns of tobacco use in interaction models: exclusive use (p<0.001), dual/poly tobacco use (p<0.001); p-value for the two-way interaction between discrimination and race/ethnicity for tobacco use disorder (p<0.001)

^d The outcome referent group: never/former use

^e The outcome referent group: no tobacco use disorder

Chapter 3 Racial/Ethnic Discrimination and Tobacco and Cannabis Use Outcomes Among US Adults²

3.1 Introduction

As a leading cause of morbidity and mortality in the US, tobacco use continues to be a public health problem.^{15,193} Among US adults, the prevalence of cigarette use is at an all-time low, but the rise in use of ENDS and the continued use of other tobacco products, such as cigars, remain at high levels.^{3,15,193} As more products are introduced into the market, dual (two products) and polytobacco (three or more products) use increases.^{17,194,195,232} For example, polytobacco use without cigarettes increased among US adults from 2014 to 2019.¹⁷ Dual/poly tobacco use is associated with several deleterious health outcomes, including nicotine dependence,^{199,201} higher frequency of use,^{201,202} and higher mortality risk,²⁰² making dual/poly tobacco use an important public health issue to study.

Adult cannabis use is an additional public health concern, especially given the shifting legal landscape in the US, conflicting perceptions of social norms and harms related to use, and the many forms through which cannabis can be consumed.^{31,41,42,233-239} Cannabis use is intertwined with tobacco in many ways.⁴⁶ Cannabis use is more common among people who use tobacco than people who do not use tobacco,^{240,241} and vice versa.^{242,243} Co-use is another use modality that increases the risk for additive toxicant exposure, use disorders, and difficulty quitting both substances.^{42,244} Since tobacco and cannabis share similar ROA,^{42,46} use of one

² A version of this chapter has been published as: Mattingly DT, Neighbors HW, Mezuk B, Elliott MR, Fleischer NL. Racial/ethnic discrimination and tobacco and cannabis use outcomes among US adults. *J Subst Abuse Treat*. DOI: 10.1016/j.josat.2023.208958.

substance might facilitate the other, which is an important consideration given that the health effects of nicotine and cannabis co-administration are not well understood.^{8,42,244}

Using cannabis in tobacco products is most common among younger adults and certain racial/ethnic groups. For example, 80% of YAs who use cannabis have done so at least once using a tobacco product, with cigars, hookah, and ENDS as the most commonly used products.²⁴⁵ Research has examined racial/ethnic disparities in cannabis use within tobacco products, such as blunting and vaping cannabis.^{48,49,246} Findings reveal that NH Black YAs initiate and use more blunts than Hispanic or NH White YAs.⁴⁹ Furthermore, Hispanic and NH Black adults are more likely to vape nicotine and cannabis than White adults.²⁴⁶ These studies highlight the need for additional explanation and understanding of disparate use and co-use patterns across racial/ethnic groups. Common ROA and enhancing the experienced effects of each substance are cited as reasons that encourage co-use.^{42,247,248} However, other factors, such as social determinants that might be driving disparities in tobacco and cannabis use by race/ethnicity, require further inquiry.

Exploring risk factors that determine variation in tobacco and cannabis use and co-use by race/ethnicity will shed light on ways to prevent use and promote health equity. One determinant of racial/ethnic disparities in health is racial/ethnic discrimination (hereafter, discrimination).^{86,249} Discrimination is a direct result of racism, associated with poorer mental and physical health outcomes, and a potential cause of racial/ethnic health inequities.^{81,85,86,92,205,223,250} Discrimination is a psychological stressor that can elicit coping responses, such as substance use,^{66,207} and prior work demonstrates that discrimination is associated with tobacco and cannabis use in youth and adult populations.^{181,208,251-254} However, the extent to which discrimination is associated with dual/poly tobacco use with or without

cannabis is not well known,²⁵⁵ and an important line of inquiry since use of tobacco products and cannabis vary by race/ethnicity.^{3,195,235,236} Furthermore, studies investigating the relationship between discrimination and substance use disorders^{216,256-259} and discrimination and substance use outcomes stratified by race/ethnicity are limited. Discrimination affects racial/ethnic populations differently,^{81,85,260-263} and additional insight into how these experiences shape substance use by race/ethnicity is needed.

In this paper I examined associations between discrimination and tobacco and cannabis use outcomes. Specifically, I investigated whether past-year discrimination was associated with past 30-day patterns of tobacco and cannabis use as well as past-year tobacco and cannabis use disorders. Given that discrimination quantitatively varies across racial/ethnic groups in the US,⁸¹ its relationship with tobacco and cannabis use may also depend on racial/ethnic identity. Thus, to examine these racial/ethnic differences, I additionally assessed effect modification through stratification by race/ethnicity.

3.2 Methods

3.2.1 Data

I used data from the 2012-2013 NIAAA NESARC-III which is a cross-sectional study that evaluated the mental health status among US adults and is nationally representative of the adult (18 years or older) noninstitutionalized, civilian population. Hispanic, Black, and YAs (aged 18-24) were oversampled. Data in NESARC-III were collected via the AUDADIS-5, a semi-structured, face-to-face diagnostic interview method that reliably captures mental health disorders according to the APA DSM-5.^{212,213} More details on NESARC-III methodology are reported elsewhere.²¹³ I received approval from the University of Michigan Institutional Review Board to conduct this research.

3.2.2 Participants

NESARC-III included 36,309 adults. Respondents who identified as Hispanic (n=7,037) were asked about ethnic discrimination and respondents who identified as NH and any race (n=29,272) were asked about racial discrimination. I included respondents who had complete information on either racial/ethnic discrimination measure, each tobacco product and cannabis use measure, and each sociodemographic and geographic characteristic included in the analyses, resulting in an analytic sample size of 35,744. I display the selection of the analytic sample in a flow chart in Figure 3.1.

3.2.3 Measures

Racial/Ethnic Discrimination

NESARC-III included measures on EOD.²⁴⁹ Respondents were asked six questions on EOD in specified settings, once for discrimination that occurred prior to the past year, and once for discrimination that occurred in the past year. These six questions included, “(about) how often did you experience discrimination because you are Hispanic or Latino/because of your race or ethnicity in: 1) your ability to obtain health care or health insurance coverage, 2) how you were treated when you got care, 3) public, like on the street, in stores or in restaurants, 4) ANY other situation, like obtaining a job or on the job, getting admitted to a school or training program, in the courts or by the police,” and “(about) how often were you 5) called a racist name or 6) made fun of, picked on, pushed, shoved, hit, or threatened with harm.” Response options for each scenario included: 0) never, 1) almost never, 2) sometimes, 3) fairly often, and 4) very often. For past-year discrimination, I summed the six experiences to create summary scales (range 0-24) according to prior research using these measures.^{216,257,258} The Cronbach’s alpha for the discrimination summary scale was 0.81, demonstrating excellent internal reliability.

Individual Tobacco Product Use

I used four classifications of tobacco products: cigarettes, ENDS (i.e., e-cigarettes and e-liquid), OC (cigars, pipe), and SLT (i.e., snuff, moist, dipping tobacco). I defined current tobacco use as any use in the past 30 days.

Cannabis Use

NESARC-III respondents were asked about any cannabis use (i.e., weed, pot, dope, hashish, Mary Jane, joints, blunts). I defined current cannabis use as any use in the past 30 days.

Patterns of Tobacco and Cannabis Use

In this study, co-use of both substances was defined as the use of tobacco and cannabis within the past 30 days. I classified the four tobacco product use variables (i.e., cigarettes, ENDS, OC, SLT), into three use categories: never/former, individual (i.e., only one tobacco product), and dual/poly tobacco (i.e., two or more products). I combined this variable with past 30-day cannabis use to create a six-category use variable: 1) never/former tobacco and cannabis, 2) individual tobacco and non-cannabis, 3) individual tobacco and cannabis, 4) individual cannabis and non-tobacco, 5) dual/poly tobacco and non-cannabis, and 6) dual/poly tobacco and cannabis.

Tobacco and Cannabis Use Disorders

I also examined tobacco use disorder (TUD) and cannabis use disorder (CUD) outcome measures (see Table B.1), defined based on DSM-5 criteria using AUDADIS-5.²¹⁷ AUDADIS-5 operationalized TUD symptoms pertaining to all types of tobacco products, and operationalized CUD symptoms pertaining to all types of cannabis use.^{212,213} I included two variables that indicated whether participants had a past-year DSM-5 TUD or a past-year DSM-5 CUD (both yes/no). With these two variables, I created a four-category variable indicating whether

participants had 1) no TUD/CUD, 2) individual TUD, 3) individual CUD, or 4) joint TUD and CUD.

Covariates

I included the following characteristics as covariates: age (continuous), sex (male, female), race/ethnicity (Hispanic, NH White, NH Black, another race/ethnicity), highest educational attainment (high school/GED or less, some college, college degree or more), annual household income (\$25,000/year, \$25,000 to \$59,999/year, and \$60,000/year or greater), urbanicity (rural, urban), and geographic region (Northeast, North Central/Midwest, South, West). The group that I classify as “another race/ethnicity” included respondents who identified as NH AI/AN, NH A/NH/OPI, and NH multiracial (two or more races).

3.2.4 Statistical Analysis

I estimated the prevalence of participant characteristics (i.e., sociodemographic, geographic characteristics, discrimination, each outcome) in the analytic sample. I compared distributions of participant characteristics across both outcome variables using chi-square tests for independence and ANOVA.

I fit two crude multinomial logistic regression models to estimate the associations between 1) discrimination and the six-category tobacco and cannabis use variable (referent: never/former use), and 2) discrimination and the four-category TUD and CUD variable (referent: no TUD/CUD). I adjusted for mean-centered age, a quadratic term for age due to non-linearity of age and tobacco or cannabis use,^{41,234} sex, race/ethnicity, highest educational attainment, annual household income, urbanicity, and geographical region in additional models.

To investigate differences in these associations by race/ethnicity, I fit an adjusted model for each outcome with a two-way interaction term between discrimination and race/ethnicity.

Wald tests were performed at an alpha level of 0.05 to determine whether the interactions were statistically significant. To examine effect modification, I stratified each adjusted model by race/ethnicity. All analyses accounted for the complex sample design of NESARC-III using Stata SE version 16.1 (StataCorp, College Station, Texas).

I also conducted several sensitivity analyses. One analysis included prior-to-past-year discrimination, rather than past-year discrimination, to estimate associations for each outcome, following the same analysis scheme above. I did this to investigate whether timing of discriminatory experiences differentially impacted past 30-day substance use. The other analysis disaggregated the “another race/ethnicity” group into NH AI/AN and NH A/NH/OPI to estimate stratified associations as sample size allowed. I did this based on recommendations from prior research²³¹ and to be as inclusive as possible given the focus on racial/ethnic disparities. The third analysis explored other functional forms of the discrimination measure. I sought to examine whether dropping extreme cases (i.e., scores over 20) impacted the regression results. I also categorized discrimination (i.e., 0, 1-5, 6-10, 11-15, and 16+) to investigate whether a linear trend remained in regression models with this measure.

3.3 Results

3.3.1 Prevalence of Participant Characteristics

Table 3.1 shows the prevalence of participant characteristics among the analytic sample. The mean discrimination scale was 1.0 (SD: 2.3). Individual (17.9%) and dual/poly (2.2%) tobacco use groups without cannabis were more prevalent than the individual and dual/poly tobacco use groups with cannabis (3.3% and 0.7%, respectively); the prevalence of individual cannabis and non-tobacco use was 2.4%. The prevalence of individual TUD, individual CUD, and joint TUD and CUD were 18.2%, 0.9%, and 1.6%, respectively. Prevalence estimates for individual tobacco and cannabis use variables can be found in Table B.2. Distributions of

participant characteristics by patterns of tobacco and cannabis use and tobacco and cannabis use disorders are in Tables B.3-B.4.

3.3.2 Discrimination and Patterns of Tobacco and Cannabis Use

Crude associations between discrimination and patterns of tobacco and cannabis use are displayed in Table B.5. In the adjusted multinomial regression model, each one-unit increase in discrimination was associated with higher odds of each tobacco/cannabis use group compared to the never/former use group (Table 3.2). Specifically, respondents had 5% higher odds (95% CI: 1.04-1.07) of individual tobacco and non-cannabis use, 9% higher odds (95% CI: 1.07-1.12) of individual tobacco and cannabis use, 6% higher odds (95% CI: 1.03-1.09) of individual cannabis and non-tobacco use, 11% higher odds (95% CI: 1.07-1.15) of dual/poly tobacco and non-cannabis use, and 13% higher odds (95% CI: 1.07-1.19) of dual/poly tobacco and cannabis use.

3.3.3 Discrimination and DSM-5 Tobacco and Cannabis Use Disorders

I show crude associations between discrimination and tobacco and cannabis use disorders in Table B.6. In the adjusted multinomial regression model, each one-unit increase in discrimination was associated with 8% higher odds (95% CI: 1.07-1.10) of individual TUD and 8% higher odds of individual CUD (95% CI: 1.04-1.12), compared to no TUD/CUD (Table 3.3). The association for joint TUD and CUD, compared to no TUD/CUD, was stronger in magnitude, with each one-unit increase in discrimination associated with 16% higher odds (95% CI: 1.12-1.20) of joint TUD and CUD.

3.3.4 Effect Modification by Race/Ethnicity

Patterns of Tobacco and Cannabis Use

The two-way interaction between discrimination and race/ethnicity in the model estimating the association of discrimination on tobacco and cannabis use was statistically

significant overall ($p < 0.001$). When examining the statistical significance of the interaction term with specific levels of the outcome, the terms were statistically significant for individual tobacco and non-cannabis ($p = 0.001$), individual tobacco and cannabis ($p = 0.002$), dual/poly tobacco and non-cannabis ($p = 0.002$), and dual/poly tobacco and cannabis ($p < 0.001$) (Table 3.4).

In race/ethnicity-stratified models, each one-unit increase in discrimination was associated with higher odds of individual tobacco and non-cannabis use among all racial/ethnic groups. For individual tobacco and cannabis use, associations were observed only for NH White (OR: 1.14, 95% CI: 1.10-1.19), NH Black (OR: 1.09, 95% CI: 1.05-1.13), and respondents who identified as another race/ethnicity (OR: 1.10, 95% CI: 1.01-1.19), but not Hispanic respondents. For individual cannabis and non-tobacco use, associations were observed for Hispanic (OR: 1.05, 95% CI: 1.01-1.09), NH White (OR: 1.09, 95% CI: 1.02-1.17), and NH Black (OR: 1.06, 95% CI: 1.02-1.10) respondents, but not respondents who identified as another race/ethnicity. For dual/poly tobacco and non-cannabis use, each one-unit increase in discrimination was associated with use among NH White (OR: 1.17, 95% CI: 1.12-1.23) and NH Black (OR: 1.07, 95% CI: 1.01-1.12) respondents, but not Hispanic and respondents who identified as another race/ethnicity. Furthermore, each one-unit increase in discrimination was associated with dual/poly tobacco and cannabis use only among NH White respondents (OR: 1.24, 95% CI: 1.17-1.31).

Tobacco and Cannabis Use Disorder

The two-way interaction between discrimination and race/ethnicity in the model estimating the association of discrimination on the four-category TUD and CUD variable was statistically significant ($p < 0.001$). For each level of the outcome, the interaction terms were statistically significant for individual TUD ($p < 0.001$) and joint TUD and CUD ($p < 0.001$). Each

one-unit increase in discrimination was associated with higher odds of individual TUD for each racial/ethnic group. For individual CUD, discrimination was associated with 10% (95% CI: 1.05-1.14), 12% (95% CI: 1.03-1.22), and 13% (95% CI: 1.03-1.24) higher odds among NH Black, NH White, and respondents who identify as another race/ethnicity, respectively, but not Hispanic respondents. For joint TUD and CUD, each one-unit increase in discrimination was associated with 13% (95% CI: 1.09-1.18) higher odds among NH Black respondents and 24% (95% CI: 1.17-1.31) higher odds among NH White respondents, but not Hispanic respondents and respondents who identified as another race/ethnicity.

3.3.5 Sensitivity Analyses

Overall and stratified results from the first sensitivity analyses (Tables B.7-B.9), which examined prior-to-past-year discrimination and tobacco and cannabis use outcomes, yielded similar estimates to the main analyses. However, one key difference in race/ethnicity-stratified models was that each one-unit increase in prior-to-past-year discrimination was associated with higher odds of dual/poly tobacco and cannabis use among respondents who identified as another race/ethnicity (OR: 1.16, 95% CI: 1.04-1.30). Another important difference was that prior-to-past-year discrimination was associated with higher odds of joint TUD and CUD among all racial/ethnic groups as opposed to only NH White and NH Black respondents for past-year discrimination. In the second sensitivity analysis, where I further disaggregated “another race/ethnicity” in effect modification analyses, past-year discrimination was not associated with any use group among NH AI/AN respondents (n=499) (Table B.10), and the model for NH Asian/NH/OPI respondents (n=1,776) did not converge. For TUD/CUD outcomes, discrimination was not associated with disorders among NH AI/AN respondents but was associated with TUD (OR: 1.09, 95% CI: 1.03-1.17), CUD (OR: 1.24, 95% CI: 1.09-1.42), and

joint TUD and CUD (OR: 1.27, 95% CI: 1.10-1.47) among NH Asian/NH/OPI respondents. The third sensitivity analysis that examined various functional forms of the discrimination measure found that dropping extreme cases resulted in nearly identical regression estimates (data not shown). In addition, categorizing discrimination and refitting the regression models with this measure showed that the estimates remained approximately linear (data not shown).

3.4 Discussion

In a nationally representative study, adults who experienced more discrimination had higher odds of using tobacco and cannabis under two outcomes of interest: tobacco and cannabis use patterns and individual and joint TUD and CUD. Associations were stronger for dual/poly tobacco use outcomes with and without cannabis than for individual tobacco use outcomes with and without cannabis, and for joint TUD and CUD than for individual TUD or CUD. These relationships varied by race/ethnicity, with associations for more severe outcomes such as dual/poly tobacco and cannabis use and joint TUD and CUD being stronger for NH White and NH Black respondents compared to Hispanic respondents and respondents who identified as another race/ethnicity.

Like other studies, I showed that discrimination is a risk factor for substance use.^{181,208,251-254} My findings shed light on how discriminatory experiences impact tobacco and cannabis use together, such as how associations were stronger for dual/poly tobacco use groups with and without cannabis, relative to individual use groups. My results are also consistent with prior work that has observed relationships between discrimination and substance use disorders.^{216,256-259} A few studies using NESARC-III data reported associations between sexual orientation discrimination and TUD among adults who identify as sexual minorities.^{216,257,258} Another study found that sexual orientation discrimination was associated with CUD among men who

identified as sexual minorities.²⁵⁹ While my study differs in focusing primarily on racial/ethnic discrimination, as well as the intersection between TUD and CUD, minority stress experienced by sexual minoritized adults as a result of discrimination likely influences substance use in similar stress-coping mechanisms to race-related stress experienced by racial/ethnic minoritized groups.⁸³ Altogether, my findings provide further evidence that social vulnerabilities to tobacco and cannabis use and misuse may function through the stress-coping process for all minoritized population groups.^{66,69,207}

I observed substantial variation by race/ethnicity in associations between discrimination and tobacco and cannabis use outcomes. For example, I found that NH White respondents, compared to other racial/ethnic groups, had associations for discrimination with each tobacco and cannabis use outcome, including dual/poly tobacco and cannabis use, a more severe outcome than individual use of either substance. These results show that NH White adults in the US feel discriminated against based on their racial identity, which may increase their risk to use substances. This phenomenon may seem counterintuitive. While racial/ethnic discrimination is harmful to everyone, the system of racism as defined by White supremacy in the US directed at non-White populations.⁸⁵ It is counterintuitive that White Americans experience “racial/ethnic” discrimination, but their perception of being discriminated based on their race has been demonstrated in prior empirical research.^{81,264} NH White Americans have reported feeling discriminated against for reasons related to religious and political affiliations, resource entitlement, and relative social mobility.^{81,220-222,264} These factors linked to anti-White discrimination may also intersect with beliefs that discrimination occurs based on race.

I also observed an association between experiencing more discrimination and dual/poly tobacco and non-cannabis use among NH Black respondents, while these associations were null

for Hispanic respondents and respondents who identified as another race/ethnicity. Since racial/ethnic minoritized groups experience discrimination at greater rates than their NH White counterparts,^{81,260-263} the stress accompanied with such events may lead to poorer health outcomes.^{92,205,226} However, the stress accumulated from experiencing discrimination does not pattern equally across racial/ethnic groups, nor does coping with discrimination lead to uniform patterns of substance use. Further understanding of the differential mechanisms by which discrimination leads to substance use for each racial/ethnic group will help reduce associated disparities in use.

Results from the two sensitivity analyses require further inquiry. For the first analysis, timing of discrimination may matter in how it relates to tobacco and cannabis use. Prior-to-past-year discrimination was associated with dual/poly tobacco and cannabis use among respondents who identified as another race/ethnicity, but associations between past-year discrimination and this outcome were null. Discrimination occurs over the life course, and it is important to understand how these exposures collectively impact adverse health behaviors. My result might represent a phenomenon in which a population of adults who experienced discrimination prior to the year of data collection had more problematic substance use than those who experienced discrimination more recently. The second sensitivity analysis that explored effect modification in AI/AN and A/NH/OPI respondents revealed stark between-group differences. Discrimination was associated with each use disorder category for A/NH/OPI respondents, but findings for AI/AN respondents were null, indicating that adults who identify as Asian or Native Hawaiian/Other Pacific Islander or multiracial were driving the relationship between discrimination and use disorders for the “another race/ethnicity” group. Further work must unpack these exposure-outcome relationships for populations often overlooked in disparities

research. These findings also corroborate previous research promoting the importance of inclusivity while defining and operationalizing race/ethnicity for tobacco use outcomes.¹⁶

There are several potential explanations why associations between discrimination and substance use differentially affect racial/ethnic groups in the US. These explanations derive from the concept that each racial/ethnic population represents a collection of experiences rather than a monolithic identity.²²⁹ One theory is that varying availability of psychosocial and social resources may drive racial/ethnic disparities in substance use as a response to stress.^{70,228} Another theory is that some racial/ethnic groups have developed cultural resilience to race-related stressors.^{223,224,265} Cultural resilience against discrimination in the US may negate the health consequences of stress in the short term, although there are likely long-term implications over the life course for racial/ethnic minoritized populations.^{85,92,250} Thus, in the long run, eliminating racism will result in the best potential public health outcomes, and this must be achieved through a multi-faceted approach in which all sectors of society are involved and aim to create a racism-free nation.

Federal and state-level policies and interventions must appropriately address problematic forms of tobacco and cannabis use to promote health equity. From a regulatory standpoint, use and misuse of both tobacco and cannabis increases the complexity of addressing disparities, given that the FDA does not have regulatory authority over cannabis.^{237,266,267} As the intersection between tobacco and cannabis use become more complicated, interventions and policies aimed at reducing nicotine use among US adults may have to additionally consider the interacting effects of cannabis use. Tobacco and cannabis use are interrelated as use of one substance may lead to use of the other,^{42,46,240-243} complicating tobacco regulatory recommendations. For example, cannabis use is associated with difficulty quitting tobacco, tobacco use relapse, and tobacco use

intensity.⁴² If a substantial proportion of people who use tobacco also use cannabis, efforts to reduce tobacco use are undermined through the legalization of cannabis use, thereby enabling tobacco use to continue. Thus, it is important to consider the intersection of tobacco and cannabis use, and how facilitating the use of cannabis runs counter to the public health goal of reducing the use of tobacco. I need better coordination across the regulation of both tobacco and cannabis products to better improve public health and reduce associated racial inequities.

3.4.1 Limitations

This study has several limitations. First, the cross-sectional nature of the data precludes my ability to infer causal relationships. Second, all measures were captured via self-reported interviews and are potentially prone to survey biases, such as underestimating substance use due to social desirability or differentially assigning meaning to discriminatory experiences by individuals, researchers, or policymakers. For the latter, some people might not perceive certain experiences to be discriminatory and thus not report them. In a similar vein, some people who experience discrimination might not believe that such experiences were based on their race/ethnicity, and thus may lead to discrepancies in self-report methods for capturing discrimination. These factors might also explain the high proportion of respondents (72.7%) in the analytic sample who reported that they had not experienced any discrimination in the past year. Third, the social and political landscapes surrounding tobacco and cannabis use have changed since 2012-2013. For tobacco, use patterns have likely changed since 2012-2013 with new products entering the market and shifting regulations.²³² However, findings related to dual/poly tobacco use are relevant given that dual/poly tobacco use continues to be a public health problem. For cannabis, a handful of states have recently legalized use, potentially altering use patterns,^{233,237,238} with a recent study suggesting that cannabis use has increased alongside

legalization among people who smoke cigarettes.²³⁹ Fourth, due to the NESARC-III survey design and sample size limitations, it was not possible to determine whether respondents were using tobacco and cannabis simultaneously or using these substances separately but within the past 30 days. Fifth, I was unable to disaggregate dual/poly tobacco use groups due to sample size limitations. Sixth, I did not have enough statistical power to fully disaggregate the racial/ethnic group composed of NH AI/AN, NH A/NH/OPI, and multiracial respondents to further examine racial/ethnic differences. I examined associations between discrimination and both outcomes within NH AI/AN and NH A/NH/OPI as a sensitivity analysis. However, NESARC-III study investigators aggregated multiracial respondents with either NH AI/AN or NH A/NH/OPI in the data,²¹³ disallowing us to stratify these groups further. Thus, results from this sensitivity analysis should be interpreted with caution as it is difficult to tell whether multiracial respondents are driving associations between discrimination and use. Lastly, discrimination in this study represent interpersonal accounts and not structural forms of racism that can impact health behaviors and cause health inequities.^{92,250}

3.5 Conclusion

This study found that experiencing more discrimination was associated with two tobacco and cannabis use outcomes. My results also suggested that these associations varied by race/ethnicity, with NH White and NH Black respondents having higher odds of dual/poly tobacco and cannabis use and meeting the criteria for joint TUD and CUD. The detriments of discrimination might differentially affect adults' propensity to use substances as a coping mechanism. While research on discrimination and health suggests that the long-term effects of discrimination are more harmful to racial/ethnic minoritized groups than NH White individuals in the US,^{85,86,92,207} findings from this study suggest that these relationships are more complex, at

least in the context of tobacco and cannabis use. It is necessary to explore factors that lead racial/ethnic minoritized groups to differentially experience worse health outcomes associated with discrimination, and whether these mechanisms function through tobacco and cannabis use.

Figure 3.1 Flowchart Describing the Selection of the Analytic Sample

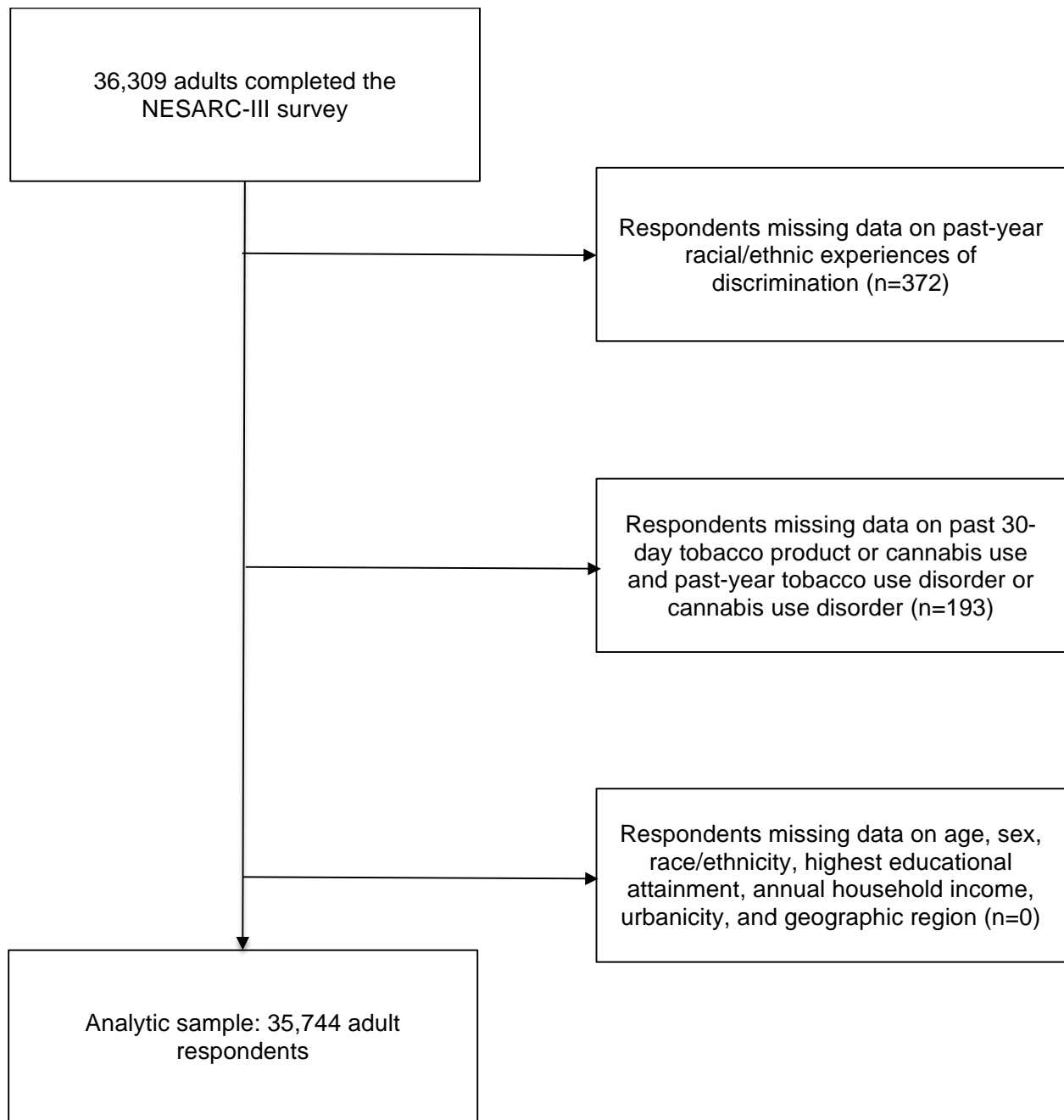


Table 3.1 Weighted Prevalence of Participant Characteristics Among the Analytic Sample

Participant Characteristics	
Age (mean \pm SD)	46.6 \pm 17.8
Sex, n (%)	
Female	20169 (52.0)
Male	15575 (48.0)
Race/ethnicity, n (%)	
Hispanic	6928 (14.7)
NH White	18930 (66.3)
NH Black	7611 (11.7)
Another race/ethnicity	2275 (7.3)
Highest educational attainment, n (%)	
High school graduate/GED or less	15030 (38.7)
Some college	11934 (33.1)
College graduate	8780 (28.1)
Annual household income, n (%)	
Less than \$25,000	12570 (27.2)
\$25,000 to \$59,999	12413 (33.2)
\$60,000 or more	10761 (39.6)
Urbanicity, n (%)	
Urban	29722 (78.7)
Rural	6022 (21.3)
Geographic region, n (%)	
Northeast	5125 (18.3)
Midwest	7465 (21.5)
South	14233 (36.9)
West	8921 (23.3)
Past-Year discrimination scale (mean \pm SD)	1.0 \pm 2.3
Past 30-day patterns of tobacco and cannabis use, n (%)	
Never/former use	25869 (73.4)
Individual tobacco & non-cannabis	6627 (17.9)
Individual tobacco & cannabis	1292 (3.3)
Individual cannabis & non-tobacco	1010 (2.4)
Dual/poly tobacco & non-cannabis	708 (2.2)
Dual/poly tobacco & cannabis	238 (0.7)
Past-Year DSM-5 Tobacco and cannabis use disorders, n (%)	
No disorders	28243 (79.3)
Individual tobacco use disorder only	6536 (18.2)
Individual cannabis use disorder only	377 (0.9)
Joint tobacco and cannabis use disorders	588 (1.6)

Table 3.2 Adjusted Associations Between Past-Year Discrimination and Past 30-Day Patterns of Tobacco and Cannabis Use

	Past 30-Day Patterns of Tobacco and Cannabis Use ^a				
	Individual Tobacco & Non-Cannabis	Individual Tobacco & Cannabis	Individual Cannabis & Non-Tobacco	Dual/Poly Tobacco & Non-Cannabis	Dual/Poly Tobacco & Cannabis
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past-year discrimination scale	1.05 (1.04-1.07)	1.09 (1.07-1.12)	1.06 (1.03-1.09)	1.11 (1.07-1.15)	1.13 (1.07-1.19)
Age (continuous) ^c	0.90 (0.88-0.92)	0.56 (0.52-0.59)	0.62 (0.58-0.66)	0.73 (0.68-0.78)	0.48 (0.41-0.55)
Age, quadratic (continuous) ^c	0.86 (0.85-0.87)	0.87 (0.84-0.91)	1.01 (0.98-1.04)	0.85 (0.81-0.89)	0.87 (0.81-0.94)
Sex (ref: female)					
Male	1.59 (1.48-1.71)	2.49 (2.12-2.94)	2.26 (1.91-2.67)	3.00 (2.45-3.68)	7.59 (4.76-12.10)
Race/ethnicity (ref: NH White)					
Hispanic	0.34 (0.30-0.38)	0.26 (0.21-0.32)	0.54 (0.43-0.68)	0.20 (0.14-0.28)	0.23 (0.13-0.39)
NH Black	0.56 (0.51-0.62)	0.74 (0.59-0.94)	1.32 (1.05-1.65)	0.25 (0.19-0.33)	0.78 (0.50-1.21)
Another race/ethnicity	0.61 (0.53-0.71)	0.54 (0.38-0.76)	0.48 (0.32-0.70)	0.48 (0.32-0.73)	0.23 (0.11-0.50)
Highest educational attainment (ref: high school graduate/GED or less)					
Some college	0.65 (0.60-0.71)	0.70 (0.59-0.82)	1.18 (0.96-1.45)	0.74 (0.59-0.93)	0.86 (0.62-1.21)
College graduate	0.27 (0.24-0.30)	0.25 (0.19-0.33)	0.80 (0.61-1.06)	0.24 (0.17-0.33)	0.26 (0.15-0.44)
Annual household income (ref: less than \$25,000)					
\$25,000 to \$59,999	0.76 (0.70-0.82)	0.50 (0.43-0.58)	0.65 (0.55-0.77)	0.85 (0.65-1.10)	0.44 (0.29-0.65)
\$60,000 or more	0.49 (0.44-0.55)	0.28 (0.22-0.36)	0.48 (0.39-0.60)	0.53 (0.38-0.73)	0.29 (0.19-0.46)
Urbanicity (ref: urban)					
Rural	1.14 (1.02-1.27)	0.78 (0.61-0.99)	0.85 (0.57-1.28)	1.55 (1.21-2.00)	1.58 (1.10-2.26)
Geographic region (Northeast)					
Midwest	1.26 (1.10-1.44)	0.76 (0.57-1.01)	0.61 (0.45-0.83)	1.76 (1.15-2.70)	0.68 (0.44-1.05)
South	1.21 (1.05-1.39)	0.61 (0.46-0.81)	0.54 (0.40-0.73)	1.86 (1.26-2.74)	0.85 (0.56-1.28)
West	0.88 (0.76-1.02)	0.87 (0.64-1.18)	1.45 (1.06-1.98)	1.69 (1.07-2.68)	0.93 (0.62-1.38)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: never/former use of both tobacco and cannabis

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for all variables in the table

^c Each one-unit increase in age is rescaled to represent 10 years

Table 3.3 Adjusted Associations Between Past-Year Discrimination and Past-Year DSM-5 Tobacco and Cannabis Use Disorders

	Past-Year DSM-5 Tobacco and Cannabis Use Disorders ^a		
	Individual Tobacco Use Disorder	Individual Cannabis Use Disorder	Joint Tobacco & Cannabis Use Disorders
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past-year discrimination scale	1.08 (1.07-1.10)	1.08 (1.04-1.12)	1.16 (1.12-1.20)
Age (continuous) ^c	0.85 (0.82-0.87)	0.57 (0.52-0.62)	0.48 (0.43-0.53)
Age, quadratic (continuous) ^c	0.86 (0.84-0.87)	1.05 (1.00-1.11)	0.91 (0.87-0.96)
Sex (ref: female)			
Male	1.45 (1.36-1.56)	2.39 (1.83-3.12)	2.27 (1.78-2.89)
Race/ethnicity (ref: NH White)			
Hispanic	0.24 (0.21-0.28)	0.78 (0.54-1.13)	0.23 (0.17-0.30)
NH Black	0.46 (0.41-0.51)	1.45 (1.09-1.94)	0.74 (0.52-1.05)
Another race/ethnicity	0.55 (0.47-0.64)	0.49 (0.29-0.81)	0.56 (0.32-0.97)
Highest educational attainment (ref: high school graduate/GED or less)			
Some college	0.68 (0.62-0.74)	1.15 (0.85-1.54)	0.79 (0.62-0.99)
College graduate	0.26 (0.23-0.29)	1.01 (0.68-1.50)	0.21 (0.14-0.31)
Annual household income (ref: less than \$25,000)			
\$25,000 to \$59,999	0.74 (0.68-0.81)	0.75 (0.56-0.99)	0.57 (0.45-0.72)
\$60,000 or more	0.46 (0.41-0.52)	0.62 (0.43-0.90)	0.36 (0.26-0.48)
Urbanicity (ref: urban)			
Rural	1.14 (1.02-1.27)	0.79 (0.51-1.21)	0.90 (0.68-1.19)
Geographic region (Northeast)			
Midwest	1.09 (0.96-1.24)	0.51 (0.32-0.81)	0.96 (0.66-1.38)
South	1.05 (0.92-1.20)	0.69 (0.50-0.94)	0.78 (0.53-1.14)
West	0.88 (0.74-1.03)	1.34 (0.93-1.93)	0.98 (0.68-1.42)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: no past-year tobacco or cannabis use disorder

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for all variables in the table

^c Each one-unit increase in age is rescaled to represent 10 years

Table 3.4 Adjusted Associations Between Past-Year Discrimination and Tobacco and Cannabis Use Outcomes Stratified by Race/Ethnicity

	Race/Ethnicity ^a			
	Hispanic	NH White	NH Black	Another Race/Ethnicity
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past 30-day patterns of tobacco and cannabis use ^{c, e}				
Individual tobacco & non-cannabis	1.03 (1.002-1.06)	1.09 (1.06-1.11)	1.03 (1.01-1.05)	1.07 (1.02-1.12)
Individual tobacco & cannabis	1.03 (0.98-1.09)	1.14 (1.10-1.19)	1.09 (1.05-1.13)	1.10 (1.01-1.19)
Individual cannabis & non-tobacco	1.05 (1.01-1.09)	1.09 (1.02-1.17)	1.06 (1.02-1.10)	1.04 (0.96-1.13)
Dual/poly tobacco & non-cannabis	1.03 (0.96-1.11)	1.17 (1.12-1.23)	1.07 (1.01-1.12)	1.05 (0.93-1.18)
Dual/poly tobacco & cannabis	0.99 (0.88-1.11)	1.24 (1.16-1.32)	1.06 (0.97-1.15)	0.95 (0.79-1.14)
Past-Year DSM-5 tobacco and cannabis use disorders ^{d, e}				
Individual tobacco use disorder only	1.04 (1.02-1.07)	1.13 (1.10-1.15)	1.06 (1.04-1.08)	1.08 (1.03-1.14)
Individual cannabis use disorder only	1.04 (0.97-1.11)	1.12 (1.03-1.22)	1.10 (1.05-1.14)	1.13 (1.03-1.24)
Joint tobacco and cannabis use disorders	1.06 (1.00-1.13)	1.24 (1.17-1.31)	1.13 (1.09-1.18)	1.11 (0.99-1.24)

Bolded text indicates statistical significance (p<0.05)

^a Each racial/ethnic category represents a separate model for each outcome

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, quadratic age, sex, highest educational attainment, annual household income, urbanicity, and geographic region

^c P-value for the two-way interaction between discrimination and race/ethnicity for each level of the outcome in interaction models: individual tobacco & non-cannabis (p<0.001), individual tobacco & cannabis (p=0.002), individual cannabis & non-tobacco (p=0.37), dual/poly tobacco & non-cannabis (p=0.002), and dual/poly tobacco & cannabis (p<0.001)

^d P-value for the two-way interaction between discrimination and race/ethnicity for each level of the outcome in interaction models: individual tobacco use disorder (p<0.001), individual cannabis use disorder (p=0.09), and joint tobacco & cannabis use disorders (p<0.001)

^e The outcome referent group: never/former use of both tobacco and cannabis, no tobacco or cannabis use disorders

Chapter 4 Latent Classes of Tobacco and Cannabis Use Among US Emerging Adults

4.1 Introduction

Emerging adulthood (ages 15-24) is a critical developmental period associated with risk for adverse health behaviors such as using tobacco and cannabis.^{268,269} Tobacco and cannabis are two of the most commonly used substances among younger populations in the US.^{40,270} While cigarette use has drastically decreased over the past decade among youth and adult populations,^{3,271} the increase in use of other products, such as ENDS/EVPs and cigars, raises alarm among health professionals.^{15,193} Both ENDS/EVPs and cigars can be used to smoke/vape cannabis, and cannabis vaping has emerged as a concerning ROA, or specific use modality, in recent years.^{51,272,273} Use and co-use of tobacco and cannabis are intertwined in many ways, with co-use prevalent among emerging adults,^{274,275} leading to added concern about how and why these substances are consumed.^{42,46,276,277}

Many studies have investigated the extent to which tobacco and cannabis use and co-use differ across populations.^{46,276,278} Tobacco use is more common among people who use cannabis and vice versa.^{240-242,279} However, the use patterns of tobacco and cannabis, with an emphasis on multiple ROA, remain less explored. Paying particular attention to ROA when examining patterns of tobacco and cannabis use and co-use is crucial to understanding disparities in use, as certain populations have higher prevalence of specific tobacco products and cannabis use modalities.^{15,48-50,193} For example, vaping is common among youth and YAs and these groups use vaping products to vape nicotine or cannabis exclusively or together.^{51,272,273} In addition, the joint harms of nicotine and cannabis are more severe than using each substance separately,^{42,244,280} and

motivations behind tobacco and cannabis co-use include coping with stress and attempts to quit either substance.^{281,282} Understanding co-use patterns is needed to inform educational interventionists and policymakers of population groups that are more susceptible to associated health effects.

When examining sociodemographic disparities in tobacco and cannabis use, it is important to consider how people use each substance separately and together. Male youth and YAs use tobacco and cannabis more commonly than their female counterparts.^{283,284} While ENDS use is higher among NH White and Hispanic youth than NH Black youth, cigar/cigarillo/little filtered cigar use is higher among NH Black youth than youth from other racial/ethnic groups.¹⁹³ In addition, other studies have found that exclusive ENDS use is more commonly used among Hispanic and NH White youth compared to NH Black youth.^{196,285,286} Similar patterns are observed for adults, except that cigar/cigarillo/little filtered cigar use is more comparable between NH White and NH Black adults.¹⁵ Hispanic youth vape cannabis more often than NH White and Black youth.⁵⁰ Differences in tobacco and cannabis use by sexual orientation identity have also been documented, with lesbian/gay and bisexual (LGB+) populations generally having higher prevalence of tobacco and cannabis use than heterosexual populations.²⁸⁷⁻²⁸⁹ In addition, youth and YAs who use either substance generally have lower education or income.^{195,196,290} However, this differed by product, with studies finding that higher education or income was associated with a lower prevalence of combustible tobacco product use, but a higher prevalence of exclusive ENDS use.²⁸⁵

Few studies have examined the ways in which using tobacco and cannabis intersect via ROA, and how these patterns shape tobacco and cannabis use disparities among a nationally representative sample of youth and YAs. There is also a limited understanding of nicotine and

cannabis consumption via multiple tobacco products (e.g., cigarettes, ENDS, cigars).⁴⁶

Therefore, this study uses latent class analysis (LCA) to identify subgroups of youth and YAs who use cigarettes, ENDS, cigars, and cannabis as blunts, cannabis in vapes, and cannabis without blunting/vaping. This study also investigates differences in classes of use by age, sex, race/ethnicity, sexual orientation identity, and socioeconomic status (SES).

4.2 Methods

4.2.1 Data

I used public-use and restricted-use data from Wave 4 of the Population Assessment of Tobacco and Health (PATH) Study.^{291,292} PATH is an ongoing nationally representative study of the civilian, noninstitutionalized US youth and adult populations. Wave 4 data were collected from December 2016 to January 2018. The weighted response rate at Wave 1 was 78.4% for youth (n=13,651) and 74.0% for adults (n=32,320). At Wave 4, 11,059 youth and 27,757 adults who enrolled at Wave 1 completed interviews. To account for attrition at previous waves and to approximate the sample size at Wave 1, Wave 4 data included a replenishment sample, adding 3,739 youth and 6,065 adults who completed interviews to the sample. These additions resulted in a total sample size of 48,620 respondents in Wave 4. More details about the PATH Study design and access are available elsewhere.^{291,292} The Westat Institutional Review Board approved the PATH Study and data were collected in-person via audio computer assisted self-interviews (ACASI).²⁹³ This study was classified as not regulated human subjects research by the University of Michigan Institutional Review Board due to the use of secondary de-identified data.

4.2.2 Participants

I included youth respondents aged 15-17 (n=7,461) and YA respondents aged 18-24 (n=11,284) who had complete data on tobacco and cannabis use and sociodemographic

characteristics. This resulted in analytic sample sizes of 7,017 for youth and 10,439 for YAs. A visual description of the selection of each analytic sample is presented in Figure 4.1.

4.2.3 Measures

Tobacco and Cannabis Use

I included indicators of past 30-day use of the following tobacco products: cigarettes, ENDS, and cigars/cigarillos/little filtered cigars (hereafter referred to as “cigars”). I also included past 30-day use of blunts (i.e., cannabis in cigars), cannabis vaping (i.e., cannabis in EVPs with or without nicotine), and cannabis without blunting/vaping (i.e., other cannabis) (e.g., smoking or ingesting edibles).

Sociodemographic Characteristics

I examined age, sex, race/ethnicity, sexual orientation identity, highest educational attainment, and annual household income as predictors of tobacco/cannabis use classes. Age was measured as continuous (15-17 for youth, 18-24 for YAs). Sex was binary (male, female). Race/ethnicity was categorized as Hispanic, non-Hispanic (NH) White, NH Black, and another race/ethnicity; the latter group included NH American Indian/Alaska Native, NH Asian, and NH Multiracial adults. Sexual orientation identity was binary (heterosexual, LGB+); LGB+ respondents identified as lesbian, gay, bisexual, or “something else.” Highest educational attainment was categorized as high school graduate or less, some college, and college graduate or more; for youth, highest educational attainment referred to their parents’ education. Annual household income was binary (<\$50,000, ≥\$50,000). I dichotomized annual household income to include additional respondents who did not answer the original income question but indicated whether their income was either below \$50,000 or above \$50,000. Both education and income variables were included as proxy measures for SES.

4.2.4 Statistical Analysis

I examined the weighted prevalence of individual tobacco and cannabis use variables and sociodemographic characteristics among youth and YAs. Next, I conducted LCA in Mplus version 8.7 (Muthén & Muthén, LA, California), separately for youth and YAs who used at least one product in the past 30 days (n=1295 for youth; n=4883 for YAs), to identify the number of latent classes based on response patterns of six binary tobacco and cannabis use indicators.²⁹⁴ I compared the fit of LCA models using the following information criteria: Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), Sample-Size Adjusted Bayesian Information Criteria (SABIC), and Constant Akaike Information Criteria (CAIC) (Figure 4.2, Table C.1), with the BIC being the most preferred and trusted fit statistic.²⁹⁴ I considered relative fit statistics such as the Vuong-Lo-Mendell-Rubin (VLMR) likelihood ratio test (LRT), Bayes Factor (BF), and the approximate correct model probability (cmP) (Table 4.1).²⁹⁴ The cmP estimates the probability that each model out of a group of models is correct, assuming the “true” model is among them.²⁹⁴ The LCA also produces entropy, or a statistic ranging between 0 and 1 with higher values representing better class separation.²⁹⁴ In addition to these fit statistics, I considered the substantive interpretation of the latent classes when choosing the best fitting models.²⁹⁴

I exported data on class membership from Mplus and merged with Wave 4 PATH Study data in Stata SE version 16.1 (StataCorp, College Station, Texas). I assigned latent class membership to youth and YAs based on the maximum posterior probability of class membership and identified the rest as youth/YAs who never/formerly used tobacco and cannabis. I used multinomial logistic regression to estimate adjusted associations between sociodemographic characteristics and each class variable, with never/former use as the referent category. As a supplementary analysis, I disaggregated the “another race/ethnicity” category and calculated and

compared distributions of latent use classes by race/ethnicity using chi-square tests of independence. To account for the complex survey design, I computed all analyses, including the LCA, using Wave 4 cross-sectional survey weights (i.e., youth weights for youth analyses and adult weights for YA analyses) and calculated variance in Stata SE version 16.1 (StataCorp, College Station, Texas) using the Balanced Repeated Replication method with Fay's adjustment set to 0.3.²⁹⁵

4.3 Results

4.3.1 Participant Characteristics of Youth and Young Adult Samples

Table 4.2 displays participant characteristics for both youth and YA samples. Among youth, 5.6% used cigarettes in the past 30 days, while 7.4% used ENDS, 2.2% used cigars, 3.3% used blunts, 2.7% vaped cannabis, 7.2% used other cannabis, and 82.0% never/formerly used tobacco/cannabis. YAs had higher past 30-day prevalence of use for all groups: 22.2% used cigarettes, 13.8% used ENDS, 12.4% used cigars, 7.5% used blunts, 5.6% vaped cannabis, 13.6% used other cannabis, and 59.0% never/formerly used tobacco/cannabis.

4.3.2 Latent Classes of Tobacco and Cannabis Use

For youth and YA samples, the BIC, SABIC, and CAIC bottomed out and supported the 6-class model (Figure 4.2), and the VLMR LRT demonstrated no significant difference in fit between LCA models with 5 and 6 latent classes (p-value for youth: 0.3375, for adults: 0.054) (Table 4.1), indicating that a more parsimonious model was not justified. Thus, I chose the 6-class model for youth according to fit criteria and having meaningful latent classes. For YAs, models with 6 and 7 latent classes yielded similarly low values for fit criteria, and I examined both models for substantive relevance. I decided against the 7-class model for YAs given the ambiguity in describing two of the latent classes based on conditional item-response probabilities

and selected the 6-class model. These ambiguities included one class that had 61% probability of cigarette use and 49% probability of cigar use along with 100% probability of blunt use and 0% probability of using each remaining product, and another class that had 54% probability of cigarette use, 41% of other cannabis use, 17% probability of ENDS use, and 0% probability of using each remaining product. The average latent posterior probabilities (AvePP), or the average probabilities of the model accurately predicting which latent classes respondents belong in depending on their response patterns to indicator variables,²⁹⁴ were between 0.81 and 0.99 for youth and 0.79 and 1.00 for YAs (Table 4.3). I present a conditional item-response probability plot, demonstrating the probability of endorsement of each item conditional on class membership, for each 6-class model solutions (Figure 4.3, Table C.2). Values below 0.3 and above 0.7 represent high homogeneity,²⁹⁴ which corresponds to a higher likelihood that respondents are not using (below 0.3) or are using (above 0.7) a particular substance. While these criteria are loosened in some cases, I attempted to describe latent classes based on these cut points.

I display the prevalence of the latent class membership for both youth and YAs in Table 4.4 and describe the latent classes based on the conditional item probabilities (Figure 4.3, Table C.2). I ordered the latent classes by number of substances used, from exclusive use (i.e., only one substance) to dual use (i.e., two substances) to poly use (i.e., three or more substances). Both youth and YA samples had similar latent classes with respect to exclusive use but differed in dual/poly use classes. Among the youth sample, respondents classified as using exclusive cigarettes made up 2.5% of the sample, followed by youth who used exclusive ENDS (2.6%), exclusive blunts (2.5%), exclusive other cannabis (6.3%), ENDS + cannabis vaping (2.7%), and cigarettes + cigars + other cannabis (1.5%). Among the YA sample, respondents classified as

using exclusive cigarettes made up 11.7% of the sample, followed by YAs who used exclusive ENDS (3.9%), exclusive blunts (5.3%), exclusive other cannabis (7.0%), cigarettes + cigars (8.2%), and cigarettes + ENDS + cannabis vaping (4.9%).

4.3.3 Sociodemographic Characteristics by Latent Classes of Tobacco and Cannabis Use

Tables C.3 (youth) and C.4 (YAs) show distributions of each sociodemographic characteristic by latent classes of tobacco and cannabis use. Among youth, the latent class membership differed with respect to age ($p < 0.001$), race/ethnicity ($p < 0.001$), sexual orientation identity ($p < 0.001$), highest parental educational attainment ($p < 0.001$), and annual household income ($p < 0.001$), but not sex ($p = 0.55$). Among YAs, latent class membership differed by all sociodemographic characteristics ($p < 0.05$).

4.3.4 Associations Between Sociodemographic Characteristics and Latent Classes of Tobacco and Cannabis Use

Table 4.5 displays results from the adjusted multinomial logistic regression models for youth. A one-year increase in age was associated with higher odds of each tobacco and cannabis use class, compared to never/former use. Female youth had lower odds of using cigarettes + cigars + other cannabis (OR: 0.55, 95% CI: 1.50-2.60), compared to never/former use, than male youth. Associations involving race/ethnicity were statistically significant for exclusive cigarette use, exclusive ENDS use, and ENDS + cannabis vaping, compared to never/former use. For example, Hispanic (OR: 0.37, 95% CI: 0.23-0.60), NH Black (OR: 0.06, 95% CI: 0.01-0.40), and youth from another race/ethnicity (OR: 0.53, 95% CI: 0.30-0.93) all had lower odds of using exclusive ENDS, relative to NH White youth. Hispanic (OR: 0.58, 95% CI: 0.35-0.96) and NH Black (OR: 0.12, 95% CI: 0.03-0.43) youth also had lower odds than NH White youth for using ENDS + cannabis vaping. Youth who identified as LGB+ had higher odds of using exclusive cigarettes (OR: 2.81, 95% CI: 1.94-4.07), exclusive blunts (OR: 2.51, 95% CI: 1.77-3.56),

exclusive other cannabis (OR: 1.70, 95% CI: 1.24-2.32), and cigarettes + cigars + other cannabis (OR: 2.64, 95% CI: 1.38-5.06), compared to never/former use, relative to heterosexual youth. Lastly, youth with household incomes <\$50,000 had higher odds of using cigarettes + cigars + other cannabis (OR: 3.26, 95% CI: 1.74-6.12), compared to never/former use, than youth with household incomes ≥\$50,000.

I show results from the adjusted multinomial logistic regression models for YAs in Table 4.6. With each one-year increase in age, the odds of use were higher for YAs who used exclusive cigarettes (OR: 1.23, 95% CI: 1.18-1.29), exclusive blunts (OR: 1.09, 95% CI: 1.04-1.13), and cigarettes + cigars (OR: 1.06, 95% CI: 1.02-1.10), but lower for YAs who used exclusive ENDS (OR: 0.90, 95% CI: 0.84-0.96), compared to never/former use. Female YAs had lower odds of product use than male YAs for each class (vs. never/former use), except for exclusive other cannabis use, where there were no differences. Hispanic YAs, NH Black YAs, and YAs from another race/ethnicity had lower odds of using exclusive cigarettes, compared to never/former use, than NH White YAs. Regarding exclusive blunt use, NH Black YAs had higher odds of use (OR: 1.49, 95% CI: 1.02-2.04) and YAs from another race/ethnicity had lower odds of use (OR: 0.54, 95% CI: 0.36-0.81) than NH White YAs. Similarly, NH Black YAs had higher odds of using cigarettes + cigars (OR: 1.51, 95% CI: 1.18-1.94) than NH White YAs. Hispanic and NH Black YAs additionally had lower odds of using cigarettes + ENDS + cannabis vaping than NH White YAs. Like youth, LGB+ YAs had higher odds of each use group, compared to never/former use, than heterosexual YAs, except the exclusive ENDS use class, where there was no statistical difference. YAs who had high school or less education had higher odds of using exclusive cigarettes (OR: 1.75, 95% CI: 1.45-2.10) and cigarettes + cigars (OR: 1.48, 95% CI: 1.23-1.79), compared to never/former use, relative to YAs with college graduate or more

education. Contrarily, YAs with some college education had lower odds of using exclusive cigarettes and cigarettes + ENDS + cannabis vaping compared to YAs with college graduate or more education. YAs with <\$50,000 household income had higher odds of using exclusive cigarettes (OR: 1.68, 95% CI: 1.40-2.01) and cigarettes + cigars (OR: 1.19, 95% CI: 1.01-1.42) than YAs with household incomes \geq \$50,000.

4.4 Discussion

This study used LCA to identify subgroups of emerging adults who used tobacco and cannabis in the past 30 days, including various ROA for both substances. For youth, four classes represented exclusive use of a substance (i.e., exclusive cigarettes, exclusive ENDS, exclusive blunts, exclusive other cannabis), whereas two classes represented dual/poly use (i.e., ENDS + cannabis vaping, cigarettes + cigars + other cannabis). Latent classes for YAs were similar in that four classes were dominated by the same exclusive use groups as youth and two classes represented dual/poly use (i.e., cigarettes + cigars, cigarettes + ENDS + cannabis vaping). For both youth and YAs, latent classes of tobacco and cannabis use differed by age, sex, race/ethnicity, sexual orientation identity, and SES indicators.

The critical transition period during emerging adulthood poses unique life changes that might make this population more susceptible to tobacco and cannabis use.²⁶⁸ Use of multiple tobacco and cannabis products (e.g., dual/poly use) can detrimentally impact the health of younger people, especially as they continue to age into and through adulthood.^{269,296} Examples of health effects associated with tobacco and cannabis use include higher risk for dependence, cognitive impairment, additive toxicant exposure, and increased risk for premature mortality.^{42,244,269,296} Problematic patterns of tobacco and cannabis use typically emerge during young adulthood, making it essential to address and prevent use at earlier ages. Health

professionals and policymakers must further consider the various ways in which youth and YAs consume tobacco and cannabis when aiming to prevent and reduce use through targeted interventions.

Other studies have used LCA to identify classes for multiple tobacco products (e.g., cigarettes, ENDS, cigars, pipe, smokeless tobacco, etc.)^{297,298} or multiple substances (e.g., tobacco, cannabis, alcohol, etc.),^{299,300} but, to my knowledge, none have examined tobacco and cannabis use and co-use incorporating distinct ROA. LCAs in prior research have identified one or several classes that represent dual/poly tobacco use or tobacco and cannabis co-use among youth or YAs.^{298,299} One study identified a class of high overall tobacco use, including the concurrent use of cigarettes, ENDS, hookah, and cigars among YAs.²⁹⁸ While I did not include hookah use in this study to focus on ROA commonly shared for tobacco and cannabis consumption, I identified latent use classes of cigarette + cigar and cigarette + ENDS + cannabis vaping among YAs. This finding might suggest that problematic concurrent use of multiple tobacco products is more prevalent for YAs compared to other age groups. Another study identified separate classes of polytobacco use (e.g., heavy polytobacco use) and tobacco and cannabis co-use (e.g., cigars, hookah, cannabis co-use) among YA college students.²⁹⁹ ROA was not specified, making it difficult to precisely compare classes between studies. Nevertheless, this study is similar in that it reports unique latent classes of concurrent tobacco and cannabis use.

Among recent studies that have employed finite mixture modeling techniques to characterize unobserved patterns of tobacco and cannabis use,^{301,302} several have reported heterogeneity in use patterns. One study identified latent trajectories of use among youth, two of which included youth who later initiated with both cannabis and ENDS and youth who initiated with cannabis and multiple tobacco products.³⁰² In this study, I identified a class that represents

ENDS + cannabis vaping among youth and a class that represents cigarettes + ENDS + cannabis vaping among YAs, shedding further light on differences in use patterns throughout the developmental period from youth to young adulthood. Collectively, these findings are helpful in unveiling subgroups of tobacco and cannabis use for public health intervention for youth and YA populations, which may emphasize the need for age-specific preventive measures. In addition, vaping-related interventions must recognize the importance of vaping both nicotine and cannabis while addressing use.

My findings provide insight into specific use patterns of tobacco and cannabis among US youth and YAs, and how these use patterns vary by sociodemographic factors. Regarding age, I explored variation among youth (15-17) and YAs (18-24) separately. Like previous research,^{195,196} I documented exclusive use groups of cigarettes and ENDS with concerning prevalence in both samples. The lower prevalence of exclusive ENDS use is attributed to its combination of use in other classes. While I observed that higher age was associated with increased odds of each use group in youth and most use groups in YAs, the opposite was observed for exclusive ENDS use in YAs. This might be due to YAs transitioning away from ENDS use as they age either to cease use completely or to use other products/substances.³⁰³

I also observed differences by race/ethnicity. Racial/ethnic minoritized youth and YAs had lower odds of exclusive cigarette use compared to their NH White counterparts, consistent with prior work.¹⁹⁶ Among youth, racial/ethnic minoritized youth had lower odds of exclusive ENDS use than NH White youth, possibly suggesting that racial/ethnic minoritized youth initiate ENDS use at later ages,³⁰⁴ especially since differences in exclusive ENDS use were not observed in the YA sample. Furthermore, NH Black YAs had higher odds of exclusive blunt use compared to their NH White counterparts. For dual/poly use groups, racial/ethnic minoritized youth and

YAs had lower odds of use, with exception of cigarettes + cigar use, where NH Black YAs had higher odds of use compared to NH White YAs. These two findings may indicate that NH Black YAs disproportionately use cigars to consume both tobacco and cannabis. Previous work on blunting and cigar use among NH Black populations in the US have provided similar conclusions.^{48,49,305} My results also suggest that most dual/poly tobacco and cannabis use groups were less common among Hispanic and NH Black youth/YAs than NH White youth/YAs, indicating that NH White youth/YAs may be at greater risk for the ill effects of dual/poly use. This inference corroborates prior research suggesting that co-use might be more prevalent among NH White populations than other racial/ethnic populations.³⁰⁴

LGB+ youth and YAs had higher odds of exclusive and dual/poly use classes, including cigarettes + cigars + other cannabis use among youth and cigarettes + ENDS + cannabis vaping use among YAs, compared to their heterosexual counterparts. These results corroborate previous research that calls to address the alarmingly high prevalence of tobacco and cannabis use in LGB+ populations.²⁸⁷⁻²⁸⁹ As posited by the minority stress model, sexual minority youth and YA populations experience elevated stress that might increase their risk for dual/poly substance use.⁸³ In line with prior work, I urge researchers to pay particular attention to how tobacco and cannabis use differs by considering using patterns distinct to each sexual orientation identity.²⁸⁷⁻

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For SES measures, lower versus higher annual household income was only associated with the cigarettes + cigars + other cannabis use group among youth. However, among YAs, lower versus higher annual household income was associated with using exclusive cigarettes and cigarettes + cigar. These findings are consistent with previous research that generally indicates that use of combustible tobacco products is more common among people from lower SES

backgrounds.^{195,196,290} In addition, some college education was associated with lower odds of exclusive cigarette use and use of cigarettes + ENDS + cannabis vaping, compared to college graduate or more. My findings regarding educational attainment should be approached with caution given that the entire YA sample did not have the opportunity to complete college. Nevertheless, these insights into sociodemographic differences in tobacco and cannabis latent use classes may benefit substance use health services in identifying groups of youth and YAs who are more susceptible to the harms associated with tobacco and cannabis use.^{42,46}

4.4.1 Limitations

I acknowledge several study limitations. First, class description of several latent classes for either youth or YAs relied on lower conditional item-response probability thresholds than recommended for class homogeneity. One example is the description of cigarette + cigar use for YAs where YAs had a 54% conditional probability of using cigarettes. This probability may represent arbitrary classification; however, it represented the next highest probability of cigarette use in the sample aside from the exclusive use group and poly use group. Nevertheless, I acknowledge that this class could be identified as exclusive cigar use. Second, my findings represent a cross-section of youth and YAs between 2016 and 2018, and tobacco and cannabis use patterns may have shifted since then. For example, data were collected during the pre-JUUL era, and JUUL products were especially common among youth and YAs for several years.³⁰⁶ Cannabis legalization may also impact consumption patterns and ROA preferences, and laws related to recreational and medical use in the US are changing with some evidence suggesting that these changes impact use.³⁰⁷⁻³¹⁰ Third, all variables collected in this study were self-reported and are subject to response biases. Fourth, due to sample size limitations, I collapsed certain racial/ethnic groups into an “another race/ethnicity” category as well as LGB+ identity into one

category and acknowledge that I am potentially masking heterogeneity in use patterns within these groups.

4.5 Conclusion

I identified six distinct classes of tobacco and cannabis use for youth and YAs, separately, including four exclusive use groups (which were the same for youth and YAs) and two dual/poly use groups (which differed between youth and YAs). I additionally considered cannabis ROA, such as blunting and vaping, when constructing the classes to examine how tobacco products pattern with cannabis via various modalities. In addition, I found that substance use classes differed by age, sex, race/ethnicity, sexual orientation identity, and SES for youth and YAs. My findings may be useful for health professionals who create population-level interventions aimed to prevent and reduce substance use among younger populations, and to better tailor interventions to groups more at-risk for the health consequences of tobacco and cannabis use and co-use.

Figure 4.1 Flowchart Describing the Selection of Each Analytic Sample

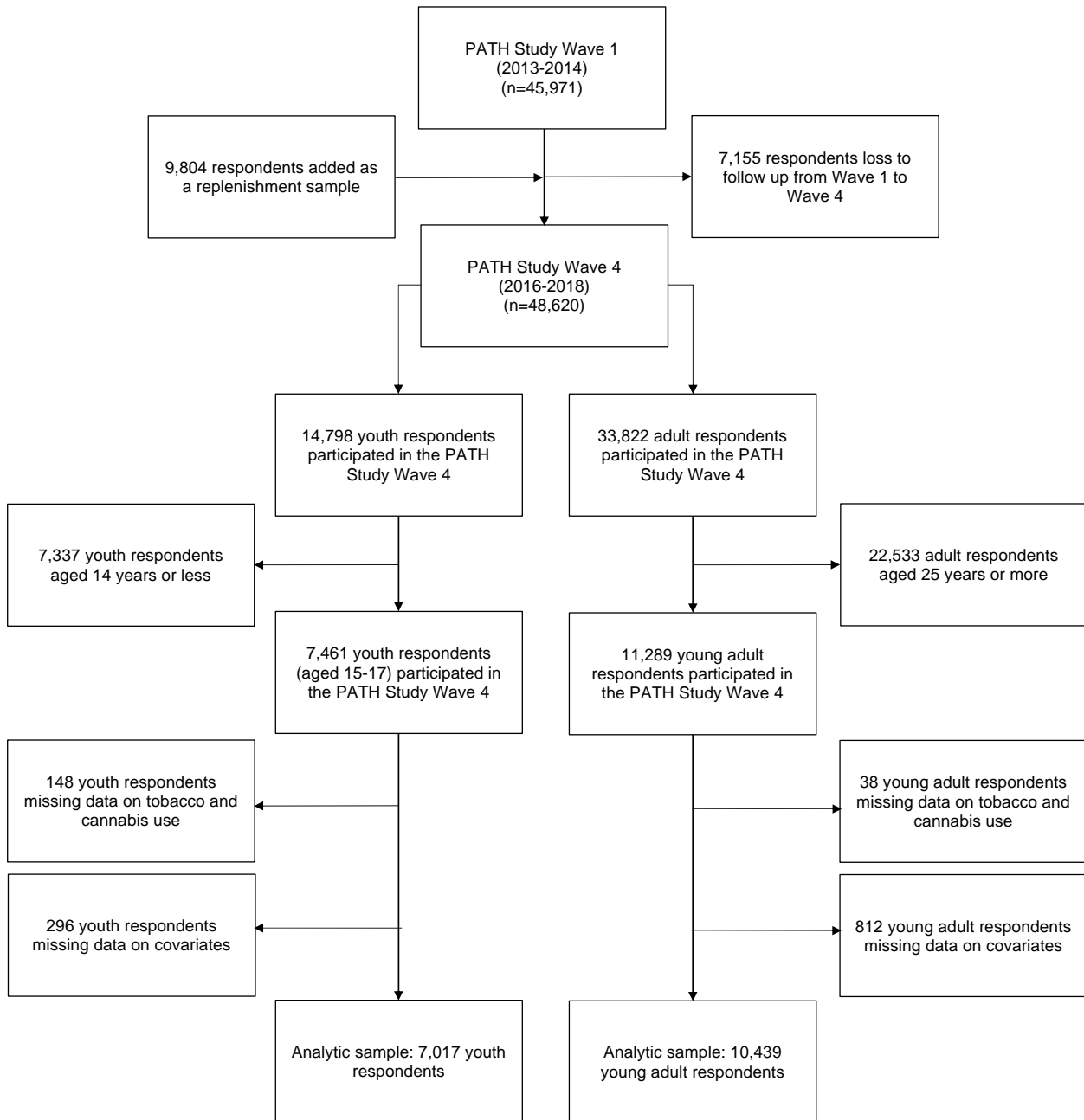


Figure 4.2 Latent Class Analysis Information Criteria Plots for Youth and Young Adult Samples

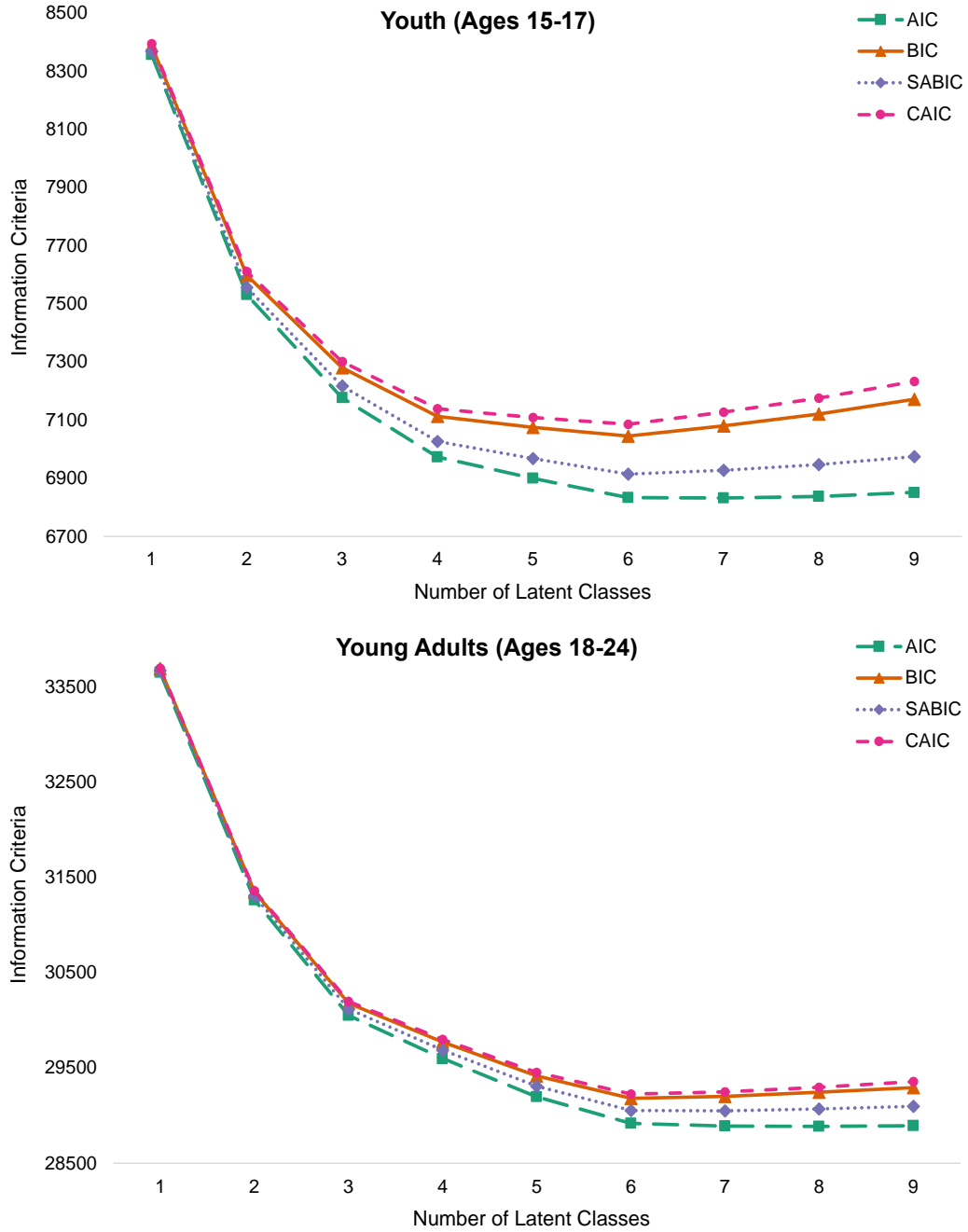


Table 4.1 Relative Fit Statistics for Latent Classes Among Youth and Young Adult Samples

Class Solution	Relative Fit Statistics for Youth				
	Log Likelihood	VLMRT ^a	BF (K, K+1) ^b	cmP(K) ^c	Entropy ^d
1-class	-4172.17	0.00	0.00	0.00	1.00
2-class	-3751.96	0.00	0.00	0.00	1.00
3-class	-3568.41	0.00	0.00	0.00	0.99
4-class	-3459.26	0.00	0.00	0.00	0.92
5-class	-3415.73	0.00	0.00	0.00	0.87
6-class	-3375.28	0.34	>15.00	1.00	0.94
7-class	-3367.61	0.60	>15.00	0.00	0.91
8-class	-3363.29	0.44	>15.00	0.00	0.90
9-class	-3363.25	--	--	0.00	0.89

Class Solution	Relative Fit Statistics for Young Adults				
	Log Likelihood	VLMRT ^a	BF (K, K+1) ^b	cmP(K) ^c	Entropy ^d
1-class	-16821.49	0.00	0.00	0.00	1.00
2-class	-15619.25	0.00	0.00	0.00	0.84
3-class	-15005.44	0.00	0.00	0.00	1.00
4-class	-14772.14	0.00	0.00	0.00	0.91
5-class	-14564.35	0.00	0.00	0.00	1.00
6-class	-14417.50	0.054	>15.00	1.00	0.95
7-class	-14397.61	0.46	>15.00	0.00	0.93
8-class	-14388.19	0.43	>15.00	0.00	0.93
9-class	-14384.10	--	--	0.00	0.86

^a Vuong-Lo-Mendell-Rubin likelihood ratio test p-value; non-statistical significance indicates that K+1 model does not perform better

^b Bayes factor; compares fit between models K and K+1; BF > 10 provides strong evidence for K model

^c Approximate correct model probability; estimates the probability that each model out of a group of models is correct, assuming the "true" model is among them; the model with the largest cmP is best

^d A statistic between 0 and 1, with higher values indicating better class separation

Table 4.2 Weighted Prevalence of Participant Characteristics Among Youth and Young Adult Samples

	Youth (n=7,017)	Young Adults (n=10,439)
Age (mean ± SD)	16.0 ± 0.8	21.0 ± 3.3
Sex, n (%)		
Female	3374 (48.6)	5289 (49.8)
Male	3643 (51.4)	5150 (50.2)
Race/ethnicity, n (%)		
Hispanic	2108 (22.5)	2813 (21.6)
NH White	3284 (54.3)	5040 (54.2)
NH Black	979 (13.6)	1612 (13.9)
Another race/ethnicity	646 (9.6)	974 (10.3)
Sexual orientation identity, n (%)		
Heterosexual	6201 (88.3)	9063 (87.5)
Lesbian, gay, bisexual, or something else	816 (11.7)	1376 (12.5)
Highest (parental) educational attainment, n (%) ^a		
High school or less	2671 (34.2)	5278 (42.5)
Some college	2227 (31.2)	4185 (45.4)
College graduate or more	2119 (34.6)	976 (12.1)
Annual household income, n (%)		
Less than \$50,000	3366 (43.4)	6933 (64.2)
\$50,000 or more	3651 (56.6)	3506 (35.8)
Past 30-day tobacco and cannabis use, n (%)		
Cigarettes (yes)	395 (5.6)	2492 (22.2)
ENDS (yes)	480 (7.4)	1556 (13.8)
Cigars (yes)	154 (2.2)	1461 (12.4)
Blunts (yes)	242 (3.3)	849 (7.5)
Vaping cannabis (yes)	179 (2.7)	613 (5.6)
Other cannabis (yes) ^b	514 (7.2)	1506 (13.6)

^a Estimates represent highest parental educational attainment for youth and highest educational attainment for young adults

^b Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

Table 4.3 Average Latent Class Probabilities for Most Likely Latent Class Memberships (Row) by Latent Classes (Column) for Youth and Young Adult 6-Class Model Solutions

	Youth Latent Classes ^a					
	C1	C2	C3	C4	C5	C6
C1: Exclusive cigarettes	0.95	0.00	0.00	0.04	0.00	0.01
C2: Exclusive ENDS	0.00	0.98	0.00	0.00	0.00	0.01
C3: Cigarette, cigar, and other cannabis ^b	0.00	0.00	0.99	0.00	0.00	0.01
C4: Exclusive other cannabis ^b	0.04	0.00	0.00	0.97	0.00	0.00
C5: Exclusive blunts	0.00	0.00	0.00	0.00	0.99	0.01
C6: ENDS and cannabis vaping	0.00	0.19	0.00	0.00	0.00	0.81
	Young Adult Latent Classes ^a					
	C1	C2	C3	C4	C5	C6
C1: Exclusive other cannabis ^b	1.00	0.00	0.00	0.00	0.00	0.00
C2: Cigarette, ENDS, and cannabis vaping	0.00	0.99	0.00	0.01	0.00	0.00
C3: Cigarette and cigar	0.00	0.07	0.93	0.00	0.00	0.00
C4: Exclusive ENDS	0.00	0.20	0.00	0.79	0.00	0.00
C5: Exclusive blunts	0.00	0.00	0.00	0.00	1.00	0.00
C6: Exclusive cigarettes	0.00	0.04	0.00	0.00	0.00	0.97

^a Diagonal values refer to the probability of how well respondents are assigned membership in their most likely latent class

^b Other cannabis use includes cannabis use without blunts or vaping

Figure 4.3 Conditional Item-Response Probability Plots for Youth and Young Adult 6-Class Model Solutions

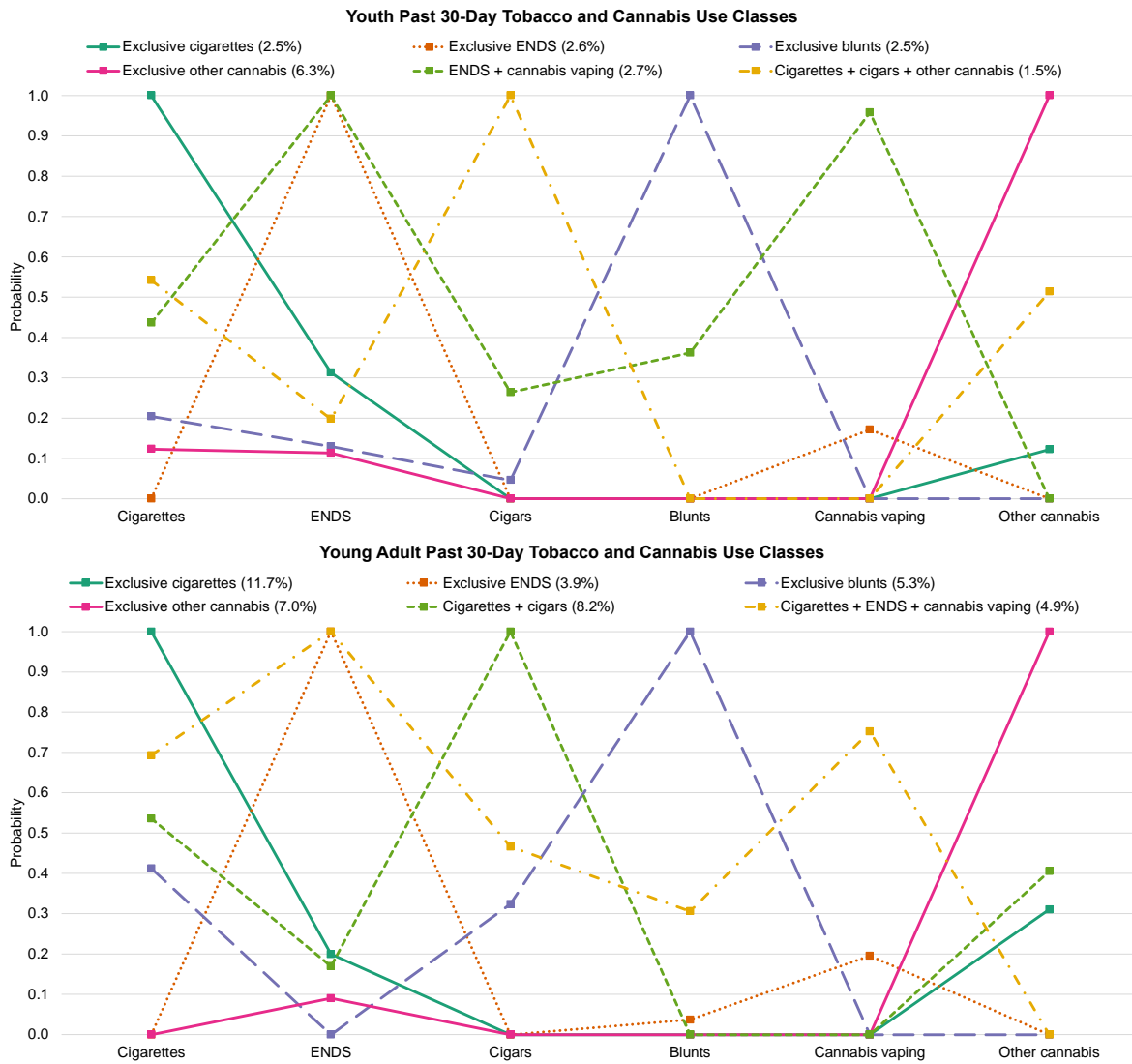


Table 4.4 Weighted Prevalence of Past 30-Day Latent Classes of Tobacco and Cannabis Use Among Youth and Young Adult Samples

Youth latent classes, n (%)	
Never/former	5760 (82.0)
Exclusive cigarettes	172 (2.5)
Exclusive ENDS	163 (2.6)
Exclusive blunts	186 (2.5)
Exclusive other cannabis ^a	447 (6.3)
ENDS + cannabis vaping	180 (2.7)
Cigarettes + cigars + other cannabis	109 (1.5)
Young adult latent classes, n (%)	
Never/former	5847 (59.0)
Exclusive cigarettes	1278 (11.7)
Exclusive ENDS	443 (3.9)
Exclusive blunts	603 (5.3)
Exclusive other cannabis ^a	749 (7.0)
Cigarettes + cigars	978 (8.2)
Cigarettes + ENDS + cannabis vaping	541 (4.9)

^a Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

Table 4.5 Adjusted Multinomial Logistic Regression Estimating Associations Between Sociodemographic Characteristics and Latent Classes of Tobacco and Cannabis Use Among Youth

	Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis ^b	ENDS + Cannabis Vaping	Cigarettes + Cigars + Other Cannabis
	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c
Age (continuous)	1.74 (1.41-2.15)	1.50 (1.21-1.86)	1.64 (1.30-2.07)	1.45 (1.27-1.66)	1.68 (1.34-2.12)	1.97 (1.50-2.6)
Sex (ref: male)						
Female	0.72 (0.50-1.05)	1.00 (0.70-1.43)	0.77 (0.53-1.12)	0.98 (0.80-1.19)	0.89 (0.62-1.28)	0.55 (0.35-0.88)
Race/ethnicity (ref: NH White)						
Hispanic	0.48 (0.31-0.74)	0.37 (0.23-0.60)	1.37 (0.91-2.05)	1.11 (0.89-1.37)	0.58 (0.35-0.96)	0.52 (0.27-1.00)
NH Black	0.23 (0.08-0.65)	0.06 (0.01-0.40)	1.57 (0.94-2.62)	0.79 (0.55-1.13)	0.12 (0.03-0.43)	1.34 (0.73-2.44)
Another race/ethnicity	0.54 (0.33-0.91)	0.53 (0.30-0.93)	1.19 (0.69-2.08)	0.73 (0.47-1.15)	0.75 (0.40-1.41)	0.64 (0.30-1.35)
Sexual orientation identity (ref: Heterosexual)						
Lesbian, gay, bisexual, or something else	2.81 (1.94-4.07)	0.64 (0.35-1.16)	2.51 (1.77-3.56)	1.70 (1.24-2.32)	1.58 (0.92-2.72)	2.64 (1.38-5.06)
Highest parental educational attainment (ref: college graduate or more)						
High school or less	1.14 (0.73-1.79)	1.09 (0.71-1.66)	0.91 (0.63-1.33)	0.92 (0.72-1.19)	0.79 (0.54-1.16)	1.40 (0.84-2.33)
Some college	0.67 (0.40-1.13)	0.99 (0.70-1.41)	0.83 (0.51-1.34)	0.80 (0.60-1.06)	0.83 (0.56-1.24)	1.06 (0.55-2.05)
Annual household income (ref: more than \$50,000)						
Less than \$50,000	1.49 (0.99-2.26)	0.75 (0.49-1.13)	1.32 (0.90-1.94)	1.14 (0.89-1.47)	1.02 (0.73-1.44)	3.26 (1.74-6.12)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: never/former use of both tobacco and cannabis

^b Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

^c Odds ratios (OR) and 95% confidence intervals adjusted for age, sex, race/ethnicity, sexual orientation identity, highest (parental) educational attainment, and annual household income

Table 4.6 Adjusted Multinomial Logistic Regression Estimating Associations Between Sociodemographic Characteristics and Latent Classes of Tobacco and Cannabis use Among Young Adults

	Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis ^b	Cigarettes + Cigars	Cigarettes + ENDS + Cannabis Vaping
	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c
Age (continuous)	1.23 (1.18-1.29)	0.90 (0.84-0.96)	1.09 (1.04-1.13)	1.00 (0.95-1.06)	1.06 (1.02-1.10)	0.97 (0.91-1.02)
Sex (ref: male)						
Female	0.69 (0.60-0.80)	0.52 (0.42-0.64)	0.74 (0.61-0.90)	0.91 (0.76-1.09)	0.36 (0.30-0.42)	0.37 (0.30-0.47)
Race/ethnicity (ref: NH White)						
Hispanic	0.60 (0.48-0.74)	0.76 (0.53-1.09)	1.08 (0.83-1.40)	0.83 (0.64-1.09)	0.68 (0.52-0.88)	0.71 (0.55-0.93)
NH Black	0.36 (0.28-0.48)	0.67 (0.44-1.01)	1.49 (1.09-2.04)	1.07 (0.78-1.46)	1.51 (1.18-1.94)	0.58 (0.41-0.81)
Another race/ethnicity	0.63 (0.45-0.88)	0.83 (0.51-1.36)	0.54 (0.36-0.81)	0.93 (0.65-1.32)	0.56 (0.39-0.80)	0.73 (0.48-1.13)
Sexual orientation identity (ref: Heterosexual)						
Lesbian, gay, bisexual, or something else	2.02 (1.64-2.49)	1.45 (0.88-2.40)	2.26 (1.73-2.96)	1.88 (1.50-2.34)	2.03 (1.64-2.52)	2.45 (1.89-3.18)
Highest educational attainment (ref: college graduate or more)						
High school or less	1.75 (1.45-2.10)	0.86 (0.67-1.11)	1.14 (0.92-1.42)	0.90 (0.74-1.09)	1.48 (1.23-1.79)	0.94 (0.76-1.17)
Some college	0.46 (0.33-0.64)	0.43 (0.26-0.72)	0.38 (0.25-0.58)	0.87 (0.64-1.17)	0.76 (0.55-1.04)	0.38 (0.25-0.58)
Annual household income (ref: more than \$50,000)						
Less than \$50,000	1.68 (1.40-2.01)	1.12 (0.85-1.49)	1.24 (0.97-1.58)	0.95 (0.78-1.15)	1.19 (1.01-1.42)	1.12 (0.89-1.42)

Bolded text indicates statistical significance (p<0.05)

^aThe outcome referent group: never/former use of both tobacco and cannabis

^bOther cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

^cOdds ratios (OR) and 95% confidence intervals adjusted for age, sex, race/ethnicity, sexual orientation identity, highest educational attainment, and annual household income

Chapter 5 Racial/Ethnic Disparities in Mental Health Problems and Tobacco and Cannabis Use Among US Emerging Adults

5.1 Introduction

Emerging adulthood (ages 15-24), is a critical life period during which most substance use, including tobacco and cannabis use, begins.^{268,269} Tobacco and cannabis use are two of the most used substances in the US.^{40,270} Co-use also raises public health concern,^{248,275,276,301,311} with intersecting modalities of use, or ROA,⁴⁷ potentially facilitating using both substances. For example, ENDS/EVPs can be used to vape cannabis,^{51,272,273} and ENDS use is highly prevalent among emerging adults.^{15,193} Tobacco and cannabis use are related in numerous ways, making the investigation of determinants, such as mental health problems, salient to these younger populations.

Mental health problems and substance use are interrelated, such as through common risk factors (e.g., biological susceptibility), self-medication (e.g., using substances to cope with mental health symptoms), and their bidirectional relationship (e.g., increased substance use may lead to mental health symptoms, and vice versa).³¹² However, the extent to which internalizing and externalizing problems, defined broadly as symptoms in behavioral, emotional, and social domains,^{103,104} are associated with specific tobacco and cannabis use patterns is less known.^{313,314} In addition, given observed differences in tobacco and cannabis use by race/ethnicity in the US,^{48,193,272,273,315} it is imperative to explore whether mental health problems shape racial/ethnic disparities in substance use during emerging adulthood.

Racial/ethnic disparities in tobacco and cannabis have become increasingly complex due to multiple types of products and ROA. For example, the use of cigars is typically higher among younger NH Black populations than other younger racial/ethnic groups,¹⁹³ and this might be driven by disproportionate use of cannabis in cigars (i.e., blunting), irrespective of whether NH Black youth smoke blunts to consume tobacco, cannabis, or both.⁴⁸ Co-use of tobacco and cannabis is prevalent among emerging adults,^{278,316} but research on whether use patterns differ by race/ethnicity is limited.³¹⁵ One study found that, compared to White emerging adults, Hispanic and Asian emerging adults had lower probabilities of tobacco and cannabis co-use.²⁷⁸ Several additional investigations found no racial/ethnic differences in tobacco and cannabis co-use, but they were limited by including only cigarette use, failing to capture patterns of co-use with other tobacco products.³¹⁷⁻³¹⁹ This gap in the literature warrants future research that examines racial/ethnic disparities in mental health problems and tobacco and cannabis use.

To date, two studies have examined racial/ethnic differences in relationships between mental health and substance use.^{320,321} One study among Hispanic and Black emerging adults found externalizing, but not internalizing, problems to be associated with substance use, specifically alcohol and cannabis use.³²⁰ Another longitudinal study found internalizing problems to be predictive of substance use, particularly cigarette, alcohol, and cannabis use, among Hispanic but not Black emerging adults.³²¹ I expand on these existing studies by using LCA to produce distinct subgroups of tobacco and cannabis use and co-use patterns, and examine whether internalizing and externalizing problems are associated with use classes among emerging adults using nationally representative data. I also investigate how these associations vary by race/ethnicity.

5.2 Methods

5.2.1 Data

I used data from Wave 4 of the PATH Study, an ongoing nationally representative study of the civilian, noninstitutionalized US youth and adult populations.^{291,292} Wave 4 data were collected from December 2016 to January 2018, and included a replenishment sample of the cohort established in Wave 1, weighted to be nationally representative of the US population. Further information about the PATH Study design and access is available elsewhere.^{291,292} This study was classified as not regulated human subjects research by the University of Michigan Institutional Review Board due to the use of secondary de-identified data.

5.2.2 Participants

This analysis included two samples representing different stages of emerging adulthood: youth ages 15-17 (n=7,461) and YAs aged 18-24 (n=11,284). For both samples, respondents who had complete data on internalizing and externalizing problems, six tobacco and cannabis use indicators, and sociodemographic characteristics were retained, resulting in analytic sample sizes of 6,898 for 15-17-year-old respondents and 10,304 for 18-24-year-old respondents. The process by which I selected the analytic samples is displayed in Figure 5.1.

5.2.3 Measures

Internalizing and Externalizing Problems

The PATH Study included questions about internalizing and externalizing problems in a modified version of the Global Appraisal of Individual Needs Short Screener (GAIN-SS).¹⁸⁶ GAIN-SS is a psychopathological assessment of people presenting to substance misuse treatment and was developed to be administered in five minutes or less as opposed to the full 1-2-hour assessment.^{322,323}

Respondents were asked four questions regarding the last time they experienced internalizing problems and seven questions regarding the last time they experienced externalizing problems. Respondents were also asked to report on the timing of these symptoms (i.e., “past month,” “2-12 months ago,” “over a year ago,” or “never”). The four questions for internalizing problems asked, “When was the last time you had significant problems with...” 1) “feeling very trapped, lonely, sad, blue, depressed, or hopeless about the future?”, 2) “sleep trouble, such as bad dreams, sleeping restlessly, or falling asleep during the day?”, 3) “feeling very anxious, nervous, tense, scared, panicked, or like something bad was going to happen?”, and 4) “becoming very distressed and upset when something reminded you of the past?”. The seven questions for externalizing problems asked, “When was the last time that you did any of the following things two or more times...” 1) “lied or conned to get things you wanted or to avoid having to do something?”, 2) “had a hard time paying attention at school, work, or home?”, 3) “had a hard time listening to instructions at school, work, or home?”, 4) “were a bully or threatened other people?”, 5) “started physical fights with other people?”, 6) “felt restless or the need to run around or climb on things?”, 7) “gave answers before the other person finished asking the question?”.

I dichotomized (yes/no) each symptom based on past month (hereafter, past 30-day) occurrence and created summary scales for internalizing problems (0-4) and externalizing problems (0-7). These summary scales were categorized into low (0 symptoms), moderate (1-2 symptoms), and high (3 or more symptoms) separately for internalizing and externalizing problems, informed by previous validation studies.^{322,323} Low severity implies respondents are unlikely to require mental health services; moderate severity implies respondents might present clinically relevant levels of internalizing/externalizing problems and should seek brief

intervention; high severity implies a high probability of clinically relevant levels of internalizing/externalizing problems and should seek intervention.^{322,323}

Tobacco and Cannabis Use

I used the following indicators of tobacco products: cigarettes, ENDS, and cigars/cigarillos/little filtered cigars. For cannabis use, I included indicators of blunts (i.e., cannabis in cigars/cigarillos/little filtered cigars), cannabis vaping (i.e., cannabis in EVPs with or without nicotine), and other cannabis, such as use not in tobacco products (e.g., smoking joints, ingesting edibles). All six indicators were measured in the past 30 days (yes/no).

Covariates

I included age, sex, race/ethnicity, sexual orientation identity, highest educational attainment, and annual household income. I categorized sex as male or female and classified race/ethnicity as Hispanic, NH White, NH Black, and another race/ethnicity, with the latter group including NH American Indian/Alaska Native, NH Asian, and NH Multiracial respondents. I dichotomized sexual orientation identity as heterosexual, and LGB+; LGB+ respondents identified as lesbian, gay, bisexual, or “something else.” I categorized highest (parental for youth) educational attainment as high school graduate or less, some college, and college graduate or more, and annual household income as <\$50,000 or ≥\$50,000. For YAs, I collapsed educational attainment categories for some college and college graduate or more in regression models.

5.2.4 Statistical Analysis

I calculated the weighted prevalence of six binary tobacco and cannabis use indicators for each sample. Then, I conducted LCA to identify latent classes based on patterns of tobacco and cannabis use among youth (n=1295) and YAs (n=4883) who used at least one product,

separately, using Mplus version 8.7 (Muthén & Muthén, LA, California).^{294,324} I compared model fit using AIC, BIC, SABIC, and CAIC and calculated the VLMR LRT, BF, and cmP statistics to determine the best class solution for both samples (see Chapter 4).²⁹⁴

I exported data on class membership from Mplus and merged with Wave 4 PATH Study data in Stata SE version 16.1 (StataCorp, College Station, Texas). I assigned latent class membership to full youth and YA samples based on the maximum posterior probability of class membership; youth and YA not included in the LCA were identified as youth and YA who never/formerly used tobacco and cannabis. I fit four multinomial logistic regression models, two to estimate associations between internalizing problems (i.e., low (referent), moderate, high) and latent classes of tobacco and cannabis use, adjusted for mean-centered age, sex, race/ethnicity, sexual orientation identity, highest educational attainment, and annual household income for youth and YAs separately, and two to estimate adjusted associations between externalizing problems and latent classes of use for youth and YA samples. To investigate whether both internalizing and externalizing differed by race/ethnicity, I fit additional adjusted models with two-way interaction terms between each exposure and race/ethnicity. I performed Wald tests at an alpha level of 0.05 to determine whether the interactions were statistically significant. To explore effect modification, I stratified adjusted models by race/ethnicity. In these models, the exposure was dichotomized (i.e., low/medium (referent), high) to assist with model convergence (due to lower samples sizes in stratified models) and interpretation. I computed all analysis using survey weights and calculated variance using the Balanced Repeated Replication method with Fay's adjustment set to 0.3²⁹⁵ to account for the complex sample design of the PATH Study.

I conducted a sensitivity analysis that included adjusting for internalizing problems in models with externalizing problems as the primary exposure, and vice versa. This approach

aimed to investigate whether type of mental health problem (e.g., internalizing), in the absence of another (e.g., externalizing) is important to consider when analyzing how they relate to tobacco and cannabis use.¹⁸⁷ I conducted another sensitivity analysis that disentangled NH Asian respondents from the “another race/ethnicity” category to estimate whether associations varied within these groups, as possible given sample size limitations.

5.3 Results

5.3.1 Participant Characteristics

The average age was 16.0 (SD: 0.8) for youth and 21.0 (SD: 3.3) for YAs (see Table 5.1). Sex was nearly even among both samples. NH White race/ethnicity composed the majority among youth (54.3%) and YAs (54.3%), followed by Hispanic (22.5% for youth, 21.7% for YAs). About 1 in 8 youth (11.7%) and YAs (12.5%) were LGB+. For youth, highest parental educational attainment was nearly split among high school or less (33.9%), some college (31.3%), and college graduate (34.8%). Among YAs, most had some college or more education (57.6%). About 40% of youth had annual household incomes of less than \$50,000 while most YAs (64.1%) did. Internalizing (23.3%) and externalizing (25.4%) problems were more prevalent among youth than YAs (18.6% for internalizing, 16.6% for externalizing). However, YAs generally had higher prevalence of tobacco and cannabis use, with 22.1% using cigarettes in the past 30 days, 13.7% using ENDS, 12.3% using cigars, 7.5% using blunts, 5.5% vaping cannabis, and 13.5% using other cannabis, compared to 5.5%, 7.3%, 2.1%, 3.2%, 2.7%, and 7.1%, respectively, among youth.

5.3.2 Latent Classes of Tobacco and Cannabis Use

For both youth and YA analyses, I decided on 6-class models as described in more detail in Chapter 4. I present the prevalence of latent classes for youth and YAs in Table 5.2. Exclusive

cigarettes (2.4%), exclusive ENDS (2.6%), exclusive blunts (2.4%), exclusive other cannabis (6.3%), ENDS + cannabis vaping (2.7%) (i.e., youth dual use), and cigarettes + cigars + other cannabis (1.4%) (i.e., youth poly use) made up youth latent use classes. Exclusive cigarettes (11.6%), exclusive ENDS (3.9%), exclusive blunts (5.4%), exclusive other cannabis (7.0%), cigarettes + cigars (8.1%) (i.e., YA dual use), and cigarettes + ENDS + cannabis vaping (4.8%) (i.e., YA poly use) made up YA latent use classes.

5.3.3 Mental Health Problems and Latent Classes of Tobacco and Cannabis Use

I present unadjusted associations between internalizing/externalizing problems and tobacco and cannabis use classes in Table 5.3. Table 5.4 shows adjusted associations between internalizing and externalizing problems and tobacco and cannabis use classes for youth and YAs. Compared to youth with low internalizing problems, youth with moderate internalizing problems had higher odds of using exclusive blunts (OR: 1.63, 95% CI: 1.04-2.56) and exclusive other cannabis (OR: 1.49, 95% CI: 1.08-2.06), and youth with high internalizing problems had higher odds (OR range: 1.80-2.38) of all use classes except cigarettes + cigars + other cannabis. Similar associations were observed for externalizing problems with moderate problems being associated with using exclusive blunts and exclusive other cannabis, and high externalizing problems associated with using exclusive ENDS, exclusive blunts, exclusive other cannabis, and ENDS + cannabis vaping, with the strongest association for exclusive blunts (OR: 3.73, 95% CI: 2.30-6.07).

Compared to YAs with low internalizing problems, YAs with moderate internalizing problems had higher odds of using exclusive blunts and cigarettes + ENDS + cannabis vaping, but not other use classes. However, YAs with high internalizing problems had higher odds of all use classes compared to YAs with low internalizing problems, with associations strongest for

using exclusive blunts (OR: 2.24, 95% CI: 1.74-2.89) and cigarettes + ENDS + cannabis vaping (OR: 2.77, 95% CI: 2.14-3.60). YAs with moderate externalizing problems had higher odds of using exclusive ENDS, exclusive other cannabis, and cigarettes + ENDS + cannabis vaping. YAs with high externalizing problems had higher odds of using each use class except exclusive ENDS, with the strongest association for cigarettes + ENDS + cannabis vaping (OR: 2.98, 95% CI: 2.29-3.87).

5.3.4 Effect Modification by Race/Ethnicity

When examining effect modification for internalizing problems and use classes by race/ethnicity among youth, only the two-way interaction term between internalizing problems and race/ethnicity was statistically significant (F: 53.96, $p < 0.001$) for exclusive ENDS use (see Table D.1). Similar results were found for externalizing problems among youth. When examining the two-way interaction between internalizing/externalizing problems and race/ethnicity for each use class among YAs, none of the terms was statistically significant, indicating no statistical evidence for differences in the associations by race/ethnicity. However, I stratified each model by race/ethnicity to ascertain racial/ethnic-specific associations despite statistically non-significant interactions.

Internalizing Problems Among Youth

In stratified models, among Hispanic youth, high internalizing problems were associated with using exclusive blunts (OR: 3.21, 95% CI: 1.75-5.87), exclusive other cannabis (OR: 2.04, 95% CI: 1.35-3.08), and ENDS + cannabis vaping (OR: 2.50, 95% CI: 1.09-5.74), compared to low/moderate internalizing problems (see Table 5.5). NH White youth with higher internalizing problems had higher odds of using exclusive cigarettes, exclusive ENDS, exclusive other cannabis, and ENDS + cannabis vaping compared to low/moderate internalizing problems, with

associations stronger in magnitude for exclusive cigarettes (OR: 2.75, 95% CI: 1.82-4.16) than other use classes. Among NH Black youth and youth from another race/ethnicity, high internalizing problems were associated with at least 2.5 times increased odds of using exclusive other cannabis.

Externalizing Problems Among Youth

Hispanic youth with high externalizing problems had higher odds of using exclusive blunts (OR: 3.46, 95% CI: 1.90-6.32), exclusive other cannabis (OR: 2.24, 95% CI: 1.53-3.29), and ENDS + cannabis vaping (OR: 3.36, 95% CI: 1.44-7.84) compared to low/moderate externalizing problems. I also found that high externalizing problems were associated with exclusive blunts, exclusive other cannabis, and ENDS + cannabis vaping among NH White youth, in addition to using exclusive ENDS (OR: 1.64, 95% CI: 1.10-2.45). Youth from another race/ethnicity with high externalizing problems had higher odds of using exclusive blunts (OR: 3.56, 95% CI: 1.01-12.61) and cigarettes + cigars + other cannabis (OR: 5.18, 95% CI: 1.01-26.52) compared to low/moderate externalizing problems.

Internalizing Problems Among YAs

Hispanic YAs with high internalizing problems had higher odds of using exclusive cigarettes (OR: 2.66, 95% CI: 1.79-3.96) as well as exclusive blunts, exclusive other cannabis, and cigarettes + ENDS + cannabis vaping compared to low/moderate internalizing problems (see Table 5.6). NH White YAs with high internalizing problems had higher odds of using all use classes compared to low/moderate internalizing problems, with associations being stronger in magnitude for cigarettes + ENDS + cannabis vaping (OR: 2.79, 95% CI: 2.07-3.77). In addition, YAs from another race/ethnicity with high internalizing problems had higher odds of using

exclusive cigarettes, exclusive blunts, exclusive other cannabis, and cigarettes + cigars (OR: 2.38, 95% CI: 1.11-5.09) compared to low/moderate internalizing problems.

Externalizing Problems Among YAs

Among Hispanic YAs, high externalizing problems were associated with higher odds of using exclusive cigarettes, exclusive other cannabis, and cigarettes + ENDS + cannabis vaping compared to low/moderate externalizing problems. NH White YAs with high externalizing problems had higher odds of using exclusive blunts, cigarettes + cigars, and cigarettes + ENDS + cannabis vaping compared to low/moderate externalizing problems. For both racial/ethnic groups, associations were stronger in magnitude for cigarettes + ENDS + cannabis vaping (Hispanic, OR: 2.65, 95% CI: 1.60-4.37; NH White, OR: 2.53, 95% CI: 1.73, 3.67). Among NH Black YAs, high externalizing problems were associated with using exclusive ENDS, exclusive blunts, exclusive other cannabis, and cigarettes + ENDS + cannabis vaping, with associations strongest in magnitude for exclusive ENDS (OR: 3.28, 95% CI: 1.08-9.99) and cigarettes + ENDS + cannabis vaping (OR: 2.66, 95% CI: 1.22-5.80).

5.3.5 Sensitivity Analyses

The sensitivity analysis that aimed to adjust for internalizing problems in models with externalizing problems for youth and YAs resulted in the attenuation of several regression coefficients (see Tables D.2-D.3). For youth, ORs for cigarettes only and other cannabis only remained statistically significant for associations with high internalizing problems; most effect estimates for externalizing problems remained statistically significant. For YAs, most associations between internalizing problems and use classes remained statistically significant. However, for externalizing problems, several associations were attenuated toward the null. These

associations include the relationships between high externalizing problems and cigarette use and cigarette + cigar use.

The second analysis explored racial/ethnic disparities in associations further by disentangling NH Asian respondents from the “another race/ethnicity” group (see Tables D.4-D.7). I did not have sufficient sample sizes to detect associations for the NH Asian group for youth and YAs. In addition, associations for YAs from another race/ethnicity, no longer including NH Asian YAs, were not statistically significant likely due to power limitations.

5.4 Discussion

The aim of this study was to identify whether mental health problems were associated with specific tobacco and cannabis use patterns, including how these associations varied by race/ethnicity, using large nationally representative data on emerging adults in the US. I found that moderate and high internalizing and externalizing problems were associated with tobacco and cannabis use classes in youth and YA samples. Stratified analyses suggested that the associations varied by race/ethnicity. In general, among youth and YAs, high internalizing and externalizing problems were associated with exclusive use classes. These problems were associated with dual/poly use classes among Hispanic and NH White youth and all racial/ethnic YA groups.

Prior research that has evaluated relationships between mental health problems and tobacco or cannabis use have reported findings parallel to this study.^{184-187,189,313,314,325-327} For co-use outcomes, a previous study found major depressive disorder to be associated with current co-use of ENDS and cannabis.³¹⁴ Another study found mental health problems, both internalizing and externalizing, to be more prevalent among adults who co-use tobacco and cannabis.³¹³ I produced several classes of tobacco and cannabis co-use using LCA. For youth, internalizing and

externalizing problems were not associated with poly co-use (i.e., cigarettes + cigars + other cannabis), but high internalizing and externalizing problems were associated with dual co-use (i.e., ENDS + cannabis vaping). Specific ROA might play a role in determining at risk groups as EVPs used to vape nicotine or cannabis are becoming increasingly popular among younger populations.²⁷⁰ Another important consideration is the associations between mental health problems and poly co-use (i.e., cigarettes + ENDS + cannabis vaping) among YAs, an association not observed for youth. Youth mental health problems were associated with ENDS + cannabis vaping and the period through which they age into adulthood is an important intervention point, if some respondents might go on to poly use cigarettes + ENDS + cannabis vaping as observed among YAs.

In this study, internalizing and externalizing problems were associated with most tobacco and cannabis use classes for youth and YAs. Potential mechanisms have been proposed for both types of problems, such as that youth and YAs with internalizing problems might have underlying issues with emotional self-regulation and coping, including urges to withdraw and self-medicate.^{328,329} For externalizing problems, issues with behavioral dysregulation, such as impulsivity and attentional deficits, may lead youth and YAs to use substances, or affiliate with peers who use or encourage the use of substances.^{330,331} Possible explanations behind why, for example, I did not observe statistically significant relationships between externalizing problems and tobacco and cannabis use among NH Black youth are needed. These differences have important implications for mental health treatment and tobacco and cannabis use prevention efforts in deciding which groups will benefit most from tailored interventions.

This study is unique in that it examines racial/ethnic disparities in associations between mental health problems and tobacco and cannabis use with consideration of use modalities,

which has not been done in previous research. I observed important variation in associations among youth and YA samples, with internalizing/externalizing problems being associated with ENDS + cannabis vaping among Hispanic and NH White youth. In addition, among YAs, internalizing problems was associated with cigarettes + ENDS + cannabis vaping among Hispanic and NH White YAs, and externalizing problems was associated with the same use class among Hispanic, NH White, and NH Black YAs. That said, limited research has aimed to understand how associations between mental health problems and substance use differ by race/ethnicity.^{320,321} Two longitudinal analyses on African American/Black and Latinx/Hispanic youth produced conflicting results. One study reported that elevated externalizing problems, but not internalizing problems, were associated with substance use in both samples,³²⁰ while another reported that internalizing problems predicted substance use among Hispanic youth only.³²¹ While not longitudinal in design, this study found distinct relationships between internalizing and externalizing problems and tobacco and cannabis use among Hispanic and NH Black youth and YAs. Particularly, associations were more robust across most use classes for Hispanic youth than NH Black youth, especially for cannabis use outcomes. For YAs, internalizing and externalizing problems were associated with tobacco and cannabis use and co-use among Hispanic YAs, but only externalizing problems were associated with use classes among NH Black YAs. These complexities highlight the continued need to assess possible drivers of racial/ethnic disparities in tobacco and cannabis use among young people in the US.

While I observed racial/ethnic differences in associations between mental health problems and tobacco and cannabis use, the consistent strengths of associations across many use classes might suggest that specific attention to type, or combination of, tobacco products and cannabis by ROA is less important than generalized use patterns. An important line of inquiry in

the substance use literature is how and why substances are used alone or together, and whether these patterns differ across various populations.^{312,332} Patterns of specific tobacco and cannabis use and co-use may present unique health consequences over time.^{312,332} However, mental health problems are generally associated with any substance use, and how these relationships vary by key groups, such as race/ethnicity, are driven by differences in place, access, and economic and psychosocial resources.⁷⁰ This is akin to the common liability theory, which focuses less on the order by which substances are used across a developmental trajectory and more on understanding underlying latent factors that make some people “liable” to using multiple substances.³³³ Specific ROA may be less relevant but rather a propensity to use any substance, or the combination of substances, can be exacerbated due to common characteristics. One such factor, mental health problems, functions as a liability and can help explain mechanisms driving racial/ethnic variation in use.

5.4.1 Limitations

This study comes with several limitations. First, given the cross-sectional nature of the analysis, I cannot infer temporal relationships. However, I used past 30-day indicators for both the exposure and outcome, demonstrating comorbidity between mental health problems and tobacco and cannabis use among youth and YAs. Second, the tobacco and cannabis use landscapes might have shifted since data were collected (2016-2018) due to market changes, FDA regulations, state-specific cannabis legalization, and ROA preferences.^{307,310,334} Third, I did not consider the possible comorbidity of psychopathology. Previous research has found the development of internalizing and externalizing comorbidity to be common,³³⁵ and such comorbidity might be differentially associated with tobacco and cannabis use.¹⁸⁴ However, in the sensitivity analysis that included internalizing and externalizing problems in one model, I found

that most results remained statistically significant as compared to models examining these mental health problems separately. Fourth, this analysis relied on self-reported data that are subject to recall and social desirability biases. Fifth, due to sample size concerns, I aggregated certain racial/ethnic groups into an “another race/ethnicity” category, potentially masking important race/ethnicity-specific associations. I conducted a sensitivity analysis attempting to disaggregate this group as much as possible, but sample size limitations might have also played a role in my inability to detect additional associations in race/ethnicity-stratified models.

5.5 Conclusion

I examined associations between mental health problems and latent classes of tobacco and cannabis use among a large sample of US emerging adults. My findings show that both internalizing and externalizing problems were linked to multiple tobacco and cannabis use classes during emerging adulthood, and that these associations varied by race/ethnicity. I detected more robust associations for Hispanic and NH White youth and YAs across most use classes compared to other racial/ethnic groups. My findings provide implications for public health prevention and treatment interventions that address the comorbidity of mental health problems and tobacco and cannabis use outcomes. For example, digital tobacco and cannabis or school-based interventions aimed to prevent and reduce use can emphasize the salience of mental health. As associations between mental health problems and tobacco and cannabis use vary by race/ethnicity, policies and interventions must also be developed and implemented through a health equity lens.

Figure 5.1 Flowchart Describing the Selection of Each Analytic Sample

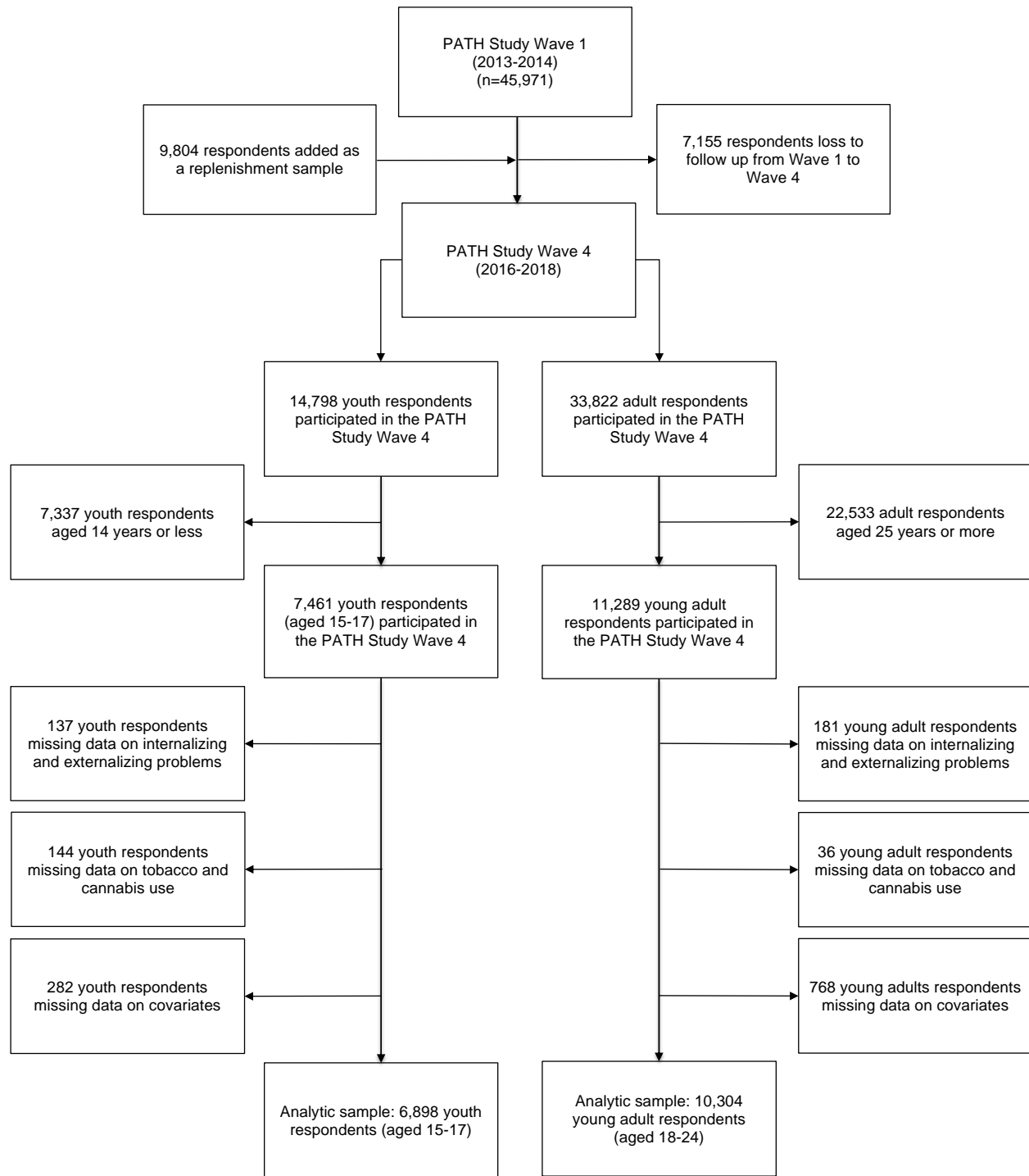


Table 5.1 Weighted Prevalence of Participant Characteristics Among Youth and Young Adult Samples

	Youth (n=6,898)	Young Adults (n=10,304)
Age (mean \pm SD)	16.0 \pm 0.8	21.0 \pm 3.3
Sex, n (%)		
Female	3330 (48.8)	5239 (50.0)
Male	3568 (51.2)	5065 (50.0)
Race/ethnicity, n (%)		
Hispanic	2073 (22.5)	2780 (21.7)
NH White	3234 (54.3)	4982 (54.3)
NH Black	954 (13.5)	1588 (13.8)
Another race/ethnicity	637 (9.7)	954 (10.1)
Sexual orientation status, n (%)		
Heterosexual	6099 (88.3)	8955 (87.5)
Lesbian, gay, bisexual, or something else	799 (11.7)	1349 (12.5)
Highest (parental) educational attainment, n (%) ^a		
High school or less	2607 (33.9)	5201 (42.3)
Some college	2194 (31.3)	4146 (45.6)
College graduate or more	2097 (34.8)	957 (12.0)
Annual household income, n (%)		
Less than \$50,000	3292 (43.2)	6837 (64.1)
\$50,000 or more	3606 (56.8)	3467 (35.9)
Past 30-day internalizing problems scale, n (%)		
Low (0)	3330 (47.9)	5976 (58.1)
Moderate (1-2)	1938 (28.8)	2359 (23.2)
High (3+)	1630 (23.3)	1969 (18.6)
Past 30-day externalizing problems scale, n (%)		
Low (0)	2911 (41.6)	5487 (52.5)
Moderate (1-2)	2223 (33.0)	3096 (30.9)
High (3+)	1764 (25.4)	1721 (16.6)
Past 30-day tobacco and cannabis use, n (%)		
Cigarettes (yes)	382 (5.5)	2448 (22.1)
ENDS (yes)	468 (7.3)	1522 (13.7)
Cigars (yes)	149 (2.1)	1431 (12.3)
Blunts (yes)	236 (3.2)	837 (7.5)
Vaping cannabis (yes)	177 (2.7)	594 (5.5)
Other cannabis (yes) ^b	506 (7.1)	1477 (13.5)

^a Estimates represent highest parental educational attainment for youth and highest educational attainment for young adults

^b Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

Table 5.2 Prevalence of Latent Classes of Tobacco and Cannabis Use for Youth and Young Adult Samples

Youth past 30-day use classes, n (%)	
Never/former	5670 (82.2)
Exclusive cigarettes	164 (2.4)
Exclusive ENDS	158 (2.6)
Exclusive blunts	182 (2.4)
Exclusive other cannabis ^a	440 (6.3)
ENDS + cannabis vaping	178 (2.7)
Cigarettes + cigars + other cannabis ^a	106 (1.4)
Young adult past 30-day use classes, n (%)	
Never/former	5794 (59.2)
Exclusive cigarettes	1258 (11.6)
Exclusive ENDS	434 (3.9)
Exclusive blunts	598 (5.4)
Exclusive other cannabis ^a	736 (7.0)
Cigarettes + cigars	958 (8.1)
Cigarettes + ENDS + cannabis vaping	526 (4.8)

^a Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

Table 5.3 Unadjusted Multinomial Logistic Regression Associations Between Internalizing and Externalizing Problems and Latent Classes of Tobacco and Cannabis Use Among Youth and Young Adult Samples

	Youth Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis ^b	ENDS + Cannabis Vaping	Cigarettes + Cigars + Other Cannabis ^b
	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c
Youth past 30-day internalizing problems scale (ref: low (0))						
Moderate (1-2)	0.70 (0.42-1.17)	1.31 (0.89-1.92)	1.52 (0.97-2.38)	1.45 (1.06-1.99)	0.90 (0.59-1.36)	1.06 (0.61-1.84)
High (3+)	2.08 (1.43-3.03)	1.68 (1.10-2.57)	2.36 (1.59-3.51)	2.25 (1.67-3.03)	1.91 (1.32-2.77)	1.39 (0.89-2.17)
Youth past 30-day externalizing problems scale (ref: low (0))						
Moderate (1-2)	0.62 (0.39-0.98)	1.52 (1.05-2.22)	1.91 (1.18-3.09)	1.76 (1.29-2.39)	1.62 (1.05-2.51)	0.89 (0.54-1.46)
High (3+)	1.35 (0.89-2.05)	1.82 (1.23-2.70)	3.65 (2.29-5.82)	2.44 (1.85-3.22)	2.72 (1.86-3.97)	1.19 (0.72-1.98)
	Young Adult Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis ^b	Cigarettes + Cigars	Cigarettes + ENDS + Cannabis Vaping
	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c
Young adult past 30-day internalizing problems scale (ref: low (0))						
Moderate (1-2)	1.17 (0.99-1.38)	1.04 (0.78-1.38)	1.45 (1.16-1.83)	1.07 (0.83-1.37)	0.93 (0.76-1.13)	1.44 (1.12-1.83)
High (3+)	1.97 (1.66-2.34)	1.68 (1.21-2.34)	2.27 (1.79-2.89)	1.94 (1.50-2.50)	1.40 (1.13-1.75)	2.66 (2.11-3.36)
Young adult past 30-day externalizing problems scale (ref: low (0))						
Moderate (1-2)	1.01 (0.85-1.19)	1.54 (1.18-2.01)	1.19 (0.93-1.52)	1.57 (1.29-1.90)	0.98 (0.82-1.16)	1.47 (1.15-1.87)
High (3+)	1.41 (1.16-1.70)	1.47 (1.05-2.07)	2.10 (1.62-2.71)	1.98 (1.49-2.64)	1.35 (1.09-1.67)	3.30 (2.56-4.25)

Bolded text indicates statistical significance (p<0.05)

^aThe outcome referent group: never/former use of both tobacco and cannabis

^b Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

^c Unadjusted odds ratios (OR) and 95% confidence intervals

Table 5.4 Adjusted Multinomial Logistic Regression Associations Between Internalizing and Externalizing Problems and Latent Classes of Tobacco and Cannabis Use Among Youth and Young Adult Samples

	Youth Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis ^b	ENDS + Cannabis Vaping	Cigarettes + Cigars + Other Cannabis ^b
	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c
Youth past 30-day internalizing problems scale (ref: low (0))						
Moderate (1-2)	0.70 (0.42-1.18)	1.31 (0.89-1.94)	1.63 (1.04-2.56)	1.49 (1.08-2.06)	0.90 (0.58-1.40)	1.19 (0.68-2.08)
High (3+)	1.85 (1.23-2.79)	1.80 (1.17-2.77)	2.38 (1.58-3.59)	2.20 (1.60-3.02)	1.85 (1.21-2.82)	1.53 (0.89-2.62)
Youth past 30-day externalizing problems scale (ref: low (0))						
Moderate (1-2)	0.58 (0.37-0.91)	1.48 (1.01-2.17)	1.95 (1.20-3.17)	1.76 (1.29-2.40)	1.55 (0.99-2.40)	0.94 (0.57-1.57)
High (3+)	1.22 (0.79-1.86)	1.81 (1.20-2.74)	3.73 (2.30-6.07)	2.45 (1.85-3.25)	2.60 (1.76-3.83)	1.31 (0.75-2.29)
	Young Adult Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis ^b	Cigarettes + Cigars	Cigarettes + ENDS + Cannabis Vaping
	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c
Young adult past 30-day internalizing problems scale (ref: low (0))						
Moderate (1-2)	1.18 (0.98-1.43)	1.06 (0.79-1.42)	1.50 (1.19-1.89)	1.03 (0.80-1.33)	0.99 (0.81-1.21)	1.47 (1.14-1.89)
High (3+)	1.83 (1.51-2.20)	1.76 (1.31-2.38)	2.24 (1.74-2.89)	1.83 (1.43-2.33)	1.54 (1.22-1.95)	2.77 (2.14-3.60)
Young adult past 30-day externalizing problems scale (ref: low (0))						
Moderate (1-2)	1.05 (0.88-1.26)	1.49 (1.15-1.92)	1.28 (1.00-1.64)	1.52 (1.25-1.85)	1.04 (0.87-1.24)	1.40 (1.11-1.77)
High (3+)	1.40 (1.13-1.73)	1.37 (0.96-1.94)	2.11 (1.62-2.74)	1.84 (1.38-2.45)	1.36 (1.09-1.70)	2.98 (2.29-3.87)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: never/former use of both tobacco and cannabis

^b Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

^c Odds ratios (OR) and 95% confidence intervals adjusted for mean-centered age, sex, race/ethnicity, sexual orientation status, highest educational attainment (parental for youth), and annual household income

Table 5.5 Adjusted Multinomial Logistic Regression Associations Between Internalizing and Externalizing Problems and Latent Classes of Tobacco and Cannabis Use Among Youth Stratified by Race/Ethnicity

	Youth Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis ^b	ENDS + Cannabis Vaping	Cigarettes + Cigars + Other Cannabis ^b
Past 30-day internalizing and externalizing problems by race/ethnicity	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c
Internalizing problems						
Hispanic youth						
High (3+)	0.83 (0.29-2.34)	1.44 (0.51-4.02)	3.21 (1.75-5.87)	2.04 (1.35-3.08)	2.50 (1.09-5.74)	1.20 (0.48-3.01)
NH White youth						
High (3+)	2.75 (1.82-4.16)	1.68 (1.08-2.60)	1.49 (0.85-2.63)	1.60 (1.12-2.28)	1.90 (1.18-3.06)	1.78 (0.90-3.54)
NH Black youth						
High (3+)	2.96 (0.73-12.01)	-- ^d	1.18 (0.47-3.01)	2.50 (1.19-5.25)	1.33 (0.09-19.31)	0.93 (0.36-2.41)
Youth from another race/ethnicity						
High (3+)	0.75 (0.15-3.84)	1.07 (0.20-5.65)	2.58 (0.92-7.27)	2.63 (1.01-6.87)	1.30 (0.43-3.90)	1.83 (0.19-17.37)
Externalizing problems						
Hispanic youth						
High (3+)	1.49 (0.64-3.46)	0.62 (0.12-3.19)	3.46 (1.90-6.32)	2.24 (1.53-3.29)	3.36 (1.44-7.84)	1.35 (0.47-3.85)
NH White youth						
High (3+)	1.60 (0.95-2.70)	1.64 (1.10-2.45)	2.77 (1.66-4.60)	1.65 (1.18-2.30)	1.77 (1.14-2.75)	1.40 (0.67-2.90)
NH Black youth						
High (3+)	2.40 (0.51-11.38)	-- ^d	1.29 (0.52-3.21)	1.78 (0.87-3.66)	13.15 (0.95-181.38)	0.73 (0.25-2.14)
Youth from another race/ethnicity						
High (3+)	0.52 (0.07-3.88)	1.70 (0.43-6.70)	3.56 (1.01-12.61)	2.32 (0.88-6.09)	1.84 (0.49-6.87)	5.18 (1.01-26.52)

Bolded text indicates statistical significance (p<0.05)

^a The exposure referent group: low (0) or moderate (1-2) problems; outcome referent group: never/former use of both tobacco and cannabis

^b Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

^c Odds ratios (OR) and 95% confidence intervals adjusted for mean-centered age, sex, sexual orientation status, highest parental educational attainment, and annual household income

^d Dashes indicate a lack of model convergence

Table 5.6 Adjusted Multinomial Logistic Regression Associations Between Internalizing and Externalizing Problems and Latent Classes of Tobacco and Cannabis Use Among Young Adults Stratified by Race/Ethnicity

	Young Adult Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis ^b	Cigarettes + Cigars	Cigarettes + ENDS + Cannabis Vaping
Past 30-day internalizing and externalizing problems by race/ethnicity	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c	OR (95% CI) ^c
Internalizing problems						
Hispanic young adults						
High (3+)	2.66 (1.79-3.96)	1.59 (0.90-2.84)	2.12 (1.40-3.22)	1.83 (1.23-2.71)	1.36 (0.86-2.13)	1.79 (1.06-3.01)
NH White young adults						
High (3+)	1.53 (1.19-1.97)	1.75 (1.14-2.70)	1.92 (1.33-2.78)	1.84 (1.34-2.51)	1.82 (1.32-2.50)	2.79 (2.07-3.77)
NH Black young adults						
High (3+)	1.13 (0.61-2.11)	2.16 (0.73-6.37)	1.61 (0.97-2.65)	1.40 (0.77-2.54)	0.97 (0.60-1.57)	2.09 (0.98-4.47)
Young adults from another race/ethnicity						
High (3+)	2.13 (1.17-3.91)	1.48 (0.27-8.18)	2.50 (1.03-6.05)	2.02 (1.03-3.99)	2.56 (1.21-5.40)	2.15 (0.79-5.86)
Externalizing problems						
Hispanic young adults						
High (3+)	1.74 (1.19-2.55)	1.08 (0.55-2.13)	2.08 (1.29-3.35)	1.30 (0.84-2.01)	1.31 (0.82-2.10)	2.65 (1.60-4.37)
NH White young adults						
High (3+)	1.23 (0.93-1.64)	1.01 (0.63-1.63)	1.82 (1.26-2.63)	1.40 (0.98-2.00)	1.43 (1.06-1.93)	2.53 (1.75-3.67)
NH Black young adults						
High (3+)	1.47 (0.84-2.58)	3.28 (1.08-9.99)	2.01 (1.24-3.25)	2.18 (1.12-4.25)	1.02 (0.56-1.85)	2.66 (1.22-5.80)
Young adults from another race/ethnicity						
High (3+)	1.65 (0.83-3.26)	0.72 (0.22-2.40)	1.98 (0.63-6.23)	1.85 (0.73-4.66)	1.88 (0.83-4.26)	2.20 (0.93-5.20)

Bolded text indicates statistical significance (p<0.05)

^a The exposure referent group: low (0) or moderate (1-2) problems; outcome referent group: never/former use of both tobacco and cannabis

^b Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

^c Odds ratios (OR) and 95% confidence intervals adjusted for mean-centered age, sex, sexual orientation status, highest educational attainment, and annual household income

Chapter 6 Negative Affect About Social Problems and Tobacco and Cannabis Use Outcomes Among Young Adults in Los Angeles, California

6.1 Introduction

Emerging adulthood is a critical developmental period during which some YAs (aged 18-24) may experiment with and use tobacco and cannabis.^{268,336} YAs initiate and use these substances as a result of factors such as experiencing major life changes throughout the developmental period.^{268,278,301} Several additional factors help explain the elevated prevalence of tobacco and cannabis use and co-use among YAs.^{46,47,247,274,278,301} For example, YAs might have common liabilities, or genetic and socio-environmental risk factors, to using multiple substances.^{218,219} Another example is the increasing number of options for ROA (e.g., vaping products) that allow people to consume nicotine and cannabis might promote use and co-use.^{42,46,277} Finally, co-use of nicotine and cannabis may be promoted due to the enhancement of neurobiological effects of nicotine with cannabis consumption, such as increases in mood or pleasure, or the compensatory effects of nicotine on memory impairments due to cannabis.^{248,277,337}

Investigating the ways in which tobacco and cannabis use intersect is pertinent to understanding associated substance use disparities. Recent studies have estimated that about 21% of YAs currently co-use tobacco and cannabis,²⁷⁴ and that co-vaping of nicotine and cannabis starts in early adulthood.²⁷⁵ In addition, tobacco and cannabis use vary across racial/ethnic groups.¹⁵ For example, in nationally representative studies, nicotine vaping was more prevalent among NH White adults than other adults, while cannabis vaping was more prevalent among

Hispanic and NH Black adults.^{51,246} Racial/ethnic disparities in co-use have also been documented, with one study reporting that co-use was higher in NH White than Hispanic and Asian respondents.²⁷⁸ Disparities in tobacco and cannabis use may lead to inequities in health outcomes at the population level and must be explored further, including investigation into factors that are driving these differences such as stressors that differentially affect racial/ethnic groups.

The social determinants of health framework³³⁸ may be useful to explain drivers of racial/ethnic disparities in substance use. Some social determinants salient to YAs and disproportionately common for racial/ethnic minoritized populations in the US are exposure to racial/ethnic discrimination,^{81,86,205,339} shootings or violence,^{124,340-342} and police brutality.^{136,141,343,344} Experiencing racial/ethnic discrimination is associated with negative physical and mental health effects,^{86,205} including use of tobacco and cannabis.^{181,191,208,251,345} Exposure to shootings or violence is a documented risk factor for mental health problems,^{192,346} which can lead to substance use and misuse.³⁴⁷ Further, police brutality, defined as unwarranted or illegal violence against civilians by law enforcement,¹⁴¹ is entrenched in racial/ethnic minoritized communities, due in part to increased policing related to the perception that illicit substance use is more prevalent in these communities.³⁴⁸ Distress related to police encounters is associated with mental health problems as well as substance use.^{136,141,343}

Discrimination, shootings or violence, and police brutality share three important characteristics that warrant public health investigation. First, exposure to each of these situations likely causes stress among people who experience them. Stress responses may impact YA populations, especially racial/ethnic minoritized populations, differentially depending on the context of the exposures.^{69,349} Research has shown that stress responses elicit adverse coping

mechanisms for short-term alleviation (e.g., self-medication),^{69,349} and a common coping strategy is substance use and misuse.⁶⁵ Second, each of these exposures likely occurs over the life course, potentially beginning prior to adulthood, whether directly (e.g., being called a racial slur) or indirectly/vicariously (e.g., hearing about a family member being called a racial slur).^{124,339,344} Third, YAs may uniquely process direct or vicarious discrimination, shootings/violence, and police brutality in ways that encourage adverse coping behaviors.^{268,336} For example, a study found that anticipating prejudice, irrespective of experiencing it, was associated with a stress response.¹⁷⁴

Vicarious exposure to social problems such as discrimination, shootings or violence, and police brutality may lead to stress due to the fear of future victimization, concern for the well-being of others who are directly impacted, and an increased awareness of inequities in the US if the problems are racialized.^{123,137,350,351} Through a stress-coping framework, vicarious exposure to social problems, whether racialized or not,¹⁴² may contribute to racial/ethnic disparities in tobacco and cannabis use among YAs. In this study, I used EFA to describe the underlying structure of nine measures of concern, worry, and stress about social problems (i.e., societal discrimination, societal shootings or violence, and community police brutality) among a racially/ethnically diverse sample of YAs living in LA, California. I also examined the association between the factor scores generated by the EFA and tobacco and cannabis use, including whether these relationships varied by race/ethnicity.

6.2 Methods

6.2.1 Data

This study used data from the University of Southern California (USC) Happiness & Health (H&H) Study, an on-going longitudinal cohort study that enrolled 9th grade youth from ten high schools in LA County in 2013. Approximately 40 schools were asked to participate

based on their diverse demographic characteristics and proximity to USC.³⁵² Ten schools agreed to participate, and students were asked to assent and provide parental consent to participate. Surveys were administered at six-month follow-ups in classrooms during the normal school day. If students were absent, surveys were abbreviated and administered by telephone, Internet, or postal mail. Starting in 2019, after respondents had completed high school, surveys were administered exclusively online through REDCap. More information about the study and sampling design are published in detail elsewhere.¹⁹¹ The USC Institutional Review Board approved the study.

6.2.2 Participants

I used data from Waves 10 (spring/summer 2020 (May 2020 to October 2020)) and 11 (winter/spring 2021 (January 2021 to June 2021)). The timing of these waves coincided with the national discourse and outcry about police brutality and other social problems; these two waves were also the two most recent waves with consecutive data on the exposures of interest. At Wave 10 (hereafter referred to as “baseline”), 2,429 respondents completed the survey. Among these respondents, 2,294 (94.4%) had complete data on social problems. Of these respondents, 268 were missing data at follow-up (Wave 11) due to attrition (312 total from Waves 10 to 11) and 1,975 (81.3%) had complete outcome and covariate data and were included in the analytic sample. I display a flowchart describing the process to arrive at the final analytic sample in Figure 6.1.

6.2.3 Measures

Social Problems

At baseline, respondents indicated whether they were “concerned,” “worried,” or “stressed” (three individual questions) about three social problems: 1) “increasing hostility and

discrimination of people because of their race, ethnicity, sexual orientation/identity, immigrant status, religion, or disability status in society” (i.e., societal discrimination); 2) “shootings or violence in society” (i.e., societal shootings/violence); and 3) “police brutality or the unfair treatment of members in your community by law enforcement” (i.e., community police brutality). Response options for each of the nine items (three each for concern, worry, and stress) included 0) “not at all,” 1) “slightly,” 2) “somewhat,” 3) “very,” and 4) “extremely.”

Tobacco and Cannabis Use

I included the following past 30-day tobacco use variables at follow-up: 1) cigarette, 2) e-cigarettes with nicotine, 3) big cigars, 4) cigarillos/little cigars, 5) hookah/waterpipe, and 6) e-hookah. I also included the following past 30-day cannabis use variables assumed to be related to tobacco consumption: 1) smoking cannabis, 2) blunts, 3) cannabis in EVPs, 4) dabbing cannabis/vaping cannabis concentrates, 5) ingesting cannabis. I combined big cigars and cigarillos/little cigars, and hookah/waterpipe into OC tobacco product use, e-cigarettes with nicotine and e-hookah into ENDS use, and dabbing cannabis/vaping cannabis concentrates and ingesting cannabis into “other cannabis” use.

I created a primary 4-category outcome variable defined as tobacco and cannabis use and co-use. This variable had the following use categories: 0) never/former (i.e., not past 30-day), 1) exclusive tobacco, 2) exclusive cannabis, and 3) dual tobacco and cannabis (i.e., co-use).

Covariates

The following sociodemographic characteristics at follow-up were included in this analysis: age (20-21, 22-23), sex (male, female), race/ethnicity (Hispanic, NH White, NH Black, NH Asian, NH Multi, another race/ethnicity), sexual orientation identity (heterosexual, LGBTQ+), highest educational attainment (high school graduate or less, some college or more),

and personal financial status (do not meet basic expenses, just meet basic expenses, meet needs with a little left, live comfortably). Another race/ethnicity included YAs who identified as NH AI/AN, NH NH/OPI, and respondents who identified as another race/ethnicity in open-ended responses or their race/ethnicity was unknown or unreported.

6.2.4 Statistical Analysis

Factor Analysis

I used EFA to determine whether nine original indicators of social problems at baseline (i.e., concern, worry, and stress about societal discrimination, societal shootings/violence, and community police brutality) represented latent factors or whether the original items were more appropriate to use for analysis.^{353,354} Since the response pattern of these indicators were ordinal (i.e., from “not at all (0)” to “extremely (4)”), I employed polychoric correlations to the factor model as Pearson’s correlations have been found to be less suitable.³⁵⁵ I present the distribution and means of each societal stressor at baseline in Table 6.1 and a correlation matrix of the nine indicators in Table 6.2.

I explored several criteria to determine the number of extracted factors such as Kaiser’s criteria, the cumulative percentage of variance explained by each factor, communalities, a scree plot (Figure 6.2), and factor loadings after rotating the component matrix.³⁵⁴ I used oblique factor rotation (i.e., promax), which allows the latent factors in the model to be correlated and to generate a more interpretable approximation of the underlying factor structure.³⁵⁴ The cutoff value that I used for rotated factor loadings was 0.3, representing moderate correlation between each item and factor.^{354,356} I used Cronbach’s alpha to examine the internal consistency of the items that made up each factor. Factors were extracted using principal axis factoring. All statistical analyses were performed using Stata SE version 16.1 (StataCorp, College Station, Texas).

Main Analysis

I examined the prevalence of sociodemographic and tobacco and cannabis use characteristics at follow-up. Using multinomial logistic regression, I estimated four unadjusted models examining the associations between each factor score at baseline and tobacco and cannabis use (referent: never/former use) at follow-up. I ran four additional models to adjust each association for potential confounders (i.e., age, sex, race/ethnicity, sexual orientation identity, highest educational attainment, and personal financial status). To supplement this analysis, I estimated associations between each factor at baseline and individual binary (yes/no) past 30-day tobacco (three variables) and cannabis (four variables) use outcomes at follow-up using adjusted logistic regression. To examine differences in these associations by race/ethnicity, I fit each adjusted model with two-way interaction terms between each factor and race/ethnicity (Table E.1). Wald tests at alpha levels of 0.05 were calculated to determine whether interaction terms were statistically significant.

Sensitivity Analysis

I explored two sensitivity analyses. First, I created indices to mirror each factor score as well as a summary scale to be consistent with prior research.^{141,191,192} For example, to mirror factor 1, I summed concerned, worried, and stressed about police brutality and divided that variable by three to create an index representing distress about police brutality (0-4).¹⁴¹ I examined associations between each index at baseline and tobacco and cannabis use at follow-up. In addition, since factor loadings pre-rotation heavily loaded onto one factor for all nine indicators, I created a summary scale by summing each indicator and dividing it by nine. I estimated the relationship between the summary scale at baseline and tobacco and cannabis use at follow-up. Second, I evaluated the potential impact of missing data by comparing study

sample distributions of sociodemographic characteristics across respondents who were lost-to-follow-up between Waves 10 and 11 (n=312) and the analytic sample (n=1,975).

6.3 Results

6.3.1 Participant Characteristics at Follow-Up

Within the analytic sample, most participants were aged 20-21 (66.0%) and female (61.1%) (see Table 6.3). Nearly half of participants identified as Hispanic (46.5%), followed by NH Asian (18.1%), NH White (16.0%), another race/ethnicity (7.8%), NH multiracial (7.5%), and NH Black (4.1%). About 1 in 4 YAs identified as LGBTQ+ (24.2%), and a similar proportion had a high school diploma or less education (23.3%). About 5% of YAs do not meet basic expenses, with 24.2% just meeting them, 30.7% meeting needs with a little left, and 40.0% living comfortably. Over half the sample never/formerly used tobacco and cannabis (57.1%), while 6.6% exclusively used tobacco, 22.4% exclusively used cannabis, and 13.9% used dual tobacco and cannabis. The prevalence of sample characteristics stratified by tobacco and cannabis use is presented in Table E.2. In addition, the prevalence of each individual tobacco and cannabis use variable is displayed in Table E.3.

6.3.2 Factor Analysis

I included the nine items representing concern, worry, and stress about societal discrimination, societal shootings/violence, and community police brutality in the EFA. A five-factor model was initially identified following examination of the eigenvalues (Table E.4). The value of the Kaiser-Meyer-Olkin (KMO) measure of sampling accuracy was 0.856 and the p-value for Bartlett's Test of Sphericity was <0.001.

The eigenvalue for factors 1, 2, 3, 4, and 5 were 7.131, 0.737, 0.424, 0.273, and 0.035, respectively, explaining all the variance. Table 6.4 shows the EFA results after rotation. Because

I did not consider factor loadings lower than 0.30, or the standard cutoff for EFAs,^{354,356} I omitted factor 5 from further analysis. The first factor (F1) represented distress (i.e., concern, worry, and stress) about community police brutality (items 7-9), with high factor loadings on concern (0.866), worry (0.852), and stress (0.754) about community police brutality. The second factor (F2) represented distress about societal shootings/violence (items 4-6), with high factor loadings on concern (0.806), worry (0.789), and stress (0.619) about societal shootings/violence. The third factor (F3) represented distress about societal discrimination (items 1-3), with high factor loadings on concern (0.887), worry (0.878), and stress (0.723) about societal discrimination. Lastly, the fourth factor (F4) represented stress about community police brutality (0.346), societal shootings/violence (0.439), and societal discrimination (0.371), with moderate factor loadings. I standardized factor scores to have means of zero and standard deviations of one for further analysis.

6.3.3 Negative Affect About Social Problems and Tobacco and Cannabis Use

Unadjusted and adjusted associations between each factor score at baseline and tobacco and cannabis use at follow-up are presented in Table 6.5. After adjustment for potential confounders, each of the four factors was associated with exclusive cannabis use and, in some cases, dual tobacco and cannabis use, relative to never/former use. Specifically, a one SD increase in F1 at baseline was associated with exclusive cannabis use (OR: 1.38, 95% CI: 1.22-1.56) and dual tobacco and cannabis use (OR: 1.50, 95% CI: 1.28-1.75) at follow-up; F2 was associated with exclusive cannabis use (OR: 1.21, 95% CI: 1.08-1.37) and dual tobacco and cannabis use (OR: 1.17, 95% CI: 1.01-1.35); F3 was associated with exclusive cannabis use (OR: 1.23, 95% CI: 1.09-1.38); and F4 was associated with exclusive cannabis use (OR: 1.16, 95% CI: 1.03-1.30) and dual tobacco and cannabis use (OR: 1.23, 95% CI: 1.06-1.42). I found no

associations between factor scores and exclusive tobacco use. In addition, I did not observe any statistically significant interactions between factor scores and race/ethnicity for each association (Table E.1).

6.3.4 Supplementary and Sensitivity Analyses

For the analysis exploring associations between factor scores and individual substance use outcomes, I found certain substances to be driving associations between factor scores and the 4-category tobacco and cannabis use variable (Table E.5). For example, each factor was associated with vaping cannabis and other cannabis use. The only tobacco use variable associated with factors scores was ENDS use for F1 (OR: 1.16, 95% CI: 1.02-1.32) and F4 (OR: 1.23, 95% CI: 1.08-1.41). The analysis exploring associations between the social problems indices and summary scale and tobacco and cannabis use revealed that associations were similar to associations with factor scores (Table E.6). Finally, the analysis of the potential impact of missing data showed that the prevalence of age and sex varied across respondents loss-to-follow-up between Waves 10 and 11 and respondents in the analytic sample (Table E.7). This suggests that there might exist selective attrition with respect to age and sex across the study samples. However, both samples did not differ with respect to race/ethnicity, sexual orientation status, highest educational attainment, and personal financial status.

6.4 Discussion

I found that concern, worry, and stress about discrimination, shootings/violence, and police brutality were associated with exclusive cannabis use and dual tobacco and cannabis use in a racially/ethnically diverse sample of YAs living in LA, California. Recent widespread social problems, such as discrimination against racial/ethnic minoritized populations, gun violence, and wrongful killings by law enforcement, may have produced concern, worry, or stress in this

sample and among younger populations across the nation.^{139,357,358} I found that distress about each exposure at baseline was associated with exclusive cannabis use at follow-up. Further, distress about police brutality, distress about shootings/violence, and stress about discrimination, shootings/violence, and police brutality were associated with dual tobacco and cannabis use. Given that the health effects of dual tobacco and cannabis use are not well understood but may lead to increased toxicant exposure, worsened dependence symptoms, and altered neurobiological development, relative to exclusive use,^{42,46} understanding and addressing co-use among YA populations is vital.

Several studies have used similar exposures to examine their relationship with adverse behavioral outcomes and mental health problems.^{141,191,192} These studies showed associations between increasing concern, worry, and stress about discrimination, shootings/violence, or police brutality and substance use outcomes such as tobacco and cannabis use,^{141,191} or mental health problems such as anxiety and panic symptoms.¹⁹² I built on this prior work by conducting exploratory factor analysis to identify if negative affect regarding these social problems operated together instead of evaluating each one separately. I also assumed that psychological responses to racial/ethnic discrimination, societal shootings/violence, and community police brutality were correlated, based on prior research suggesting that each of these exposures derive from systems of marginalization in the US.^{86,91,359} I observed three factors representing distress for each social problem separately. I also identified a factor representing stress, but not concern or worry, for all social problems included in this study. This fourth factor might characterize an underlying subpopulation of YAs who are at heightened stress across multiple domains of social problems, and who therefore may be at unique risk for associated health consequences. The three stages of psychological strain in this study, concern, worry, and stress, were adopted to encompass a

spectrum of the stress process, from less severe (i.e., concern), to moderately severe (i.e., worry), to most severe (i.e., stress). As such, YAs who contributed only stress to discrimination, shootings/violence, and police brutality in this sample might identify a group more burdened by these social problems. Psychological responses to social problems likely mediate associations between exposure to social problems and substance use. Regardless of whether exposure to these problems is direct or vicarious, further exploration of YAs burdened by concern, worry, or stress about social problems is needed to address increasing negative affect that can lead to worsened health outcomes, including substance use.³⁶⁰

The study sample offered an opportunity to explore these relationships with sizable samples of Hispanic (46.5%) and NH Asian (18.1%) YAs somewhat parallel to the racial/ethnic demographic of LA County.³⁶¹ While results from the two-way interaction models were null and suggested no racial/ethnic differences in the relationship between factor scores and tobacco and/or cannabis use, my findings are especially salient to these populations. For example, the police agency in LA, California is one of the largest in the US, with a history of violence directed toward communities of color.³⁶² Racial/ethnic minoritized groups living in LA might be at higher risk for using multiple substances due to police exposure and violence. Policing, whether direct or indirect, can generate a psychological response and cause psychological distress, likely putting some YAs at increased risk for using tobacco and cannabis.^{136,343} The same may be said about racial/ethnic discrimination and shootings/violence, which have historically plagued racial/ethnic minoritized communities in the US.^{86,342}

I conducted a supplementary analysis estimating relationships between factors and individual use outcomes to understand products or ROAs that might be driving associations in the main analysis (Table E.5). I did not observe associations between factors and cigarette use

nor factors and cigar use, possibly suggesting that these tobacco products are not being used in response to the psychological stress generated by these particular social problems or among this sample. The only tobacco product that was associated with factors was ENDS use. As ENDS use is a primary source of nicotine consumption among YAs in the US,^{15,51} this finding is important, especially given that the long-term health consequences of ENDS use are not well understood. In addition, more robust associations were observed for cannabis, as opposed to tobacco, use outcomes, which helps explain the relationships I observed between factor scores and exclusive cannabis use.

The sensitivity analysis exploring the same exposure-outcome associations but using created indices that mirror factor constructs showed that each exposure was associated with exclusive cannabis use and dual tobacco and cannabis use. The drawback to this analysis is that the indices do not account for intercorrelation between social problem indicators like the factor scores. For example, factor 1, or distress about community police brutality, was also defined by its low factor loadings on concern, worry, and stress about societal discrimination and societal shootings/violence. I also found that a summary scale of all nine concern, worry, and stress variables was associated with dual tobacco and cannabis use. This result may indicate that a general increasing level of negative affect about discrimination, shootings/violence, or police brutality can lead to use of multiple substances, but masks associations specific to each social problem. Further research aimed at confirming the validity of the factor structure to these social problems, and related social phenomena, might benefit efforts to reduce the psychological burden on YAs and subsequent substance use.

6.4.1 Limitations

This study has several limitations. First, the study measures were self-reported and subject to response biases, and substance use outcomes were not biochemically confirmed. Second, residual confounding from variables, such as direct experiences of discrimination, might have introduced bias. Third, unlike Chapters 2-5, this study did not have adequate sample sizes to detect certain race/ethnicity-specific associations. While I could have stratified models by race/ethnicity to examine effect modification, the small sample sizes of most racial/ethnic minoritized groups would have yielded statistically unreliable estimates. Nonetheless, while it is possible that racial/ethnic differences did not exist in this sample, it is also possible that the lack of statistically significant interaction terms were due to a lack of statistical power. Fourth, selection bias might have impacted these study results. Missingness due to attrition may not have been completely at random (Table E.7). Fifth, the non-probability sampling design of the USC H&H Study yielded a sample with demographic characteristics not entirely representative of LA, California, or the rest of the United States, resulting in limited external validity.

6.5 Conclusion

This study found that separate factors representing distress about societal racial/ethnic discrimination, societal shootings/violence, and community police brutality were associated with exclusive cannabis use and dual tobacco and cannabis use among YAs living in LA, California. An additional factor representing stress about each social problem was also associated with exclusive cannabis and dual tobacco and cannabis use. Taken together, public health intervention and policies aimed to prevent and address tobacco and cannabis use, separately and together, should consider the role psychological stress caused by contemporary social problems play in determining substance use patterns and disparities in use. Discrimination, shootings/violence, and police brutality are widespread social problems that impact many younger populations across

the US,^{86,123,136} and efforts that address these problems at systemic levels are needed to create beneficial downstream effects on reducing substance use.

Figure 6.1 Flowchart Describing the Selection of the Analytic Sample

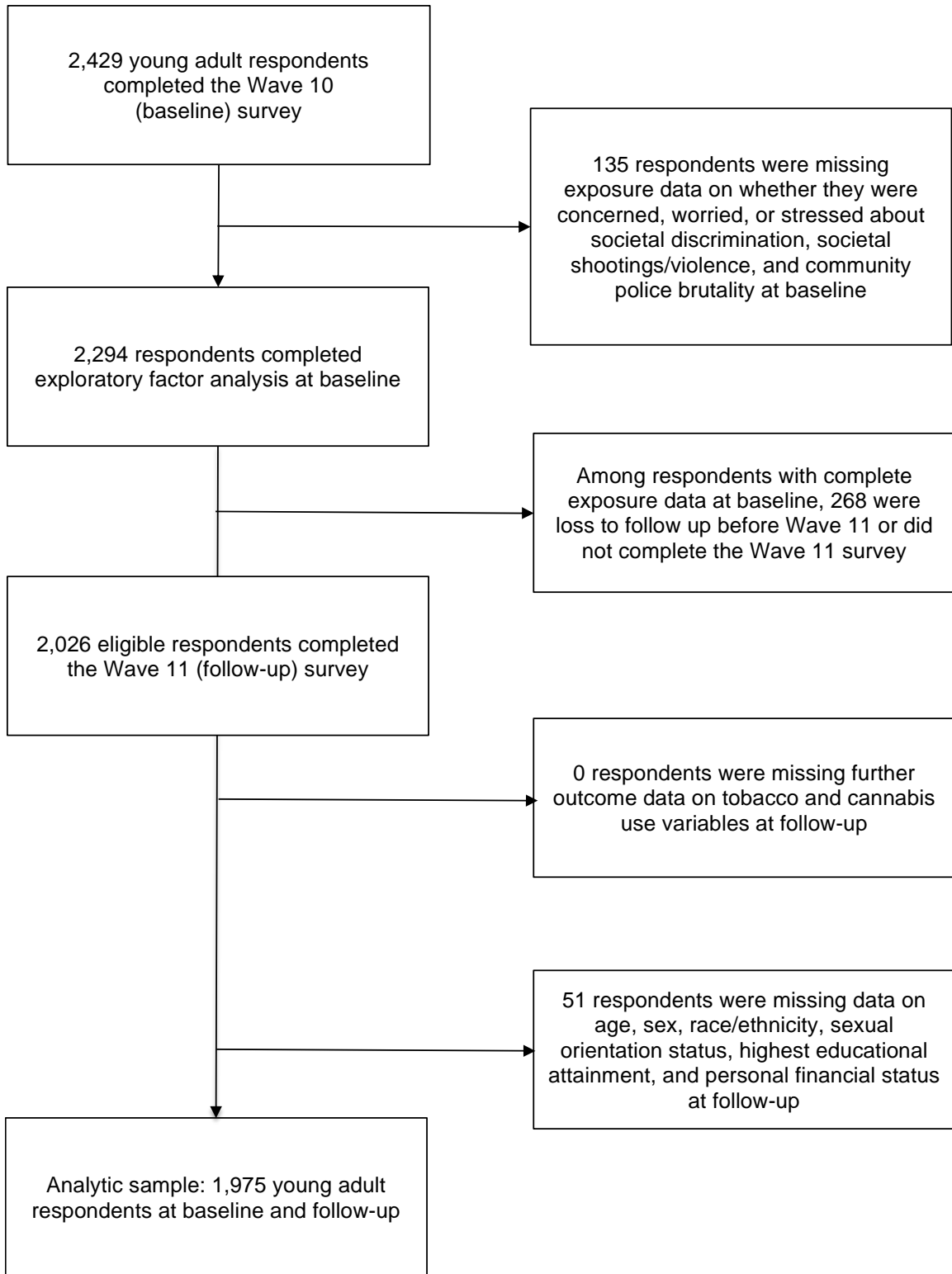


Figure 6.2 Scree Plot Displaying Eigenvalues by Number of Factors

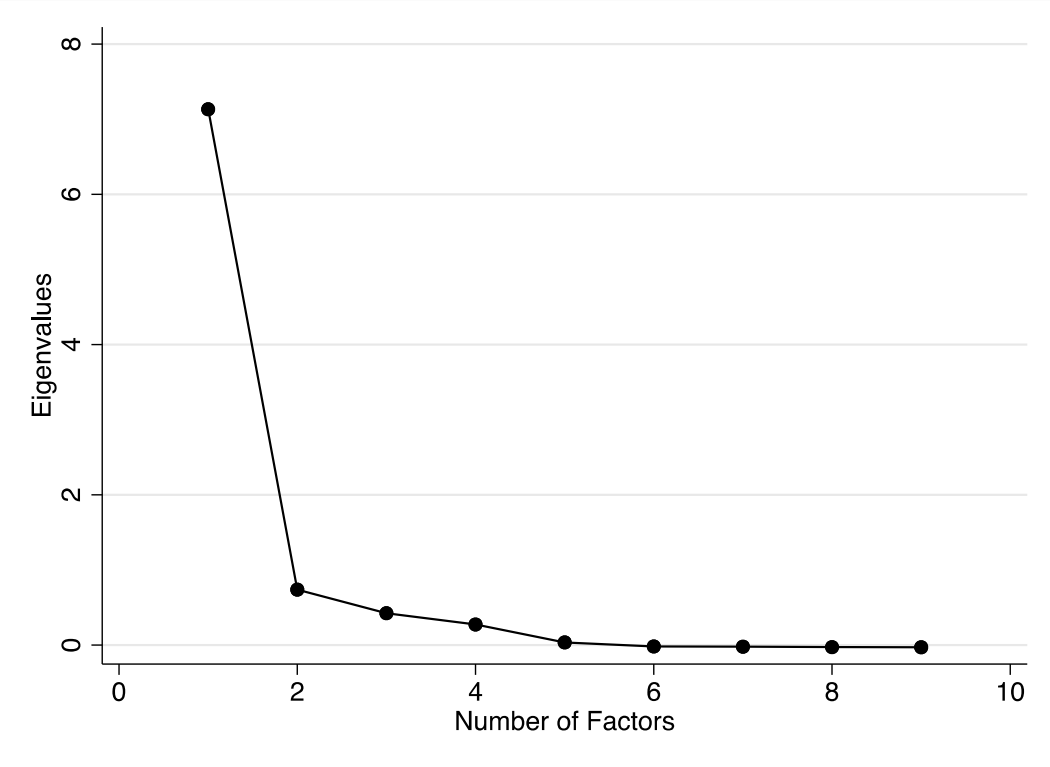


Table 6.1 Weighted Distributions and Means of Each Social Problem Indicator at Wave 10

	n (%)	Mean ± SD
Societal Discrimination		
Concerned		1.9 ± 1.4
(0) - Not at all	557 (24.3)	
(1) - Slightly	317 (13.8)	
(2) - Somewhat	517 (22.5)	
(3) - Very	506 (22.1)	
(4) - Extremely	397 (17.3)	
Worried		1.8 ± 1.4
(0) - Not at all	609 (26.6)	
(1) - Slightly	377 (16.4)	
(2) - Somewhat	523 (22.8)	
(3) - Very	457 (19.9)	
(4) - Extremely	328 (14.3)	
Stressed		1.6 ± 1.4
(0) - Not at all	694 (30.3)	
(1) - Slightly	476 (20.8)	
(2) - Somewhat	518 (22.6)	
(3) - Very	345 (15.0)	
(4) - Extremely	261 (11.4)	
Societal Shootings/Violence		
Concerned		2.4 ± 1.3
(0) - Not at all	311 (13.6)	
(1) - Slightly	299 (13.0)	
(2) - Somewhat	454 (19.8)	
(3) - Very	680 (29.6)	
(4) - Extremely	550 (24.0)	
Worried		2.2 ± 1.4
(0) - Not at all	390 (17.0)	
(1) - Slightly	347 (15.1)	
(2) - Somewhat	484 (21.1)	
(3) - Very	589 (25.7)	
(4) - Extremely	484 (21.1)	
Stressed		1.8 ± 1.4
(0) - Not at all	535 (23.3)	
(1) - Slightly	482 (21.0)	
(2) - Somewhat	474 (20.7)	
(3) - Very	438 (19.1)	
(4) - Extremely	365 (15.9)	
Community Police Brutality		
Concerned		2.6 ± 1.4
(0) - Not at all	302 (13.2)	
(1) - Slightly	237 (10.3)	
(2) - Somewhat	338 (14.7)	

	n (%)	Mean ± SD
(3) - Very	577 (25.2)	
(4) - Extremely	840 (36.6)	
Worried		2.4 ± 1.5
(0) - Not at all	371 (16.2)	
(1) - Slightly	262 (11.4)	
(2) - Somewhat	382 (16.7)	
(3) - Very	539 (23.5)	
(4) - Extremely	740 (32.3)	
Stressed		2.1 ± 1.5
(0) - Not at all	501 (21.8)	
(1) - Slightly	359 (15.7)	
(2) - Somewhat	395 (17.2)	
(3) - Very	416 (18.1)	
(4) - Extremely	623 (27.2)	

Table 6.2 Correlation Matrix of the Nine Social Problem Indicators

	Correlation Matrix								
	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9
Item 1 - Concerned about societal discrimination	1.000								
Item 2 - Worried about societal discrimination	0.917*	1.000							
Item 3 - Stressed about societal discrimination	0.773*	0.841*	1.000						
Item 4 - Concerned about societal shootings/violence	0.689*	0.658*	0.573*	1.000					
Item 5 - Worried about societal shootings/violence	0.655*	0.696*	0.623*	0.905*	1.000				
Item 6 - Stressed about societal shootings/violence	0.600*	0.664*	0.707*	0.783*	0.862*	1.000			
Item 7 - Concerned about community police brutality	0.614*	0.597*	0.530*	0.736*	0.699*	0.621*	1.000		
Item 8 - Worried about community police brutality	0.590*	0.628*	0.577*	0.720*	0.752*	0.690*	0.919*	1.000	
Item 9 - Stressed about community police brutality	0.553*	0.608*	0.644*	0.649*	0.704*	0.766*	0.812*	0.879*	1.000

* P-value < 0.05

Table 6.3 Prevalence of Sociodemographic and Tobacco and Cannabis Use Characteristics at Follow-Up

Age (Wave 11), n (%)	
20-21	1304 (66.0)
22-23	671 (34.0)
Sex (Wave 11), n (%)	
Female	1207 (61.1)
Male	768 (38.9)
Race/ethnicity (Wave 11), n (%)	
Hispanic	918 (46.5)
Non-Hispanic White	316 (16.0)
Non-Hispanic Black	81 (4.1)
Non-Hispanic Asian	358 (18.1)
Non-Hispanic multiracial	148 (7.5)
Another race/ethnicity	154 (7.8)
Sexual orientation status (Wave 11), n (%)	
Heterosexual	1496 (75.8)
LGBTQ+	479 (24.2)
Highest educational attainment (Wave 11), n (%)	
High school grad or less	460 (23.3)
Some college or more	1515 (76.7)
Personal financial status (Wave 11), n (%)	
Do not meet basic expenses	100 (5.1)
Just meet basic expenses	477 (24.2)
Meet needs with a little left	607 (30.7)
Live comfortably	791 (40.0)
Past 30-day tobacco and cannabis use (Wave 11), n (%)	
Never/former	1127 (57.1)
Exclusive tobacco	131 (6.6)
Exclusive cannabis	443 (22.4)
Dual tobacco and cannabis	274 (13.9)

Table 6.4 Exploratory Factor Analysis of the Nine Indicators of Negative Affect About Social Problems

Items	Factor Components	Rotated factor loadings ^a					Communalities ^g	Cronbach's α ^h
		Factor 1 ^b	Factor 2 ^c	Factor 3 ^d	Factor 4 ^e	Factor 5 ^f		
7	Concerned about community police brutality	0.866	0.109	0.084	-0.024	-0.083	0.967	0.952 ^b
8	Worried about community police brutality	0.852	0.117	0.057	-0.010	0.112	0.975	0.944 ^c
9	Stressed about community police brutality	0.754	0.031	0.024	0.346	-0.003	0.958	0.942 ^d
4	Concern about societal shootings/violence	0.134	0.806	0.104	0.030	-0.106	0.958	0.877 ^e
5	Worry about societal shootings/violence	0.127	0.789	0.088	0.048	0.114	0.967	
6	Stress about societal shootings/violence	0.086	0.619	0.056	0.439	0.003	0.953	
1	Concern about societal discrimination	0.054	0.102	0.887	-0.013	-0.096	0.963	
2	Worry about societal discrimination	0.059	0.075	0.878	0.012	0.102	0.970	
3	Stress about societal discrimination	0.042	-0.010	0.723	0.371	0.001	0.891	

^a Oblique promax rotation with Kaiser normalization where factors are allowed to be correlated; bolded factor loadings ≥ 0.3 were retained

^b Factor 1: Distressed (concerned, worried, stressed) about community police brutality

^c Factor 2: Distressed (concerned, worried, stressed) about societal shootings/violence

^d Factor 3: Distressed (concerned, worried, stressed) about societal discrimination

^e Factor 4: Stressed about community police brutality, societal shootings/violence, and societal discrimination

^f Factor 5: Not defined, omitted

^g The proportion of each component's variance being captured by the factor model

^h Internal consistency of components for each factor

Table 6.5 Multinomial Logistic Regression Models Examining Associations Between Factors Scores at Wave 10 and Past 30-Day Tobacco and Cannabis Use at Follow-Up

	Past 30-Day Nicotine and Cannabis Use (Wave 11) ^a					
	Unadjusted			Adjusted		
	Exclusive Tobacco	Exclusive Cannabis	Dual Tobacco and Cannabis	Exclusive Tobacco	Exclusive Cannabis	Dual Tobacco and Cannabis
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Factor scores (Wave 10) ^c						
Factor 1 ^d	0.78 (0.66-0.93)	1.43 (1.27-1.61)	1.45 (1.25-1.67)	0.85 (0.71-1.02)	1.38 (1.22-1.56)	1.50 (1.28-1.75)
Factor 2 ^e	0.88 (0.74-1.05)	1.22 (1.09-1.37)	1.14 (1.00-1.31)	1.00 (0.82-1.21)	1.21 (1.08-1.37)	1.17 (1.01-1.35)
Factor 3 ^f	0.83 (0.69-1.00)	1.27 (1.13-1.42)	1.12 (0.98-1.28)	0.91 (0.74-1.10)	1.23 (1.09-1.38)	1.11 (0.96-1.28)
Factor 4 ^g	1.02 (0.86-1.22)	1.22 (1.09-1.36)	1.25 (1.09-1.43)	1.08 (0.89-1.31)	1.16 (1.03-1.30)	1.23 (1.06-1.42)

Bolded text indicates statistical significance (p<0.05)

^aThe outcome referent group: never/former use of both tobacco and cannabis

^bOdds ratios (OR) and 95% confidence intervals adjusted for age, sex, race/ethnicity, sexual orientation identity, highest educational attainment, and personal financial status

^c Each factor represents separate unadjusted and adjusted models

^d Factor 1: Distressed (concerned, worried, stressed) about community police brutality

^e Factor 2: Distressed (concerned, worried, stressed) about societal shootings/violence

^f Factor 3: Distressed (concerned, worried, stressed) about societal discrimination

^g Factor 4: Stressed about community police brutality, societal shootings/violence, and societal discrimination

Chapter 7 Discussion

7.1 Summary of Main Findings

Tobacco and cannabis use and co-use in the US remain public health problems despite substantial efforts by public health professionals, clinicians, and policymakers to prevent, reduce, and eliminate use.^{1,2,363} Tobacco use is the leading cause of preventable morbidity and mortality in the US,¹ and use of tobacco, such as cigarettes, cigars, and ENDS/EVPs, is linked to short- and long-term respiratory and cardiovascular disease health effects as well as types of cancer.^{1,2,197} Cannabis is one of the more commonly used illicit substances, though recently legal in some states and local jurisdictions.³⁷ It can be harmful, especially to younger populations, leading to impaired cognitive growth as well as respiratory and cardiovascular health effects similar to those caused by tobacco products.^{56,58} Tobacco and cannabis co-use, referred to by public health and addiction researchers as a “public health emergency,”⁶⁴ poses significant health risks in addition to use of each substance independently.^{42,46,57} For example, the use of one substance might facilitate the use of the other through common dependency mechanisms.^{42,46} In addition, racial/ethnic disparities in tobacco and cannabis use and co-use likely contribute to disparities in tobacco- and cannabis-related health outcomes. Per the conceptual model outlining the mechanisms proposed in this dissertation (Figure 1.1), psychosocial determinants of health could lead to the development of, and racial/ethnic disparities in, key health outcomes such as substance use disorder, physical health effects, and cessation difficulties. This dissertation was inspired by the need for additional work that aims to unveil factors contributing to racial/ethnic

disparities in tobacco and cannabis use to 1) identify and prevent mechanisms leading to these health outcomes, and 2) mitigate associated racial/ethnic disparities.

I explored various aspects of tobacco and cannabis use disparities, including disparities in self-reported current use (i.e., use in the past 30 days), self-reported past-year tobacco and cannabis use disorders, and current tobacco and cannabis use and co-use with consideration of various ROA such as smoking and vaping. Prior research has documented racial/ethnic disparities in each of these types of use groups,⁴⁸⁻⁵¹ but there is scant literature examining whether psychological or social factors relevant to US racial/ethnic populations are associated with tobacco and cannabis use outcomes among youth or adults. To fill this gap, I investigated three aims: 1) to examine the associations between racial/ethnic discrimination and patterns of tobacco use and patterns of tobacco and cannabis use and co-use among US adults, 2) to evaluate associations between severity of internalizing/externalizing problems and tobacco and cannabis use and co-use separately for US youth and YAs, and 3) to assess the extent to which concern, worry, and stress about social problems, such as societal discrimination, societal shootings/violence, and community police brutality, predict longitudinal tobacco and cannabis use and co-use among a racially/ethnically diverse cohort of YAs living in LA, California. In addition, for each aim I explored effect modification by race/ethnicity, or whether differences in associations varied across racial/ethnic groups. The following section dives deeper into my dissertation findings per chapter and provides further discussion about policies and interventions that help reduce substance use inequities, future directions, strengths and limitations of each chapter, and conclusions.

In Chapter 2, I analyzed data from NESARC-III (2012-2013) to investigate associations between past-year racial/ethnic discrimination and past 30-day/past-year tobacco and cannabis

use outcomes among US adults. I also explored the potential contribution of these associations to racial/ethnic disparities in use outcomes by conducting analysis of effect modification. I found that adults who experienced more past-year racial/ethnic discrimination had higher odds of current tobacco and cannabis use, especially dual/poly substance use categories (e.g., polytobacco use, tobacco and cannabis co-use) as well as past-year joint TUD and CUD. Race/ethnicity modified these associations, with NH White and NH Black adults having stronger relationships between racial/ethnic discrimination and dual/poly tobacco use than other racial/ethnic groups. While past-year racial/ethnic discrimination was associated with current tobacco and cannabis use outcomes among all racial/ethnic groups, it was associated with past-year joint TUD and CUD among only NH White and NH Black adults.

Results from Chapter 3 showed that racial/ethnic discrimination was associated with tobacco and cannabis use outcomes among US adults, as seen in prior work.^{181,183,211,251} One key takeaway is that racial/ethnic discrimination harms health through tobacco and cannabis use in addition to other preestablished health outcomes and mechanisms.^{85,86} A more novel finding details the extent to which racial/ethnic discrimination is associated with patterns of use, where associations were stronger for more deleterious use outcomes such as polytobacco use or dual/poly tobacco and cannabis use. Stratifying the racial/ethnic discrimination/tobacco and cannabis use associations by race/ethnicity revealed a complex relationship by which racial/ethnic discrimination was linked to tobacco and cannabis use. Associations between racial/ethnic discrimination and dual/poly tobacco use, and racial/ethnic discrimination and dual/poly tobacco and cannabis use were stronger among NH White adults than racial/ethnic minoritized adults. I have posited possible explanations as to why NH White adults had stronger associations, since it is, by definition, counterintuitive that White Americans: 1) experience

discrimination solely on the basis of their race/ethnicity, and 2) use tobacco or cannabis in the face of racial/ethnic discriminatory experiences.^{221,264} White Americans cannot experience structural racism, or its downstream effects, but can report self-perceived mistreatment based on their race or skin color, among other factors such as their age, weight, political affiliation, etc.^{81,264} As all self-reported measures in survey research are susceptible to subjective interpretation, we must seriously consider why and how White Americans experience racial/ethnic discrimination. These reports of race-related unfair treatment by White Americans likely intersect with other reasons that generate anti-White bias, such as religion, politics, and resource entitlement.^{221,264}

I also observed associations between racial/ethnic discrimination and tobacco and cannabis use for Hispanic, NH Black, and adults who identified as another race/ethnicity. For example, racial/ethnic discrimination was linked to individual TUD among each racial/ethnic group. There is documented evidence of the various ways in which racial/ethnic discrimination affects substance use,^{181,183,211,251} but rarely have studies examined disparities by race/ethnicity, which is an arguably serious line of inquiry in research involving components of structural racism. Research describing that racial/ethnic discrimination is harmful dates back decades,^{161,249} warranting further work on how this type of discrimination differentially affects racial/ethnic groups. Taken in total, my findings reveal that racial/ethnic discrimination is associated with tobacco and cannabis use, possibly through a stress-coping mechanism. Decreasing discriminatory practices must be foremost to decreasing the ill effects of racial/ethnic discrimination on tobacco and cannabis use. A complementary approach to develop interventions to help adults improve their coping strategies would also be beneficial. In addition, paying

attention to the variation in products used to cope with racial/ethnic discrimination can assist in building more appropriate substance-based interventions and policy.

In Chapter 4, I used data from Wave 4 (2016-2018) of the PATH Study to conduct a LCA of various tobacco and cannabis products and ROA among youth (aged 15-17) and YAs (aged 18-24). Results from the LCA described six distinct current use classes for youth (i.e., exclusive cigarette, exclusive ENDS, exclusive blunts, exclusive other cannabis, ENDS + cannabis vaping (youth dual use), and cigarettes + cigars + other cannabis (youth poly use)) and six distinct current use classes for YAs (i.e., exclusive cigarettes, exclusive ENDS, exclusive blunts, exclusive other cannabis, cigarettes + cigars (YA dual use), cigarettes + ENDS + cannabis vaping (YA poly use)). I found that these use groups differed by key sociodemographic factors, including race/ethnicity. For example, NH Black YAs had higher odds of exclusive blunt use compared to NH White YAs; however, racial/ethnic minoritized youth and YAs generally had lower odds of dual/poly use than their NH White counterparts. Overall, my findings demonstrated racial/ethnic differences in tobacco and cannabis use groups among youth and YAs.

In Chapter 5 I explored the extent to which past 30-day severity of mental health problems (i.e., internalizing/externalizing problems) were associated with current tobacco and cannabis use classes among emerging adults, and whether these associations varied across race/ethnicity. Moderate and high internalizing and externalizing problems, compared to low problems, were associated with use classes for both youth and YAs. Much like in Chapters 2 and 3, results increased in complexity after stratifying models by race/ethnicity. Among youth, high internalizing problems were linked to exclusive use classes among each racial/ethnic group, but only among Hispanic and NH White youth for dual use. In contrast, high externalizing problems

were associated with exclusive use classes for Hispanic, NH White, and youth from another race/ethnicity, but not NH Black youth, and with poly use only among youth from another race/ethnicity. For YAs, high internalizing problems were associated with exclusive use among each racial/ethnic group except NH Black YAs. High internalizing problems were also associated with dual use among NH White and YAs from another race/ethnicity, and poly use among Hispanic and NH White YAs. High externalizing problems were additionally associated with exclusive use among each racial/ethnic group except YAs from another race/ethnicity. High externalizing problems and dual use was associated only among NH White YAs and high externalizing problems and poly use among NH White and NH Black YAs. In total, associations between internalizing/externalizing problems and tobacco and cannabis use classes varied by race/ethnicity, with certain racial/ethnic groups (i.e., NH Black youth) showing no relationship between certain mental health problems (i.e., high externalizing problems) and use.

Despite preexisting literature detailing the comorbidity of mental health problems and substance use among youth and YAs,^{184,186,190} Chapter 5 provides additional insight into how these relationships vary by race/ethnicity. The patterns that emerged from this chapter reveal the intricacy of factors that drive both racial/ethnic disparities in mental health problems and substance use. As an example, high externalizing problems among youth were associated with tobacco and cannabis use classes among each racial/ethnic group except NH Black youth, and high internalizing problems among YAs showed a similar pattern in which NH Black YAs showed no association. This line of research emphasizes the importance of investigating patterns of dual/poly substance use, which could contribute to differential health consequences and possibly exacerbate racial/ethnic health disparities.^{296,300,312} Taken together, my results show that mental health problems continue to be an important determinant of tobacco and cannabis use and

underscore racial/ethnic variability in use. As we build on our understanding of underlying factors contributing to both mental health problems and tobacco and cannabis use, such as structural racism, elucidating how mental health plays a role in these higher-level relationships can inform interventions to mitigate disparate health outcomes.

Lastly, in Chapter 6, I explored the association between concern, worry, and stress about societal discrimination, societal shootings/violence, and community police brutality (collectively referred to as social problems hereafter) at baseline and current tobacco and cannabis exclusive use and co-use at six-month follow-up among a racially/ethnically diverse cohort of YAs living in LA, California. The sample of YAs was predominantly Hispanic (46.5%) and NH Asian (18.1%), representative of the racial/ethnic demographic composition of adults in LA County.³⁶¹ Using EFA, I derived four distinct factors of the nine items representing concern, worry, and stress about social problems and allowed them to be correlated. The four factors were: 1) distress (i.e., concern, worry, and stress) about community police brutality, 2) distress about societal shootings/violence, 3) distress about societal discrimination, and 4) stress (not concern or worry) about each social problem. I posited that the unique structure of the fourth factor might indicate an underlying heightened stress response to social problems requiring further inquiry, including whether subpopulations of YAs are at increased risk for negative affect.

I used the factor scores to explore associations between each factor at baseline and exclusive and dual tobacco and cannabis use at follow up. The results showed that each factor was associated with exclusive cannabis use, while factors 1, 2, and 4 were associated with dual tobacco and cannabis use. None of the factors were associated with exclusive tobacco use. However, the supplementary analysis identifying individual tobacco and cannabis use products associated with factors scores showed that higher distress due to factors 1 and 4 resulted in

higher odds of ENDS use. This finding might represent an affinity to use ENDS products to cope with the stress and distress about social problems, while other products might not be as relevant to YAs in these scenarios.

Stress or distress generated by social problems led to adverse health behaviors among a racially/ethnically diverse cohort of YAs. A unique contribution of this study is the examination of multiple social factors salient to racial/ethnic minoritized populations. For example, the increase in awareness and public outcry, especially among YAs, following the high-profile killings of Breonna Taylor and George Floyd in 2020 might have heightened concern, worry, or stress about police brutality.^{139,141} Another example is discrimination, which many minoritized populations might experience due to their intersecting identities, including race/ethnicity as well as sex, gender, or other social identities.^{87,115} For example, more recently, Asian Americans have suffered anti-Asian discrimination due to being blamed for the COVID-19 pandemic.³⁵⁷ My research adds to the larger pool of work on advancing an understanding of how negative affect influences health behaviors, with particular focus on the source of negative affect. Reducing stress or distress about pressing social problems is a crucial start to a more overarching goal of promoting health equity by eliminating its macro-level sources such as structural racism.^{91,250,364}

7.2 Policies and Interventions for Eliminating Substance Use Inequities

The first documented comprehensive report of racial/ethnic health disparities in the United States was published in 1985.^{365,366} This Heckler Report drove change in the ways in which we discuss and address health disparities. For example, the report outlined that 60,000 excess deaths each year were attributed to racial/ethnic health disparities.^{365,366} In addition, the report emphasized the importance of capturing more extensive data on other racial/ethnic minoritized groups (e.g., Hispanics) in order to explore disparities more comprehensively.^{365,366}

To continue the work of Margaret Heckler, scholars have emphasized the importance of considering structural racism as a fundamental driver of racial/ethnic health disparities in the US.^{91,93,250,364,367} Exposure to structural racism, or racism that is entrenched in systems, laws and policies, and practices that produce and sustain inequitable treatment toward racial/ethnic minoritized groups,^{91,367} influences psychosocial well-being.^{86,96} Hence, consideration of both the structural and intermediary processes that affect tobacco and cannabis use is necessary to reduce associated racial/ethnic disparities. Reducing structural racism in the US will, in theory, reduce the prevalence and incidence of racial/ethnic discrimination, internalizing/externalizing problems, and concern, worry, and stress about racially/ethnically-salient social problems. In addition, as this dissertation focuses on substance use (i.e., tobacco and cannabis) as a particular outcome driven by structural racism and its downstream psychosocial consequences, efforts that aim to prevent and reduce use are needed. Understanding psychosocial determinants related to structural racism as potential drivers of racial/ethnic disparities in tobacco and cannabis use will allow the designation of policies that reduce use throughout the life course. This dissertation includes three chapters of distinct age group samples. Chapters 2 and 3 included adults (mean age: 46.6), while Chapters 4 and 5 included youth aged 15-17 and YAs aged 18-24, and Chapter 6 included YAs at baseline (mean age: 21.2) and follow-up (mean age: 21.8). With special consideration of the role structural racism plays in perpetuating tobacco and cannabis use disparities, in this section, I discuss how tobacco and cannabis control policies and interventions addressing psychosocial determinants can help reduce and eliminate substance use inequities in the US.

7.2.1 Leveraging Tobacco and Cannabis Control Policies

Tobacco and cannabis policies can interact with specific age groups to discourage use. For example, smoke-free laws and cigarette taxes are associated with decreased initiation and smoking among youth and YAs.³⁶⁸ Recently, separate federal policies have aimed to prevent and reduce tobacco and cannabis use, with a focus on mitigating disparities. As another example, in 2022, the Food and Drug Administration (FDA) committed to eliminating menthol cigarettes and flavored cigars from the market to reduce overall use through limiting youth initiation.³⁶⁹ The FDA hopes, supported by empirical research, that these efforts will reduce tobacco-related health disparities and the number of deaths due to tobacco products in the US. While I did not measure flavored tobacco products in this dissertation, they are disproportionately used by racial/ethnic minoritized populations, and additional research will have to consider how flavored tobacco policies interact with 1) other tobacco policies, and 2) determinants related to structural racism, to promote racial/ethnic health equity.³⁷⁰ Regarding federal cannabis policy, cannabis continues to be classified as a schedule I controlled substance by the federal government, even though more than half of US states have legalized medical or recreational use in recent years.³⁷¹ Such incongruities in whether cannabis use is legal creates environments that enhance disparities, such as in scenarios where people from racial/ethnic minoritized populations are criminalized for cannabis use possession in some states as opposed to others.²³³

When policymakers are considering implementing or updating tobacco control policies, it is important to consider equity. Questions to consider during the policy implementation stage include: 1) will the policy result in an equal prevention or reduction in tobacco product use by race/ethnicity, and 2) if not, is the added population-level benefit justifiable against foreseen harms (i.e., beneficence)? In addition, scholars can leverage the 5Ps (i.e., purpose, people, place, process, and power) of Health Equity and Empowerment Lens, which are a set of guiding

principles to assess whether proposed policies will improve health and promote health equity.³⁷² Scholars have echoed these sentiments and argue that public health professionals and policymakers should prioritize tobacco control efforts that focus on health equity.^{373,374} One challenge is anticipating the potential impact cannabis policies will have on the effectiveness of tobacco control policies, though preliminary evidence suggests that these two types of policies might be unrelated.³⁷⁵

Unlike tobacco use, cannabis use has a history of being criminalized in most US states and local jurisdictions,^{376,377} and thus, many cannabis-related policies focus on decriminalization. Built on racist ideologies, the US has disproportionately incriminated racial/ethnic minoritized populations for cannabis possession.^{377,378} Studies have shown that cannabis use criminalization contributes to racial/ethnic cannabis use disparities.³⁷⁹ A common aspiration is that cannabis decriminalization will promote racial/ethnic health equity through eliminating racist practices by the criminal justice system that sends more racial/ethnic minoritized individuals to jail over possession charges than White Americans.^{380,381} Studies show that cannabis decriminalization is associated with lower possession arrests, but whether these lead to reduced racial/ethnic disparities in arrests and associated health outcomes due to cannabis use is less known.^{380,381} Overall, changes in the cannabis legalization landscape must ensure that variations in both medical and recreational policy enactments produce equitable outcomes.^{380,382} Similar to tobacco control policies with a focus on racial/ethnic health disparities, consideration of whether these policies reduce disparities in addition to overall use is appropriate. Policies that create equal net decreases in use among the overall population may not be sufficient to decrease disparities given that cannabis use rates and prevalence are not similar across racial/ethnic groups.³⁷⁸

Tobacco and cannabis policies might interact, and their impact on racial/ethnic health inequities is not well known.^{375,383,384} Some scholars call for the consideration of whether decriminalization and indoor exemptions of cannabis smoking or vaping might renormalize tobacco use.³⁸³ While some states and local jurisdictions prohibit indoor cannabis smoking, some states provide exemptions.³⁸⁵ In addition, indoor or outdoor vape-free laws have had to recently incorporate cannabis use, but there is little continuity in policies, including what is allowed and not allowed.^{383,385} The interplay of tobacco and cannabis use policies will need to be considered moving forward as products and ROA that facilitate use of both substances continue to evolve.

7.2.2 Interventions Addressing Psychosocial Determinants of Health

Specific to this dissertation, I call upon addressing psychosocial determinants of health to reduce tobacco and cannabis use and use disparities. I advocate for paying close attention to ROA preference to help eliminate use disparities as patterns of tobacco and cannabis use by product and ROA vary by race/ethnicity. Because policies aimed at addressing tobacco and cannabis use are often approached from a product-specific standpoint,^{334,386} future developments focused on promoting racial/ethnic health equity can leverage them. Given that each psychosocial factor in this dissertation has potential ties back to structural racism, the public health initiatives that will garner the best net benefits in health will be to address and eliminate racism.^{367,387} However, as many scholars have lamented, progress toward an absolute reduction in racism, and subsequently a decrease in racial/ethnic health disparities, across the nation is lacking.^{387,388} While we work toward a more equitable and anti-racist nation, other policies and interventions in the interim can contribute to promoting racial/ethnic health equity.

A key theme of this dissertation is the role that stress and coping play in determining tobacco and cannabis use patterns, including problematic dual/poly use. In each aim, I posited

that the associations between psychosocial factors and tobacco and cannabis use outcomes function through a stress response. This idea is consistent with previous research highlighting that racial/ethnic discrimination, mental health problems, and negative affect induce biological stress.^{86,160,174,389} Whether such stress encourages substance use has also been explored in the literature, suggesting that these mechanisms in fact lead some people to cope using tobacco or cannabis.^{27,390} While this dissertation does not explore specific stress-coping strategies, I assume these mechanisms are prevalent for each racial/ethnic group, albeit likely different based on numerous factors, such as personal and material resources.^{66,70,175} Nevertheless, public health professionals and clinicians can intervene during the coping process by 1) addressing the cause of stress (e.g., discrimination) and ways to reduce it (e.g., stress management), and 2) preventing adverse coping to stress (e.g., smoking).^{391,392} For example, school-based interventions can teach younger populations how to resort to problem-focused coping mechanisms over emotion-based ones and simultaneously advise to refrain from substance use.³⁹³

This dissertation reports variation in associations between psychosocial determinants and tobacco and cannabis use by race/ethnicity, indicating a possible disparity in the social patterning of these stressors, how they are appraised (i.e., determining whether the stressors are threatening and evaluating psychosocial resources), and the ways in which different racial/ethnic groups cope with them. Some stressors are more culturally relevant to certain racial/ethnic groups than others. Many findings in this dissertation call for equity in interventions that address adverse coping to factors entrenched in structural racism, akin to recent research that calls for the need to explore successful methods for coping with race-related stress.^{86,142,394} These scholars emphasize consideration of safe, inclusive spaces in treatment settings to promote successful therapy and the identification of new, effective coping strategies.³⁹⁴ They explain that public or mental health

professionals should use race-related stressors as an opportunity to utilize and encourage various positive behavioral and cognitive coping strategies.³⁹⁴ Other coping mechanisms unrelated to seeking healthcare include person-centered strategies, such as engaging in personal racial trauma healing practices.³⁹⁴

Culturally-relevant interventions focused on dealing with race-related stress should be leveraged to advance our understanding of what works (and does not) in promoting positive coping strategies and reducing substance use.³⁹⁵⁻³⁹⁹ Several studies have published on various ways to promote well-being in the face of racism and adversity via intervention. These interventions include the Engaging, Managing, and Bonding through Race (EMBRace) intervention;³⁹⁵ the Resilience, Stress, and Ethnicity (RiSE) program;³⁹⁶ and interventions that encourage mindfulness/compassionate meditation, stress management, and social support.³⁹⁷⁻³⁹⁹ As it stands, racial/ethnic minoritized populations in the US deserve appropriate assessment of the proper ways in which to heal, and these interventions are good starting points. As race-related stress and trauma continues to be linked to tobacco and cannabis use,⁴⁰⁰⁻⁴⁰² intervening at the stage where stress and distress are being appraised will lead to decreases in use, misuse, and associated health consequences.

7.3 Future Directions

This dissertation aimed to evaluate whether psychosocial determinants contribute to racial/ethnic disparities in tobacco and cannabis use outcomes. I found that racial/ethnic discrimination, internalizing/externalizing problems, and concern/worry/stress about social problems were associated with tobacco and cannabis use among samples of youth, YAs, and adults. These relationships are hypothesized to function through a stress-coping model.^{66,67,394} In addition, I observed notable variation in these associations by race/ethnicity. Some key examples

include: 1) the association between past-year racial/ethnic discrimination and current dual tobacco and cannabis use was stronger for NH White adults compared to other racial/ethnic groups (Chapters 2 and 3); 2) the association between past 30-day high externalizing problems and current tobacco and cannabis use classes were not present for NH Black youth, while the association between high internalizing problems and tobacco and cannabis use classes were not present for NH Black YAs, but were present for all other racial/ethnic groups (Chapter 5); and 3) enhanced stress about societal discrimination, societal shootings/violence, and community police brutality at baseline was associated with current dual tobacco and cannabis use at follow-up among a racially/ethnically diverse cohort of YAs (Chapter 6).

Future work can expand on these findings in several ways. One way is investigating the extent to which psychosocial determinants of health impact substance use over time.⁴⁰³ Each exposure in this study might occur more than once across the life course. To understand exposure-outcome temporality, future research must take advantage of longitudinal cohort designs. For example, there may be a gradient to which increasing psychological stress leads to the progression of tobacco and cannabis use outcomes, from less damaging (e.g., exclusive use) to more damaging (e.g., dual/poly use, use disorders). Youth and adults who use multiple substances might do so due to increased stress or exposure to psychosocial stressors, including the accumulation of stress and distress.

I also encourage future work to incorporate macro-level measures into study designs and analyses to further our understanding of how psychosocial determinants of health impact tobacco and cannabis use disparities. In the sub-section above, I discussed the role policy may have in preventing or reducing tobacco and cannabis use, and the current policy landscape might shape use patterns and interact with psychosocial determinants of health. In addition, while no

validated, comprehensive measure of structural racism exists,³⁶⁴ previous studies have used variables that represent components of structural racism, such as residential racial segregation, to investigate their impact on health; these measures could be expanded.^{404,405} Studies that incorporate multi-level mixed effects models can include macro-level independent variables to examine their relationship with tobacco and cannabis use outcomes and whether these relationships vary by race/ethnicity. These methods can also be used to examine interactions between macro-level social and individual-level psychosocial determinants of health.

Finally, findings from this dissertation, as well as existing and future studies, should inform translational research aimed to tangibly reduce racial/ethnic disparities and provide direct benefit to racial/ethnic minoritized communities. Translational research is defined by four stages: 1) advancing understanding of basic science findings through clinical trial application, 2) assessing efficacy in clinical trials, 3) implementing and disseminating results from phase two, and 4) assessing whether results from clinical trials translate to the population level.⁴⁰⁶ The existence of racial/ethnic health disparities, including disparities in substance use, in the US is largely attributed to structural racism.^{91,250,364} This makes late-stage translational research more pertinent in order to produce long-overdue equitable change.³⁸⁷ These efforts must include group-specific interventions that complement universally applied policies promoting health among the general population. As mentioned in previous work, interventions and policies that focus on the overall population, while beneficial, bear the potential harm of perpetuating disparities.³⁸⁷ Research areas that include late-stage translational research, breaking down fundamental power structures rooted in structural racism, and reducing the negative impact of structural racism on racial/ethnic minoritized groups are needed. As highlighted above, until progress is made in systematically dismantling racism in the US, interventions and policies

geared toward promoting health through positive coping strategies, and thereby reducing tobacco and cannabis use, are necessary.

7.4 Strengths and Limitations

This dissertation has several strengths and limitations. One strength is that the three aims of this dissertation contribute to a scant literature on psychosocial drivers of racial/ethnic disparities in tobacco and cannabis use. The substance use literature contains a rich source of papers that demonstrate racial/ethnic disparities in use patterns but is limited in the amount of research focused on psychosocial factors that may contribute to them. In addition, literature on psychological and social determinants of health have documented consistent associations between, for example, discrimination and health, but whether these relationships vary by race/ethnicity is not as well known. Another strength is the use of two nationally representative datasets (Chapters 2-5) to observe results with greater external validity. While the dataset in Chapter 6 is not nationally representative, it contains a racially/ethnically diverse group of YAs necessary to unpack the questions in this dissertation. Three, this dissertation includes advanced analytical methods to interrogate the latent patterning of exposures or outcomes of interest (e.g., latent class analysis, exploratory factor analysis) and examine racial/ethnic differences in statistical associations (e.g., statistical interactions, effect modification). These methods, in addition to others mentioned in the section above, are critical to advancing our understanding of psychosocial determinants of racial/ethnic disparities in tobacco and cannabis use, beyond that of descriptive studies. Lastly, the data used in this dissertation are relatively new, with the exception to Chapters 2 and 3, where data come from 2012-2013. In Chapters 4 and 5 I used data from 2016-2018; in Chapter 6 I used data from 2020-2021. Despite the near decade gap between when data were collected in Chapters 2 and 3 and the publication of this dissertation, NESARC-

III, to my knowledge, is the only nationally representative US dataset with measures of racial/ethnic discrimination and tobacco and cannabis use and use disorders among adults.

Some limitations of the dissertation include concerns with internal validity.⁴⁰⁷ For example, selection bias⁴⁰⁸ is particularly concerning in analyses for Chapter 6, where a large proportion of YAs were missing data at follow-up. While selective attrition can certainly impact my study findings, due to the COVID-19 pandemic and other related social factors, this study (in addition to others) inevitably suffers from attrition, which likely affects internal and external validity. Another concern is information bias.⁴⁰⁹ For each analysis, I relied on self-reported measures, which are prone to response biases, particularly recall and social desirability bias. The former could be an issue, for example, when somebody is attempting to recall the number of racial/ethnic discriminatory experiences in the past year. The latter could include whether younger respondents choose to refrain from indicating that they use substances since that might be a sensitive topic, potentially underestimating use.⁴⁰⁹ Confounding might have also affected my results.⁴¹⁰ In general, variables are considered confounders if they follow the following three criteria: 1) they are risk factors for the outcome, 2) they are associated with the exposure, and 3) they do not fall on the causal pathway between the exposure and the outcome.⁴¹⁰ I adjusted for sociodemographic variables conceptualized to be confounders in each analysis, but acknowledge that some residual confounding might be present,⁴¹¹ potentially biasing my study estimates.

Outside of concerns about internal validity, this dissertation has several other limitations. I discuss in each chapter the speed by which the tobacco and cannabis industries create and introduce new products, and the lag in legislation. Academic research at times is at a disadvantage due to slowly progressing alongside these industries and keeping up with novel changes. While Chapters 2 and 3 contain data collected within a decade, I acknowledge that the

results might not be fully applicable to current tobacco and cannabis use patterns. Second, in each chapter, I operationalized current tobacco and cannabis use as any use in the past 30 days, which is not always indicative of problematic use or misuse. Assessing problematic use or misuse might be better by also incorporating measures of frequency (e.g., specific number of days used in the past 30 days) and intensity (e.g., number of times used each day) into study designs and analytic plans. Third, I was limited in my ability to inclusively define race/ethnicity in each chapter. Scholars have voiced the need for inclusive operationalization of race/ethnicity variables in epidemiological studies and observational research.^{231,412} I conducted post-hoc sub-analyses that further unpacked the “another race/ethnicity” group where power permitted (Chapters 2-5) to justify (or discredit) aggregation. There are inherent disadvantages to aggregation of identity variables and sometimes the benefits do not outweigh the drawbacks. For example, given that no true inferences can be made on the groups that identify as another race/ethnicity, due to implied heterogeneity, this group’s purpose in analyses does not extend beyond preserving statistical power and practicing inclusivity in research. I attempted to disaggregate this group more to estimate associations for specific racial/ethnic groups. Despite these limitations, this dissertation is valuable in that it demonstrates clear racial/ethnic disparities in tobacco and cannabis use and how they are associated with culturally relevant psychosocial determinants of health.

7.5 Conclusion

The findings in this dissertation provide policymakers, clinicians, and public health professionals with evidence that psychosocial determinants of health that are culturally salient to racial/ethnic minoritized groups are associated with tobacco and cannabis use outcomes among US youth and adults. I found that these associations differed by race/ethnicity, indicating that

racial/ethnic disparities in tobacco and cannabis use might be driven by psychosocial factors. Specifically, racial/ethnic discrimination might be differentially associated with tobacco and cannabis use outcomes depending on race/ethnicity for adults, while the same was observed for internalizing/externalizing problems among US youth and YAs and concern/worry/stress about societal discrimination, societal shootings/violence, and community police brutality among YAs living in LA, California. As stress, whether race-related or not, continues to plague racial/ethnic minoritized populations as a potential mechanism for tobacco and cannabis use, considerations of promoting racial/ethnic health equity are needed to reduce use, mitigate disparities, and foster a healthier nation for all.

Appendix A Chapter 2

Appendix for Chapter 2: Discrimination and Tobacco Use Outcomes Among US Adults: Effect Modification by Race/Ethnicity

Table A.1 Definition and Weighted Prevalence of the Patterns of Tobacco use Variable

Past 30-Day Patterns of Tobacco Use	n (%)
16-category variable	
1. Never/former	26956 (75.8)
2. Exclusive cigarette	6999 (18.2)
3. Exclusive OC	369 (1.0)
4. Exclusive SLT	522 (1.8)
5. Exclusive ENDS	82 (0.2)
6. Dual cigarette + OC	323 (0.9)
7. Dual cigarette + SLT	195 (0.7)
8. Dual cigarette + ENDS	349 (1.1)
9. Dual OC + SLT	17 (0.1)
10. Dual OC + ENDS	9 (0.0)
11. Dual SLT + ENDS	1 (0.0)
12. Poly cigarette + OC + SLT	28 (0.1)
13. Poly cigarette + OC + ENDS	18 (0.1)
14. Poly cigarette + SLT + ENDS	10 (0.0)
15. Poly OC + SLT + ENDS	1 (0.0)
16. Poly cigarette + OC + SLT + ENDS	2 (0.0)
4-category variable	
Never/former (category 0)	26956 (75.8)
Exclusive use (categories 2-5)	7972 (21.3)
Dual use (categories 6-11)	894 (2.7)
Poly use (categories 12-16)	59 (0.2)

OC: Other combustible; SLT: Smokeless tobacco; ENDS: Electronic nicotine delivery systems

Table A.2 Diagnostic Criteria for Tobacco Use Disorder According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)

A problematic pattern of tobacco use leading to clinically significant impairment or distress, as manifested by at least two of the following, occurring within a 12-month period:

1. Tobacco is often taken in larger amounts or over a longer period than was intended.
 2. There is a persistent desire or unsuccessful efforts to cut down or control tobacco use.
 3. A great deal of time is spent in activities necessary to obtain or use tobacco.
 4. Craving, or a strong desire or urge to use tobacco.
 5. Recurrent tobacco use resulting in a failure to fulfill major role obligations at work, school, or home (e.g., interference with work).
 6. Continued tobacco use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of tobacco (e.g., arguments with others about tobacco use).
 7. Important social, occupational, or recreational activities are given up or reduced because of tobacco use.
 8. Recurrent tobacco use in situations in which it is physically hazardous (e.g., smoking in bed).
 9. Tobacco use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by tobacco.
 10. Tolerance, as defined by either of the following:
 - a. A need for markedly increased amounts of tobacco to achieve the desired effect.
 - b. A markedly diminished effect with continued use of the same amount of tobacco.
 11. Withdrawal, as manifested by either of the following:
 - a. The characteristic withdrawal syndrome for tobacco.
 - b. Tobacco (or a closely related substance, such as nicotine) is taken to relieve or avoid withdrawal symptoms.
-

Table A.3 Weighted Prevalence of Individual Tobacco Use Outcomes

Past 30-day cigarette use, n (%)	
Never/former	27957 (79.0)
Yes	7924 (21.0)
Past 30-day OC use, n (%)	
Never/former	35148 (97.8)
Yes	767 (2.2)
Past 30-day SLT, n (%)	
Never/former	35105 (97.3)
Yes	776 (2.7)
Past 30-day ENDS use, n (%)	
Never/former	35409 (98.6)
Yes	472 (1.4)

ENDS: electronic nicotine delivery systems; OC: other combustible tobacco products; SLT: smokeless tobacco

Table A.4 Weighted Prevalence of Participant Characteristics by Past 30-Day Patterns of Tobacco Use

Participant Characteristics	Past 30-Day Patterns of Tobacco Use				P-value
	Never/Former (n=26956)	Exclusive (n=7972)	Dual (n=894)	Poly (n=59)	
Age (mean \pm SD)	47.8 \pm 18.3	43.2 \pm 15.6	39.1 \pm 13.7	31.9 \pm 9.8	<0.001
Sex, n (%)					<0.001
Female	16153 (55.2)	3811 (43.8)	263 (28.7)	8 (9.6)	
Male	10803 (44.8)	4161 (56.2)	631 (71.3)	51 (90.4)	
Race/ethnicity, n (%)					<0.001
Hispanic	5732 (16.0)	1098 (10.5)	113 (9.7)	3 (2.3)	
NH White	13774 (64.6)	4610 (71.1)	574 (75.8)	50 (90.1)	
NH Black	5600 (11.5)	1876 (12.8)	164 (9.9)	2 (2.1)	
Another race/ethnicity	1850 (7.9)	388 (5.6)	43 (4.6)	4 (5.5)	
Highest educational attainment, n (%)					<0.001
High school graduate/GED or less	10389 (34.6)	4242 (52.1)	434 (49.6)	31 (50.0)	
Some college	8810 (32.5)	2774 (34.5)	360 (38.8)	24 (46.0)	
College graduate	7757 (33.0)	956 (13.3)	100 (11.6)	4 (3.9)	
Annual household income, n (%)					<0.001
Less than \$25,000	8719 (24.5)	3520 (36.1)	367 (33.7)	29 (45.5)	
\$25,000 to \$59,999	9296 (32.3)	2809 (35.9)	327 (36.8)	20 (33.5)	
\$60,000 or more	8941 (43.2)	1643 (27.9)	200 (29.5)	10 (21.0)	
Urbanicity, n (%)					<0.001
Urban	22745 (80.4)	6376 (74.3)	672 (68.4)	40 (64.1)	
Rural	4211 (19.6)	1596 (25.7)	222 (31.6)	19 (35.9)	
Geographic region, n (%)					<0.001
Northeast	3971 (19.0)	1066 (16.7)	98 (12.2)	9 (16.2)	
Midwest	5298 (20.5)	1981 (24.6)	198 (23.6)	10 (20.3)	
South	10560 (25.8)	3326 (40.3)	394 (42.9)	25 (42.2)	
West	7127 (24.7)	1599 (18.4)	204 (21.4)	15 (21.3)	
Past-year discrimination scale (mean \pm SD)	0.9 \pm 2.2	1.3 \pm 2.7	1.5 \pm 2.8	2.0 \pm 3.1	<0.001

Table A.5 Weighted Prevalence of Participant Characteristics by Past-Year DSM-5 Tobacco Use Disorder

Participant Characteristics	Past-Year DSM-5 Tobacco Use Disorder		P-value
	No (n=28703)	Yes (n=7178)	
Age (mean \pm SD)	47.65 \pm 18.24	42.11 \pm 14.99	<0.001
Sex, n (%)			<0.001
Female	16790 (53.9)	3445 (44.2)	
Male	11913 (46.1)	3733 (55.8)	
Race/ethnicity, n (%)			<0.001
Hispanic	6085 (16.1)	861 (8.8)	
NH White	14604 (64.4)	4404 (73.8)	
NH Black	6072 (11.7)	1570 (11.8)	
Another race/ethnicity	1942 (7.7)	343 (5.5)	
Highest educational attainment, n (%)			<0.001
High school graduate/GED or less	11325 (35.5)	3771 (51.8)	
Some college	9371 (32.4)	2597 (35.9)	
College graduate	8007 (32.1)	810 (12.3)	
Annual household income, n (%)			<0.001
Less than \$25,000	9425 (24.9)	3210 (36.7)	
\$25,000 to \$59,999	9916 (32.5)	2536 (36.2)	
\$60,000 or more	9362 (42.6)	1432 (27.1)	
Urbanicity, n (%)			<0.001
Urban	24187 (80.1)	5646 (73.2)	
Rural	4516 (19.9)	1532 (26.8)	
Geographic region, n (%)			<0.001
Northeast	4172 (18.6)	972 (16.9)	
Midwest	5734 (20.8)	1753 (24.4)	
South	11338 (36.2)	2967 (39.8)	
West	7459 (24.4)	1486 (18.9)	
Past-year discrimination scale (mean \pm SD)	0.9 \pm 2.2	1.4 \pm 2.8	<0.001

Table A.6 Adjusted Associations Between Past-Year Discrimination and Past 30-Day Individual Tobacco Product Use

	Past 30-Day Individual Tobacco Product Use ^{a, b}			
	Cigarette	Other Combustibles ^c	Smokeless Tobacco	Electronic Nicotine Delivery Systems
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Past-year discrimination scale	1.06 (1.05-1.08)	1.08 (1.05-1.11)	1.05 (1.01-1.10)	1.03 (1.00-1.07)
Age (continuous) ^d	0.84 (0.82-0.85)	0.94 (0.89-1.00)	0.75 (0.70-0.80)	0.71 (0.67-0.77)
Age, quadratic (continuous) ^d	0.87 (0.85-0.88)	0.95 (0.93-0.98)	0.94 (0.90-0.97)	0.89 (0.85-0.94)
Sex (ref: female)				
Male	1.33 (1.24-1.43)	8.13 (6.48-10.20)	18.00 (12.03-26.93)	0.92 (0.73-1.16)
Race/ethnicity (ref: NH White)				
Hispanic	0.35 (0.31-0.39)	0.48 (0.36-0.64)	0.15 (0.11-0.21)	0.31 (0.22-0.45)
NH Black	0.58 (0.52-0.64)	0.96 (0.76-1.21)	0.23 (0.15-0.35)	0.31 (0.22-0.44)
Another race/ethnicity	0.64 (0.55-0.75)	0.50 (0.30-0.82)	0.37 (0.24-0.58)	0.64 (0.43-0.95)
Highest educational attainment (ref: high school graduate/GED or less)				
Some college	0.65 (0.60-0.70)	1.11 (0.88-1.39)	0.84 (0.65-1.09)	0.97 (0.73-1.30)
College graduate	0.24 (0.22-0.27)	0.62 (0.47-0.82)	0.52 (0.39-0.69)	0.36 (0.25-0.54)
Annual household income (ref: less than \$25,000)				
\$25,000 to \$59,999	0.70 (0.65-0.75)	0.80 (0.65-0.98)	1.17 (0.91-1.51)	0.87 (0.67-1.14)
\$60,000 or more	0.42 (0.37-0.47)	0.66 (0.54-0.81)	1.13 (0.83-1.55)	0.81 (0.55-1.20)
Urbanicity (ref: urban)				
Rural	1.00 (0.90-1.11)	1.15 (0.90-1.45)	3.03 (2.36-3.89)	1.03 (0.77-1.38)
Geographic region (Northeast)				
Midwest	1.13 (0.98-1.30)	1.12 (0.80-1.58)	2.86 (1.95-4.19)	0.80 (0.52-1.24)
South	1.04 (0.90-1.21)	1.39 (1.03-1.88)	3.27 (2.33-4.61)	0.96 (0.65-1.43)
West	0.85 (0.73-0.98)	0.98 (0.69-1.38)	2.39 (1.49-3.82)	1.25 (0.80-1.98)

Bolded text indicates statistical significance (p<0.05)

^aThe outcome referent group: never/former use

^bAdjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, race/ethnicity, highest educational attainment, annual household income, urbanicity, and geographic region

^cOther combustibles include past 30-day use of cigar or traditional pipe products

^dEach one-unit increase in age is rescaled to represent 10 years

Table A.7 Adjusted Associations Between Prior-to-Past-Year Discrimination and Past 30-Day Patterns of Tobacco Use

	Past 30-Day Patterns of Tobacco Use ^a					
	Exclusive		Dual		Poly	
	Unadjusted	Adjusted ^b	Unadjusted	Adjusted ^b	Unadjusted	Adjusted ^b
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Prior-to-past-year discrimination scale	1.05 (1.04-1.06)	1.06 (1.05-1.07)	1.08 (1.06-1.11)	1.10 (1.08-1.13)	1.10 (1.03-1.18)	1.16 (1.08-1.25)
Age (continuous) ^c	0.86 (0.84-0.87)	0.85 (0.84-0.87)	0.74 (0.71-0.77)	0.70 (0.65-0.74)	0.52 (0.42-0.65)	0.40 (0.29-0.55)
Age, quadratic (continuous) ^c	0.90 (0.89-0.92)	0.87 (0.86-0.88)	0.91 (0.89-0.94)	0.86 (0.83-0.90)	0.98 (0.91-1.05)	0.79 (0.65-0.95)
Sex (ref: female)						
Male	1.58 (1.49-1.68)	1.64 (1.53-1.75)	3.09 (2.56-3.72)	3.13 (2.58-3.80)	11.63 (5.00-27.05)	12.01 (5.04-28.58)
Race/ethnicity (ref: NH White)						
Hispanic	0.60 (0.54-0.66)	0.33 (0.30-0.37)	0.52 (0.39-0.67)	0.24 (0.18-0.33)	0.10 (0.03-0.33)	0.03 (0.01-0.12)
NH Black	0.52 (0.39-0.67)	0.56 (0.51-0.62)	0.73 (0.58-0.93)	0.38 (0.30-0.48)	0.13 (0.03-0.62)	0.05 (0.00-0.26)
Another race/ethnicity	0.64 (0.56-0.74)	0.59 (0.51-0.69)	0.50 (0.35-0.72)	0.42 (0.29-0.61)	0.50 (0.16-1.53)	0.35 (0.13-0.99)
Highest educational attainment (ref: high school graduate/GED or less)						
Some college	0.71 (0.66-0.76)	0.65 (0.60-0.70)	0.84 (0.70-1.00)	0.74 (0.61-0.92)	0.98 (0.51-1.90)	0.86 (0.46-1.61)
College graduate	0.27 (0.24-0.29)	0.26 (0.24-0.29)	0.24 (0.19-0.32)	0.25 (0.18-0.33)	0.08 (0.03-0.24)	0.10 (0.03-0.31)
Annual household income (ref: less than \$25,000)						
\$25,000 to \$59,999	0.76 (0.71-0.81)	0.72 (0.67-0.78)	0.83 (0.68-1.02)	0.76 (0.61-0.95)	0.56 (0.29-1.08)	0.48 (0.25-0.93)
\$60,000 or more	0.44 (0.40-0.48)	0.46 (0.42-0.51)	0.50 (0.37-0.66)	0.51 (0.37-0.69)	0.26 (0.12-0.57)	0.27 (0.12-0.61)
Urbanicity (ref: urban)						
Rural	1.42 (1.25-1.62)	1.11 (1.00-1.23)	1.89 (1.49-2.40)	1.59 (1.26-2.00)	2.29 (1.37-3.82)	1.89 (1.06-3.36)
Geographic region (Northeast)						
Midwest	1.36 (1.18-1.57)	1.19 (1.05-1.35)	1.77 (1.26-2.50)	1.48 (1.04-2.11)	1.16 (0.52-2.58)	0.88 (0.39-1.98)
South	1.29 (1.12-1.48)	1.12 (0.98-1.29)	1.87 (1.36-2.58)	1.63 (1.18-2.27)	1.39 (0.73-2.62)	1.16 (0.61-2.22)
West	0.85 (0.74-0.98)	0.86 (0.75-0.99)	1.35 (0.97-1.87)	1.40 (0.99-1.98)	1.01 (0.38-2.67)	1.05 (0.40-2.75)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: never/former use

^b Odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, race/ethnicity, highest educational attainment, annual household income, urbanicity, and geographic region

^c Each one-unit increase in age is rescaled to represent 10 years

Table A.8 Adjusted Associations Between Prior-to-Past-Year Discrimination and Past-Year DSM-5 Tobacco Use Disorder

	Past-Year DSM-5 Tobacco Use Disorder	
	Unadjusted	Adjusted ^b
	OR (95% CI)	OR (95% CI)
Prior-to-past-year discrimination scale	1.07 (1.06-1.08)	1.09 (1.08-1.10)
Age (continuous) ^c	0.83 (0.82-0.85)	0.81 (0.79-0.83)
Age, quadratic (continuous) ^c	0.91 (0.89-0.92)	0.87 (0.86-0.88)
Sex (ref: female)		
Male	1.48 (1.39-1.58)	1.47 (1.36-1.58)
Race/ethnicity (ref: NH White)		
Hispanic	0.48 (0.43-0.54)	0.23 (0.21-0.28)
NH Black	0.88 (0.80-0.98)	0.45 (0.41-0.51)
Another race/ethnicity	0.62 (0.52-0.73)	0.52 (0.44-0.62)
Highest educational attainment (ref: high school graduate/GED or less)		
Some college	0.76 (0.71-0.82)	0.67 (0.62-0.73)
College graduate	0.26 (0.24-0.29)	0.25 (0.23-0.28)
Annual household income (ref: less than \$25,000)		
\$25,000 to \$59,999	0.76 (0.70-0.82)	0.72 (0.67-0.79)
\$60,000 or more	0.43 (0.39-0.48)	0.45 (0.41-0.51)
Urbanicity (ref: urban)		
Rural	1.48 (1.30-1.67)	1.15 (1.04-1.27)
Geographic region (Northeast)		
Midwest	1.29 (1.14-1.47)	1.09 (0.96-1.24)
South	1.21 (1.06-1.39)	1.04 (0.91-1.19)
West	0.86 (0.74-1.00)	0.88 (0.74-1.03)

Bolded text indicates statistical significance (p<0.05)

^aThe outcome referent group: no past-year DSM-5 tobacco use disorder

^bAdjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, race/ethnicity, highest educational attainment, annual household income, urbanicity, and geographic region

^cEach one-unit increase in age is rescaled to represent 10 years

Table A.9 Adjusted Associations Between Prior-to-Past-Year Discrimination and Tobacco Use Outcomes Stratified by Race/Ethnicity

	Race/ethnicity ^a			
	Hispanic	NH White	NH Black	Another Race/Ethnicity
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past 30-Day Patterns of Tobacco Use ^c				
Exclusive use	1.03 (1.01-1.06)	1.07 (1.05-1.09)	1.04 (1.03-1.06)	1.08 (1.05-1.11)
Dual/poly use	1.02 (0.96-1.09)	1.16 (1.12-1.19)	1.06 (1.02-1.09)	1.09 (0.98-1.21)
Past-Year DSM-5 Tobacco Use Disorder ^d				
Meets criteria	1.05 (1.02-1.08)	1.11 (1.09-1.14)	1.08 (1.06-1.10)	1.10 (1.06-1.14)

Bolded text indicates statistical significance (p<0.05)

^a Each racial/ethnic category represents a separate model for each outcome

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, highest educational attainment, annual household income, urbanicity, and geographic region

^c The outcome referent group: never/former use

^d The outcome referent group: no tobacco use disorder

Table A.10 Adjusted Associations Between Past-Year Discrimination and Past 30-Day Patterns of Tobacco Use (Referent Group: Exclusive Tobacco Use)

	Past 30-Day Patterns of Tobacco Use ^a		
	Never/Former	Dual	Poly
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past-year discrimination scale	0.95 (0.93-0.96)	1.04 (1.01-1.07)	1.11 (1.03-1.21)
Age (continuous) ^c	1.16 (1.14-1.19)	0.82 (0.77-0.87)	0.47 (0.34-0.65)
Age, quadratic (continuous) ^c	1.15 (1.13-1.17)	0.99 (0.95-1.03)	0.90 (0.75-1.08)
Sex (ref: female)			
Male	0.61 (0.57-0.65)	1.92 (1.58-2.32)	7.38 (3.13-17.43)
Race/ethnicity (ref: NH White)			
Hispanic	3.02 (2.72-3.37)	0.75 (0.55-1.02)	0.10 (0.03-0.35)
NH Black	1.73 (1.57-1.92)	0.69 (0.55-0.87)	0.09 (0.02-0.48)
Another race/ethnicity	1.63 (1.40-1.89)	0.72 (0.49-1.05)	0.60 (0.24-1.50)
Highest educational attainment (ref: high school graduate/GED or less)			
Some college	1.53 (1.42-1.65)	1.16 (0.94-1.43)	1.34 (0.72-2.50)
College graduate	3.76 (3.41-4.14)	0.95 (0.71-1.26)	0.37 (0.11-1.22)
Annual household income (ref: less than \$25,000)			
\$25,000 to \$59,999	1.39 (1.29-1.50)	1.06 (0.85-1.32)	0.68 (0.36-1.31)
\$60,000 or more	2.17 (1.96-2.41)	1.10 (0.82-1.49)	0.59 (0.25-1.37)
Urbanicity (ref: urban)			
Rural	0.91 (0.82-1.01)	1.42 (1.15-1.77)	1.68 (0.95-2.98)
Geographic region (Northeast)			
Midwest	0.84 (0.74-0.96)	1.25 (0.88-1.79)	0.74 (0.32-1.67)
South	0.89 (0.78-1.02)	1.45 (1.04-2.02)	1.02 (0.54-1.95)
West	1.16 (1.01-1.34)	1.64 (1.15-2.34)	1.24 (0.49-3.12)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: never/former use

^b Odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, race/ethnicity, highest educational attainment, annual household income, urbanicity, and geographic region

^c Each one-unit increase in age is rescaled to represent 10 years

Table A.11 Adjusted Associations Between Past-Year Discrimination and Past 30-Day Patterns of Tobacco Use (Referent Group: Exclusive Tobacco Use) Stratified by Race/Ethnicity

	Race/ethnicity ^a			
	Hispanic	NH White	NH Black	Another Race/Ethnicity
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past 30-Day Patterns of Tobacco Use ^c				
Never/former use	0.97 (0.95-1.00)	0.92 (0.89-0.94)	0.96 (0.94-0.98)	0.93 (0.89-0.97)
Dual/poly use	0.98 (0.92-1.05)	1.08 (1.04-1.12)	1.01 (0.97-1.06)	0.97 (0.86-1.08)

Bolded text indicates statistical significance (p<0.05)

^a Each racial/ethnic category represents a separate model for each outcome

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, highest educational attainment, annual household income, urbanicity, and geographic region

^c The outcome referent group: exclusive use

Table A.12 Adjusted Associations Between Past-Year Discrimination and Tobacco Use Outcomes Stratified by Race/Ethnicity After Disaggregating "Another Race/Ethnicity"

	Race/ethnicity ^a				
	Hispanic	NH White	NH Black	NH American Indian/Alaska Native	NH Asian/Native Hawaiian/other Pacific Islander
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past 30-Day Patterns of Tobacco Use ^c					
Exclusive use	1.03 (1.002-1.06)	1.09 (1.07-1.12)	1.04 (1.02-1.06)	1.03 (0.97-1.10)	1.08 (1.02-1.15)
Dual/poly use	1.01 (0.95-1.08)	1.18 (1.13-1.22)	1.05 (1.002-1.11)	0.89 (0.76-1.04)	1.10 (0.96-1.26)
Past-Year DSM-5 Tobacco Use Disorder ^d					
Meets criteria	1.05 (1.02-1.07)	1.13 (1.11-1.16)	1.07 (1.05-1.09)	1.04 (0.97-1.11)	1.10 (1.04-1.17)
Bolded text indicates statistical significance (p<0.05)					
^a Each racial/ethnic category represents a separate model for each outcome					
^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, sex, highest educational attainment, annual household income, urbanicity, and geographic region					
^c The outcome referent group: never/former use					
^d The outcome referent group: no tobacco use disorder					

Appendix B Chapter 3

Appendix for Chapter 3: Racial/Ethnic Discrimination and Tobacco and Cannabis Use Outcomes
Among US Adults

Table B.1 Diagnostic Criteria for Tobacco and Cannabis Use Disorders According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)

DSM-5 Tobacco Use Disorder

A problematic pattern of tobacco use leading to clinically significant impairment or distress, as manifested by at least two of the following, occurring within a 12-month period:

1. Tobacco is often taken in larger amounts or over a longer period than was intended.
 2. There is a persistent desire or unsuccessful efforts to cut down or control tobacco use.
 3. A great deal of time is spent in activities necessary to obtain or use tobacco.
 4. Craving, or a strong desire or urge to use tobacco.
 5. Recurrent tobacco use resulting in a failure to fulfill major role obligations at work, school, or home (e.g., interference with work).
 6. Continued tobacco use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of tobacco (e.g., arguments with others about tobacco use).
 7. Important social, occupational, or recreational activities are given up or reduced because of tobacco use.
 8. Recurrent tobacco use in situations in which it is physically hazardous (e.g., smoking in bed).
 9. Tobacco use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by tobacco.
 10. Tolerance, as defined by either of the following:
 - a. A need for markedly increased amounts of tobacco to achieve the desired effect.
 - b. A markedly diminished effect with continued use of the same amount of tobacco.
 11. Withdrawal, as manifested by either of the following:
 - a. The characteristic withdrawal syndrome for tobacco.
 - b. Tobacco (or a closely related substance, such as nicotine) is taken to relieve or avoid withdrawal symptoms.
-

DSM-5 Cannabis Use Disorder

A problematic pattern of cannabis use leading to clinically significant impairment or distress, as manifested by at least two of the following, occurring within a 12-month period

1. Cannabis is often taken in larger amounts or over a longer period than was intended.
2. There is a persistent desire or unsuccessful efforts to cut down or control cannabis use.
3. A great deal of time is spent in activities necessary to obtain cannabis, use cannabis, or recover from its effects.
4. Craving, or a strong desire or urge to use cannabis.
5. Recurrent cannabis use resulting in a failure to fulfill major role obligations at work, school, or home.

6. Continued cannabis use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of cannabis.
 7. Important social, occupational, or recreational activities are given up or reduced because of cannabis use.
 8. Recurrent cannabis use in situations in which it is physically hazardous.
 9. Cannabis use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by cannabis.
 10. Tolerance, as defined by either of the following:
 - a. A need for markedly increased amounts of cannabis to achieve intoxication or desired effect.
 - b. Markedly diminished effect with continued use of the same amount of cannabis.
 11. Withdrawal, as manifested by either of the following:
 - a. The characteristic withdrawal syndrome for cannabis (refer to Criteria A and B of the criteria set for cannabis withdrawal, pp. 517–518).
 - b. Cannabis (or a closely related substance) is taken to relieve or avoid withdrawal symptoms.
-

Table B.2 Weighted Prevalence of Individual Tobacco and Cannabis Use Outcomes

Past 30-day cigarette use, n (%)	
Never/former	27876 (79.0)
Current	7868 (21.0)
Past 30-day ENDS use, n (%)	
Never/former	35276 (98.6)
Current	468 (1.4)
Past 30-day OC use, n (%)	
Never/former	34979 (97.8)
Current	765 (2.2)
Past 30-day SLT use, n (%)	
Never/former	34973 (97.3)
Current	771 (2.7)
Past 30-day cannabis use, n (%)	
Never/former	33204 (93.6)
Current	2540 (6.4)

ENDS: electronic nicotine delivery systems; OC: other combustibles; SLT: smokeless tobacco

Table B.3 Weighted Prevalence of Participant Characteristics by Past 30-Day Patterns of Tobacco and Cannabis Use

Participant Characteristics	Past 30-Day Patterns of Tobacco and Cannabis Use						P-value ^a
	Never/former	Individual Tobacco & Non-Cannabis	Individual Tobacco & Cannabis	Individual Cannabis & Non-Tobacco	Dual/Poly Tobacco & Non-Cannabis	Dual/Poly Tobacco & Cannabis	
Age (mean ± SD)	48.3 ± 18.2	44.8 ± 15.3	34.2 ± 13.7	34.1 ± 16.0	40.6 ± 13.3	32.1 ± 12.0	<0.001
Sex, n (%)							<0.001
Female	15694 (55.9)	3285 (45.5)	504 (35.3)	419 (37.3)	224 (30.4)	43 (15.5)	
Male	10175 (44.1)	3342 (54.5)	788 (64.7)	591 (62.7)	484 (69.6)	195 (84.5)	
Race/ethnicity, n (%)							<0.001
Hispanic	5516 (16.0)	899 (10.3)	191 (11.9)	207 (17.4)	88 (8.4)	27 (10.4)	
NH White	13288 (64.8)	3926 (72.4)	652 (63.8)	445 (57.9)	488 (80.0)	131 (67.2)	
NH Black	5275 (11.3)	1487 (11.8)	378 (17.9)	306 (18.9)	93 (6.3)	72 (19.8)	
Another race/ethnicity	1790 (7.9)	315 (5.5)	71 (6.3)	52 (5.8)	39 (5.4)	8 (2.6)	
Highest educational attainment, n (%)							<0.001
High school graduate/GED or less	9962 (34.5)	3518 (52.1)	692 (52.0)	397 (36.5)	345 (49.4)	116 (50.9)	
Some college	8374 (32.2)	2299 (34.2)	464 (37.2)	416 (42.3)	282 (38.8)	99 (40.5)	
College graduate	7533 (33.3)	810 (13.7)	136 (10.8)	197 (21.1)	81 (11.8)	23 (8.7)	
Annual household income, n (%)							<0.001
Less than \$25,000	8248 (24.1)	2807 (34.1)	684 (46.6)	439 (36.9)	270 (30.5)	122 (47.9)	
\$25,000 to \$59,999	8928 (32.3)	2381 (36.7)	414 (32.2)	344 (32.6)	275 (39.0)	71 (29.4)	
\$60,000 or more	8693 (43.6)	1439 (29.2)	194 (21.2)	227 (30.5)	163 (30.6)	45 (22.7)	
Urbanicity, n (%)							<0.001
Urban	21761 (80.2)	5213 (72.6)	1128 (83.8)	913 (86.4)	522 (66.8)	185 (72.0)	
Rural	4108 (19.8)	1414 (27.4)	164 (16.2)	97 (13.6)	186 (33.2)	53 (28.0)	
Geographic region, n (%)							<0.001
Northeast	3801 (18.9)	844 (15.8)	216 (21.8)	157 (20.9)	69 (10.5)	38 (19.3)	
Midwest	5103 (20.7)	1660 (25.2)	311 (21.8)	184 (15.6)	160 (25.1)	47 (18.0)	
South	10238 (36.1)	2875 (41.8)	421 (31.8)	285 (25.5)	317 (42.8)	97 (41.8)	
West	6727 (24.3)	1248 (17.3)	344 (24.6)	384 (38.0)	162 (21.6)	56 (20.8)	
Past-year discrimination scale (mean ± SD)	0.9 ± 2.1	1.2 ± 2.6	1.8 ± 3.3	1.5 ± 3.0	1.4 ± 2.6	2.0 ± 3.2	<0.001

^a Chi-square test of independence or ANOVA comparing each participant characteristic across tobacco and cannabis use

Table B.4 Weighted Prevalence of Participant Characteristics by Past-Year Tobacco and Cannabis Use Disorders

Participant Characteristics	Past-Year DSM-5 Tobacco and Cannabis Use Disorders				P-value ^a
	No Disorder	Individual Tobacco Use Disorder	Individual Cannabis Use Disorder	Joint Tobacco & Cannabis Use Disorders	
Age (mean ± SD)	47.8 ± 18.2	43.1 ± 14.8	31.5 ± 14.6	30.7 ± 11.8	<0.001
Sex, n (%)					<0.001
Female	16609 (54.2)	3210 (45.2)	136 (33.2)	214 (34.3)	
Male	11634 (45.8)	3326 (54.8)	241 (66.8)	374 (65.7)	
Race/ethnicity, n (%)					<0.001
Hispanic	5985 (16.1)	776 (8.6)	89 (22.3)	78 (10.9)	
NH White	14412 (64.6)	4076 (74.8)	151 (51.9)	291 (62.2)	
NH Black	5931 (11.6)	1372 (11.1)	118 (20.5)	190 (20.2)	
Another race/ethnicity	1915 (7.7)	312 (5.4)	19 (5.3)	29 (6.6)	
Highest educational attainment, n (%)					<0.001
High school graduate/GED or less	11139 (35.5)	3432 (51.8)	150 (38.3)	309 (51.6)	
Some college	9200 (32.3)	2353 (35.5)	150 (39.9)	231 (41.1)	
College graduate	7904 (32.2)	751 (12.7)	77 (21.8)	48 (7.3)	
Annual household income, n (%)					<0.001
Less than \$25,000	9234 (24.8)	2870 (35.7)	155 (35.8)	311 (47.2)	
\$25,000 to \$59,999	9761 (32.5)	2338 (36.6)	129 (32.6)	185 (32.1)	
\$60,000 or more	9248 (42.7)	1328 (27.7)	93 (31.6)	92 (20.7)	
Urbanicity, n (%)					<0.001
Urban	23768 (80.0)	5108 (72.5)	344 (88.0)	502 (82.5)	
Rural	4475 (20.0)	1428 (27.5)	33 (12.0)	86 (17.5)	
Geographic region, n (%)					<0.001
Northeast	4092 (18.6)	871 (16.8)	67 (20.4)	95 (18.3)	
Midwest	5667 (20.9)	1596 (24.5)	56 (12.3)	146 (23.6)	
South	11178 (36.2)	2736 (40.2)	117 (31.0)	202 (34.5)	
West	7306 (24.3)	1333 (18.5)	137 (36.2)	145 (23.6)	
Past-year discrimination scale (mean ± SD)	0.9 ± 2.2	1.3 ± 2.7	1.7 ± 3.0	2.4 ± 3.3	<0.001

^a Chi-square test of independence or ANOVA comparing each participant characteristic across tobacco and cannabis use

Table B.5 Unadjusted Associations Between Past-Year Discrimination and Past 30-Day Patterns of Tobacco and Cannabis Use

	Past 30-Day Patterns of Tobacco and Cannabis Use ^a				
	Individual Tobacco & Non-Cannabis	Individual Tobacco & Cannabis	Individual Cannabis & Non-Tobacco	Dual/Poly Tobacco & Non-Cannabis	Dual/Poly Tobacco & Cannabis
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past-year discrimination scale	1.06 (1.04-1.07)	1.13 (1.11-1.15)	1.10 (1.08-1.13)	1.09 (1.05-1.13)	1.15 (1.11-1.19)
Age (continuous) ^c	0.89 (0.88-0.91)	0.58 (0.55-0.61)	0.58 (0.53-0.63)	0.77 (0.74-0.81)	0.52 (0.46-0.58)
Age, quadratic (continuous) ^c	0.89 (0.88-0.90)	0.97 (0.95-0.99)	1.01 (0.99-1.03)	0.89 (0.86-0.92)	0.99 (0.96-1.02)
Sex (ref: female)					
Male	1.51 (1.43-1.61)	2.32 (1.98-2.72)	2.12 (1.80-2.50)	2.89 (2.37-3.53)	6.91 (4.37-10.93)
Race/ethnicity (ref: NH White)					
Hispanic	0.57 (0.52-0.63)	0.76 (0.61-0.93)	1.22 (0.98-1.51)	0.43 (0.32-0.57)	0.63 (0.39-1.01)
NH Black	0.94 (0.85-1.03)	1.61 (1.31-2.00)	1.87 (1.55-2.27)	0.45 (0.34-0.59)	1.69 (1.16-2.46)
Another race/ethnicity	0.62 (0.54-0.72)	0.81 (0.58-1.14)	0.82 (0.56-1.19)	0.55 (0.36-0.84)	0.32 (0.15-0.69)
Highest educational attainment (ref: high school graduate/GED or less)					
Some college	0.70 (0.65-0.77)	0.77 (0.66-0.90)	1.24 (1.03-1.51)	0.84 (0.69-1.03)	0.86 (0.62-1.17)
College graduate	0.27 (0.25-0.30)	0.22 (0.17-0.28)	0.60 (0.48-0.75)	0.25 (0.19-0.33)	0.18 (0.10-0.30)
Annual household income (ref: less than \$25,000)					
\$25,000 to \$59,999	0.80 (0.74-0.87)	0.51 (0.45-0.59)	0.66 (0.55-0.78)	0.95 (0.74-1.22)	0.46 (0.32-0.66)
\$60,000 or more	0.47 (0.43-0.52)	0.25 (0.21-0.31)	0.46 (0.38-0.55)	0.55 (0.41-0.75)	0.26 (0.18-0.39)
Urbanicity (ref: urban)					
Rural	1.52 (1.32-1.76)	0.78 (0.61-0.99)	0.64 (0.43-0.95)	2.01 (1.56-2.58)	1.57 (1.08-2.27)
Geographic region (Northeast)					
Midwest	1.46 (1.24-1.70)	0.92 (0.68-1.23)	0.68 (0.49-0.95)	2.17 (1.44-3.27)	0.85 (0.55-1.31)
South	1.39 (1.19-1.62)	0.77 (0.59-0.99)	0.64 (0.47-0.88)	2.12 (1.44-3.14)	1.13 (0.77-1.67)
West	0.85 (0.73-0.99)	0.88 (0.67-1.15)	1.42 (1.05-1.91)	1.59 (1.03-2.48)	0.84 (0.57-1.23)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: never/former use of both tobacco and cannabis

^b Odds ratios (OR) and 95% confidence intervals (CI) are unadjusted

^c Each one-unit increase in age is rescaled to represent 10 years

Table B.6 Unadjusted Associations Between Past-Year Discrimination and Past-Year Tobacco and Cannabis Use Disorders

	Past-Year DSM-5 Tobacco and Cannabis Use Disorders ^a		
	Individual Tobacco Use Disorder	Individual Cannabis Use Disorder	Joint Tobacco & Cannabis Use Disorders
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past-year discrimination scale	1.08 (1.06-1.09)	1.12 (1.10-1.15)	1.18 (1.15-1.21)
Age (continuous) ^c	0.86 (0.84-0.87)	0.50 (0.45-0.57)	0.48 (0.44-0.52)
Age, quadratic (continuous) ^c	0.89 (0.88-0.90)	1.03 (1.01-1.06)	1.02 (1.00-1.04)
Sex (ref: female)			
Male	1.43 (1.35-1.53)	2.38 (1.83-3.09)	2.26 (1.77-2.88)
Race/ethnicity (ref: NH White)			
Hispanic	0.46 (0.41-0.53)	1.73 (1.27-2.35)	0.71 (0.55-0.91)
NH Black	0.83 (0.75-0.91)	2.20 (1.69-2.87)	1.81 (1.35-2.43)
Another race/ethnicity	0.61 (0.52-0.71)	0.85 (0.52-1.39)	0.88 (0.53-1.48)
Highest educational attainment (ref: high school graduate/GED or less)			
Some college	0.75 (0.70-0.81)	1.14 (0.87-1.50)	0.87 (0.70-1.09)
College graduate	0.27 (0.24-0.30)	0.63 (0.45-0.86)	0.16 (0.11-0.23)
Annual household income (ref: less than \$25,000)			
\$25,000 to \$59,999	0.78 (0.72-0.85)	0.69 (0.53-0.91)	0.52 (0.41-0.65)
\$60,000 or more	0.45 (0.40-0.50)	0.51 (0.37-0.70)	0.25 (0.19-0.33)
Urbanicity (ref: urban)			
Rural	1.52 (1.33-1.73)	0.54 (0.36-0.82)	0.85 (0.65-1.11)
Geographic region (Northeast)			
Midwest	1.30 (1.13-1.48)	0.54 (0.34-0.86)	1.15 (0.82-1.63)
South	1.23 (1.07-1.41)	0.78 (0.56-1.10)	0.97 (0.68-1.37)
West	0.85 (0.73-0.99)	1.36 (0.96-1.94)	0.99 (0.71-1.39)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: no past-year tobacco or cannabis use disorder

^b Odds ratios (OR) and 95% confidence intervals (CI) are unadjusted

^c Each one-unit increase in age is rescaled to represent 10 years

Table B.7 Adjusted Associations Between Prior-to-Past-Year Discrimination and Past 30-Day Patterns of Tobacco and Cannabis Use

	Past 30-Day Patterns of Tobacco and Cannabis Use ^a				
	Individual Tobacco & Non-Cannabis	Individual Tobacco & Cannabis	Individual Cannabis & Non-Tobacco	Dual/Poly Tobacco & Non-Cannabis	Dual/Poly Tobacco & Cannabis
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Prior-to-past-year discrimination scale	1.05 (1.04-1.07)	1.10 (1.08-1.12)	1.07 (1.05-1.10)	1.11 (1.08-1.14)	1.13 (1.09-1.18)
Age (continuous) ^c	0.90 (0.88-0.92)	0.55 (0.52-0.59)	0.61 (0.58-0.65)	0.72 (0.67-0.78)	0.47 (0.41-0.55)
Age, quadratic (continuous) ^c	0.86 (0.85-0.88)	0.88 (0.84-0.91)	1.01 (0.99-1.04)	0.85 (0.81-0.89)	0.88 (0.81-0.94)
Sex (ref: female)					
Male	1.58 (1.47-1.70)	2.45 (2.08-2.88)	2.24 (1.90-2.64)	2.97 (2.42-3.65)	7.45 (4.66-11.90)
Race/ethnicity (ref: NH White)					
Hispanic	0.33 (0.30-0.37)	0.25 (0.20-0.31)	0.53 (0.42-0.66)	0.20 (0.14-0.28)	0.22 (0.13-0.38)
NH Black	0.54 (0.49-0.60)	0.70 (0.56-0.89)	1.25 (1.00-1.57)	0.24 (0.18-0.32)	0.73 (0.46-1.14)
Another race/ethnicity	0.59 (0.51-0.69)	0.50 (0.35-0.71)	0.46 (0.31-0.68)	0.46 (0.30-0.70)	0.22 (0.10-0.47)
Highest educational attainment (ref: high school graduate/GED or less)					
Some college	0.65 (0.59-0.71)	0.68 (0.58-0.80)	1.17 (0.95-1.45)	0.73 (0.58-0.91)	0.85 (0.60-1.19)
College graduate	0.26 (0.23-0.29)	0.25 (0.19-0.33)	0.79 (0.60-1.04)	0.23 (0.17-0.32)	0.25 (0.15-0.43)
Annual household income (ref: less than \$25,000)					
\$25,000 to \$59,999	0.76 (0.70-0.83)	0.50 (0.43-0.58)	0.64 (0.54-0.76)	0.85 (0.65-1.10)	0.43 (0.29-0.64)
\$60,000 or more	0.49 (0.44-0.54)	0.28 (0.22-0.36)	0.47 (0.38-0.59)	0.53 (0.38-0.73)	0.29 (0.19-0.45)
Urbanicity (ref: urban)					
Rural	1.14 (1.02-1.27)	0.79 (0.62-1.00)	0.86 (0.57-1.29)	1.57 (1.22-2.01)	1.60 (1.12-2.28)
Geographic region (Northeast)					
Midwest	1.26 (1.11-1.45)	0.75 (0.57-1.00)	0.61 (0.45-0.82)	1.76 (1.15-2.69)	0.67 (0.43-1.05)
South	1.22 (1.06-1.40)	0.61 (0.47-0.81)	0.54 (0.40-0.73)	1.87 (1.27-2.77)	0.85 (0.56-1.29)
West	0.88 (0.77-1.02)	0.86 (0.64-1.17)	1.42 (1.04-1.94)	1.67 (1.06-2.65)	0.91 (0.60-1.36)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: never/former use of both tobacco and cannabis

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for all variables in the table

^c Each one-unit increase in age is rescaled to represent 10 years

Table B.8 Adjusted Associations Between Prior-to-Past-Year Discrimination and Past-Year Tobacco and Cannabis Use Disorders

	Past-Year DSM-5 Tobacco and Cannabis Use Disorders ^a		
	Individual Tobacco Use Disorder	Individual Cannabis Use Disorder	Joint Tobacco & Cannabis Use Disorders
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Prior-to-past-year discrimination scale	1.09 (1.07-1.10)	1.08 (1.05-1.12)	1.17 (1.13-1.20)
Age (continuous) ^c	0.84 (0.82-0.86)	0.56 (0.51-0.62)	0.47 (0.42-0.52)
Age, quadratic (continuous) ^c	0.86 (0.85-0.87)	1.06 (1.00-1.11)	0.92 (0.87-0.97)
Sex (ref: female)			
Male	1.43 (1.34-1.54)	2.39 (1.83-3.12)	2.21 (1.73-2.82)
Race/ethnicity (ref: NH White)			
Hispanic	0.24 (0.21-0.28)	0.77 (0.53-1.12)	0.22 (0.17-0.30)
NH Black	0.44 (0.39-0.49)	1.42 (1.08-1.89)	0.69 (0.49-0.97)
Another race/ethnicity	0.52 (0.44-0.61)	0.47 (0.29-0.78)	0.52 (0.30-0.88)
Highest educational attainment (ref: high school graduate/GED or less)			
Some college	0.67 (0.61-0.73)	1.15 (0.85-1.54)	0.76 (0.60-0.96)
College graduate	0.26 (0.23-0.29)	1.00 (0.67-1.48)	0.20 (0.13-0.30)
Annual household income (ref: less than \$25,000)			
\$25,000 to \$59,999	0.74 (0.68-0.81)	0.73 (0.55-0.97)	0.57 (0.45-0.72)
\$60,000 or more	0.46 (0.41-0.52)	0.61 (0.42-0.88)	0.35 (0.26-0.48)
Urbanicity (ref: urban)			
Rural	1.15 (1.04-1.28)	0.79 (0.52-1.21)	0.91 (0.69-1.20)
Geographic region (Northeast)			
Midwest	1.10 (0.97-1.24)	0.50 (0.31-0.79)	0.95 (0.66-1.36)
South	1.07 (0.93-1.21)	0.67 (0.48-0.93)	0.78 (0.53-1.14)
West	0.88 (0.74-1.03)	1.29 (0.89-1.88)	0.96 (0.66-1.39)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: no past-year tobacco or cannabis use disorder

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for all variables in the table

^c Each one-unit increase in age is rescaled to represent 10 years

Table B.9 Adjusted Associations Between Prior-to-Past-Year Discrimination and Tobacco and Cannabis Use Outcomes Stratified by Race/Ethnicity

	Race/Ethnicity ^a			
	Hispanic	NH White	NH Black	Another Race/Ethnicity
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past 30-day patterns of tobacco and cannabis use ^{c, e}				
Individual tobacco & non-cannabis	1.04 (1.01-1.06)	1.07 (1.05-1.10)	1.04 (1.02-1.06)	1.07 (1.03-1.11)
Individual tobacco & cannabis	1.04 (0.99-1.09)	1.13 (1.09-1.18)	1.08 (1.05-1.11)	1.14 (1.06-1.22)
Individual cannabis & non-tobacco	1.04 (1.002-1.08)	1.12 (1.07-1.17)	1.04 (1.01-1.08)	1.10 (1.02-1.18)
Dual/poly tobacco & non-cannabis	1.04 (0.96-1.12)	1.15 (1.11-1.20)	1.08 (1.03-1.13)	1.09 (0.96-1.23)
Dual/poly tobacco & cannabis	0.96 (0.86-1.08)	1.23 (1.16-1.30)	1.05 (1.00-1.10)	1.16 (1.04-1.30)
Past-Year DSM-5 tobacco and cannabis use disorders ^{d, e}				
Individual tobacco use disorder only	1.05 (1.02-1.08)	1.11 (1.09-1.13)	1.07 (1.05-1.09)	1.09 (1.05-1.13)
Individual cannabis use disorder only	1.04 (0.98-1.10)	1.09 (1.01-1.16)	1.10 (1.05-1.15)	1.19 (1.09-1.29)
Joint tobacco and cannabis use disorders	1.06 (1.003-1.13)	1.22 (1.17-1.28)	1.13 (1.10-1.17)	1.19 (1.06-1.34)

Bolded text indicates statistical significance (p<0.05)

^a Each racial/ethnic category represents a separate model for each outcome

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, quadratic age, sex, highest educational attainment, annual household income, urbanicity, and geographic region

^c P-value for the two-way interaction between discrimination and race/ethnicity for each level of the outcome in interaction models: individual tobacco & non-cannabis (p=0.02), individual tobacco & cannabis (p=0.006), individual cannabis & non-tobacco (p=0.02), dual/poly tobacco & non-cannabis (p=0.03), and dual/poly tobacco & cannabis (p<0.001)

^d P-value for the two-way interaction between discrimination and race/ethnicity for each level of the outcome in interaction models: individual tobacco use disorder (p=0.007), individual cannabis use disorder (p=0.01), and joint tobacco & cannabis use disorders (p=0.002)

^e The outcome referent group: never/former use of both tobacco and cannabis, no tobacco or cannabis use disorders

Table B.10 Adjusted Associations Between Past-Year Discrimination and Tobacco and Cannabis Use Outcomes Stratified by Race/Ethnicity After Disaggregating "Another Race/Ethnicity"

	Race/Ethnicity ^a				
	Hispanic	NH White	NH Black	NH American Indian/Alaska Native	NH Asian/Native Hawaiian/other Pacific Islander
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past 30-day patterns of tobacco and cannabis use ^c					
Individual tobacco & non-cannabis	1.03 (1.002-1.06)	1.09 (1.06-1.12)	1.03 (1.01-1.05)	1.05 (0.98-1.12)	-- ^d
Individual tobacco & cannabis	1.03 (0.98-1.09)	1.14 (1.10-1.19)	1.09 (1.05-1.13)	0.96 (0.84-1.11)	-- ^d
Individual cannabis & non-tobacco	1.05 (1.01-1.09)	1.09 (1.02-1.17)	1.06 (1.02-1.10)	0.96 (0.87-1.06)	-- ^d
Dual/poly tobacco & non-cannabis	1.03 (0.96-1.11)	1.17 (1.12-1.23)	1.07 (1.01-1.12)	0.91 (0.77-1.08)	-- ^d
Dual/poly tobacco & cannabis	0.99 (0.88-1.11)	1.24 (1.16-1.32)	1.06 (0.97-1.15)	0.76 (0.52-1.12)	-- ^d
Past-Year DSM-5 tobacco and cannabis use disorders ^c					
Individual tobacco use disorder only	1.04 (1.02-1.07)	1.13 (1.10-1.15)	1.06 (1.04-1.08)	1.05 (0.98-1.12)	1.09 (1.03-1.17)
Individual cannabis use disorder only	1.04 (0.97-1.11)	1.12 (1.03-1.22)	1.10 (1.05-1.14)	0.88 (0.68-1.15)	1.24 (1.09-1.42)
Joint tobacco and cannabis use disorders	1.06 (1.00-1.13)	1.24 (1.17-1.31)	1.13 (1.09-1.18)	0.92 (0.75-1.12)	1.27 (1.10-1.47)

Bolded text indicates statistical significance (p<0.05)

^a Each racial/ethnic category represents a separate model for each outcome

^b Adjusted odds ratios (OR) and 95% confidence intervals (CI) adjusted for age, quadratic age, sex, highest educational attainment, annual household income, urbanicity, and geographic region

^c The outcome referent group: never/former use of both tobacco and cannabis, no tobacco or cannabis use disorders

^d Model did not converge or standard errors were unreliable

Appendix C Chapter 4

Appendix for Chapter 4: Latent Classes of Tobacco and Cannabis Use Among US Emerging Adults

Table C.1 Information Criteria for Latent Classes Analysis Among Youth and Young Adult Samples

Model (K-class)	Information Criteria for Youth			
	AIC	BIC	SABIC	CAIC
1	8356.34	8387.33	8368.27	8393.33
2	7529.92	7597.08	7555.79	7610.08
3	7176.82	7280.14	7216.61	7300.14
4	6972.52	7112.01	7026.24	7139.01
5	6899.46	7075.12	6967.12	7109.12
6	6832.56	7044.38	6914.14	7085.38
7	6831.23	7079.21	6926.74	7127.21
8	6836.59	7120.73	6946.02	7175.73
9	6850.50	7170.81	6973.86	7232.81

Model (K-class)	Information Criteria for Young Adults			
	AIC	BIC	SABIC	CAIC
1	33654.98	33693.95	33674.88	33699.95
2	31264.50	31348.92	31307.61	31361.92
3	30050.87	30180.74	30117.19	30200.74
4	29598.29	29773.61	29687.81	29800.61
5	29196.69	29417.47	29309.43	29451.47
6	28917.00	29183.23	29052.95	29224.23
7	28891.21	29202.90	29050.37	29250.90
8	28886.38	29243.52	29068.75	29298.52
9	28892.19	29294.79	29097.78	29356.79

AIC: Akaike Information Criteria; BIC: Bayesian Information Criteria; SABIC: Sample-Size Adjusted Bayesian Information Criteria; CAIC: Constant Akaike Information Criteria
 Lowest values per sample are bolded

Table C.2 Conditional Item-Response Probabilities for Youth and Young Adult 6-Class Model Solutions

Class Indicators	Youth Latent Classes					
	Exclusive Cigarettes (2.5%)	Exclusive ENDS (2.6%)	Exclusive Blunts (2.5%)	Exclusive Other Cannabis (6.3%)	ENDS + Cannabis Vaping (2.7%)	Cigarettes + Cigars + Other Cannabis (1.5%)
Cigarette use	1.00	0.00	0.20	0.12	0.44	0.54
ENDS use	0.31	1.00	0.13	0.11	1.00	0.20
Cigar use	0.00	0.00	0.05	0.00	0.26	1.00
Blunt use	0.00	0.00	1.00	0.00	0.36	0.00
Cannabis vaping	0.00	0.17	0.00	0.00	0.96	0.00
Other cannabis use	0.12	0.00	0.00	1.00	0.00	0.51
Class Indicators	Young Adult Latent Classes					
	Exclusive Cigarettes (11.7%)	Exclusive ENDS (3.9%)	Exclusive Blunts (5.3%)	Exclusive Other Cannabis (7.0%)	Cigarettes + Cigars (8.2%)	Cigarettes + ENDS + Cannabis Vaping (4.9%)
Cigarette use	1.00	0.00	0.41	0.00	0.54	0.69
ENDS use	0.20	1.00	0.00	0.09	0.17	1.00
Cigar use	0.00	0.00	0.32	0.00	1.00	0.47
Blunt use	0.00	0.04	1.00	0.00	0.00	0.31
Cannabis vaping	0.00	0.20	0.00	0.00	0.00	0.75
Other cannabis use	0.31	0.00	0.00	1.00	0.41	0.00

Table C.3 Weighted Prevalence of Participant Characteristics by Latent Classes of Tobacco and Cannabis Use Among Youth

Participant Characteristics	Past 30-Day Latent Classes of Tobacco and Cannabis Use							P-value
	Never/Former	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis ^a	ENDS + Cannabis Vaping	Cigarettes + Cigars + Other Cannabis ^a	
Age (mean ± SD)	15.9 ± 0.8	16.3 ± 0.8	16.2 ± 0.8	16.3 ± 0.8	16.2 ± 0.8	16.3 ± 0.8	16.4 ± 0.8	<0.001
Sex, n (%)								0.55
Female	2787 (48.9)	74 (45.0)	73 (47.6)	89 (46.2)	222 (50.0)	84 (47.0)	45 (38.9)	
Male	2973 (51.1)	98 (55.0)	90 (52.4)	97 (53.8)	225 (50.0)	96 (53.0)	64 (61.1)	
Race/ethnicity, n (%)								
Hispanic	1755 (22.7)	41 (18.4)	25 (11.7)	63 (27.4)	156 (27.0)	41 (17.0)	27 (17.7)	<0.001
NH White	2636 (53.1)	108 (68.9)	121 (79.6)	63 (42.4)	202 (53.2)	112 (70.7)	42 (48.5)	
NH Black	837 (14.3)	12 (5.4)	-- ^b	39 (20.3)	54 (12.4)	5 (2.3)	30 (27.2)	
Another race/ethnicity	532 (10.0)	11 (7.3)	-- ^b	21 (9.8)	35 (7.4)	22 (10.0)	10 (6.6)	
Sexual orientation identity, n (%)								<0.001
Heterosexual	5157 (89.4)	132 (76.7)	151 (92.9)	148 (78.8)	375 (83.6)	150 (84.7)	88 (79.7)	
Lesbian, gay, bisexual, or something else	603 (10.6)	40 (23.3)	12 (7.1)	38 (21.2)	72 (16.4)	30 (15.3)	21 (20.3)	
Highest parental educational attainment, n (%)								<0.001
High school or less	2172 (33.8)	79 (40.7)	45 (27.4)	77 (38.6)	180 (36.7)	57 (27.5)	61 (50.4)	
Some college	1813 (30.8)	57 (33.5)	48 (30.1)	64 (34.4)	152 (33.9)	64 (35.2)	29 (28.3)	
College graduate or more	1775 (35.4)	36 (25.8)	70 (42.6)	45 (27.0)	115 (29.4)	59 (37.3)	19 (21.2)	
Annual household income, n (%)								<0.001
Less than \$50,000	2728 (42.7)	94 (50.7)	45 (28.0)	110 (53.9)	231 (47.6)	77 (36.4)	81 (71.9)	
\$50,000 or more	3032 (57.3)	78 (49.3)	118 (72.0)	76 (46.1)	216 (52.4)	103 (63.6)	28 (28.1)	

^a Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

^b Dashes indicate cell suppression due to low sample sizes to prevent identification of respondents

Table C.4 Weighted Prevalence of Participant Characteristics by Latent Classes of Tobacco and Cannabis Use Among Young Adults

Participant Characteristics	Past 30-Day Latent Classes of Tobacco and Cannabis Use							P-value
	Never/Former	Exclusive Cigarettes	Exclusive ENDS	Exclusive Blunts	Exclusive Other Cannabis	Cigarettes + Cigars	Cigarettes + ENDS + Cannabis Vaping	
Age (mean ± SD)	21.0 ± 3.2	21.5 ± 3.2	20.5 ± 3.3	21.1 ± 3.2	21.0 ± 3.3	21.0 ± 3.5	20.7 ± 3.2	0.03
Sex, n (%)								<0.001
Female	3233 (54.8)	621 (46.3)	182 (38.8)	313 (48.7)	404 (53.9)	334 (31.4)	202 (32.5)	
Male	2614 (45.2)	657 (53.7)	261 (61.2)	290 (51.3)	345 (46.1)	644 (68.6)	339 (67.5)	
Race/ethnicity, n (%)								
Hispanic	1707 (22.5)	289 (20.6)	121 (20.5)	171 (25.4)	194 (19.2)	196 (17.6)	135 (20.3)	<0.001
NH White	2688 (52.3)	764 (63.1)	235 (58.7)	239 (47.9)	366 (54.6)	448 (53.0)	300 (60.7)	
NH Black	909 (13.7)	110 (7.6)	42 (10.6)	144 (21.3)	115 (15.0)	239 (22.9)	53 (9.6)	
Another race/ethnicity	543 (11.5)	115 (8.7)	45 (10.1)	49 (5.5)	74 (11.1)	95 (6.6)	53 (9.4)	
Sexual orientation identity, n (%)								<0.001
Heterosexual	5269 (90.2)	1037 (82.8)	396 (87.7)	482 (81.2)	616 (83.3)	822 (84.9)	441 (81.9)	
Lesbian, gay, bisexual, or something else	578 (9.8)	241 (17.2)	47 (12.3)	121 (18.8)	133 (16.7)	156 (15.1)	100 (18.1)	
Highest educational attainment, n (%)								<0.001
High school or less	2806 (39.2)	756 (52.8)	224 (43.4)	310 (46.3)	337 (37.1)	566 (51.7)	279 (44.1)	
Some college	2400 (46.0)	439 (39.4)	195 (51.1)	255 (47.9)	330 (49.2)	336 (39.3)	230 (50.5)	
College graduate or more	641 (14.7)	83 (7.9)	24 (5.5)	38 (5.8)	82 (13.7)	76 (9.0)	32 (5.4)	
Annual household income, n (%)								<0.001
Less than \$50,000	3711 (61.9)	989 (74.9)	285 (61.8)	443 (70.5)	458 (60.2)	697 (67.3)	350 (62.1)	
\$50,000 or more	2136 (38.1)	289 (25.1)	158 (38.2)	160 (29.5)	291 (39.8)	281 (32.7)	191 (37.9)	

^a Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

Appendix D Chapter 5

Appendix for Chapter 5: Racial/Ethnic Disparities in Mental Health Problems and Tobacco and Cannabis Use Among US Emerging Adults

Table D.1 Results from Two-Way Interactions Between Internalizing Problems and Race/Ethnicity and Externalizing Problems and Race/Ethnicity in Adjusted Models Examining Associations Between Mental Health Problems and Latent Classes of Tobacco and Cannabis Use Among Youth and Young Adult Samples

	Youth Past 30-Day Tobacco and Cannabis Use Classes											
	Exclusive Cigarettes		Exclusive ENDS		Exclusive Blunts		Exclusive Other Cannabis ^a		ENDS + Cannabis Vaping		Cigarettes + Cigars + Other Cannabis	
	F ^b	P-value	F ^b	P-value	F ^b	P-value	F ^b	P-value	F ^b	P-value	F ^b	P-value
Internalizing problems*race/ethnicity ^c	1.28	0.29	53.96	<0.001	0.93	0.43	0.14	0.94	0.59	0.62	0.18	0.91
Externalizing problems*race/ethnicity ^c	0.61	0.61	47.08	<0.001	0.84	0.47	0.58	0.63	1.65	0.18	1.62	0.19
	Young Adult Past 30-Day Tobacco and Cannabis Use Classes											
	Exclusive Cigarettes		Exclusive ENDS		Exclusive Blunts		Exclusive Other Cannabis ^a		Cigarettes + Cigars		Cigarettes + ENDS + Cannabis Vaping	
	F ^b	P-value	F ^b	P-value	F ^b	P-value	F ^b	P-value	F ^b	P-value	F ^b	P-value
Internalizing problems*race/ethnicity ^c	2.09	0.11	0.03	0.99	0.62	0.60	0.45	0.72	1.69	0.17	0.49	0.69
Externalizing problems*race/ethnicity ^c	0.58	0.63	1.11	0.35	0.13	0.94	0.54	0.66	0.53	0.66	0.07	0.98

Bolded text indicates statistical significance (p<0.05)

^a Other cannabis includes any use not involving blunting or vaping (e.g., smoking, ingesting)

^b Joint F-test for interaction

^c Internalizing/externalizing problems referent: low/moderate; race/ethnicity referent: NH White

Table D.2 Multinomial Logistic Regression Associations Between Internalizing Problems and Latent Classes of Tobacco and Cannabis Use Adjusted for Sociodemographic Characteristics and Externalizing Problems Among Youth

	Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Cigarettes only	ENDS only	Blunts only	Other cannabis only	ENDS + cannabis vaping	Cigarettes + cigars + other cannabis
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past 30-day internalizing problems scale (ref: low)						
Moderate (1-2)	0.80 (0.49-1.30)	1.15 (0.77-1.73)	1.16 (0.75-1.79)	1.21 (0.84-1.75)	0.69 (0.43-1.11)	1.19 (0.67-2.14)
High (3+)	2.11 (1.31-3.39)	1.46 (0.89-2.41)	1.33 (0.85-2.09)	1.57 (1.07-2.30)	1.18 (0.73-1.90)	1.50 (0.77-2.92)
Age (continuous)	1.74 (1.40-2.16)	1.48 (1.20-1.83)	1.64 (1.30-2.08)	1.45 (1.27-1.66)	1.69 (1.34-2.14)	1.96 (1.50-2.55)
Sex (ref: male)						
Female	0.63 (0.43-0.94)	0.94 (0.65-1.34)	0.72 (0.51-1.02)	0.90 (0.73-1.12)	0.87 (0.59-1.28)	0.59 (0.39-0.90)
Race/ethnicity (ref: NH White)						
Hispanic	0.47 (0.30-0.75)	0.38 (0.23-0.61)	1.39 (0.93-2.07)	1.14 (0.92-1.42)	0.58 (0.36-0.94)	0.54 (0.28-1.05)
NH Black	0.22 (0.09-0.57)	0.07 (0.01-0.43)	1.58 (0.93-2.67)	0.86 (0.60-1.24)	0.13 (0.04-0.45)	1.38 (0.76-2.49)
Another race/ethnicity	0.52 (0.30-0.89)	0.55 (0.31-0.96)	1.24 (0.70-2.19)	0.74 (0.48-1.14)	0.77 (0.41-1.43)	0.64 (0.30-1.36)
Sexual orientation status (ref: Heterosexual)						
Lesbian, gay, bisexual, or something else	2.47 (1.61-3.79)	0.55 (0.30-1.01)	1.94 (1.33-2.83)	1.37 (0.99-1.91)	1.23 (0.67-2.26)	1.95 (1.07-3.57)
Highest parental educational attainment (ref: college graduate or more)						
High school or less	1.70 (1.00-2.91)	1.14 (0.75-1.73)	1.21 (0.72-2.03)	1.19 (0.87-1.63)	1.05 (0.68-1.61)	1.52 (0.77-3.01)
Some college	1.46 (0.86-2.46)	1.02 (0.71-1.46)	1.25 (0.77-2.03)	1.26 (0.95-1.66)	1.23 (0.81-1.89)	1.05 (0.51-2.16)
Annual household income (ref: more than \$50,000)						
Less than \$50,000	1.45 (0.93-2.26)	0.73 (0.48-1.11)	1.37 (0.91-2.04)	1.13 (0.87-1.47)	1.03 (0.73-1.45)	3.40 (1.80-6.42)
Past 30-day externalizing problems scale (ref: low)						
Moderate (1-2)	0.50 (0.32-0.78)	1.35 (0.90-2.02)	1.82 (1.13-2.92)	1.57 (1.10-2.24)	1.58 (0.98-2.55)	0.85 (0.48-1.51)
High (3+)	0.86 (0.52-1.44)	1.52 (0.94-2.46)	3.25 (1.94-5.45)	1.98 (1.40-2.80)	2.54 (1.65-3.92)	1.08 (0.55-2.12)

Bolded text indicates statistical significance (p<0.05)

^aThe outcome referent group: never/former use of both tobacco and cannabis

^bOdds ratios (OR) and 95% confidence intervals adjusted for mean-centered age, sex, sexual orientation status, highest educational attainment, annual household income, and externalizing problems

Table D.3 Multinomial Logistic Regression Associations Between Internalizing Problems and Latent Classes of Tobacco and Cannabis Use Adjusted for Sociodemographic Characteristics and Externalizing Problems Among Young Adults

	Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Cigarettes only	ENDS only	Blunts only	Other cannabis only	Cigarettes + cigars	Cigarettes + ENDS + cannabis vaping
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Past 30-day internalizing problems scale (ref: low)						
Moderate (1-2)	1.19 (0.99-1.45)	0.98 (0.73, 1.32)	1.38 (1.08-1.76)	0.90 (0.68, 1.18)	0.97 (0.78, 1.22)	1.24 (0.94, 1.62)
High (3+)	1.83 (1.48, 2.26)	1.62 (1.15, 2.29)	1.85 (1.36, 2.53)	1.46 (1.13, 1.89)	1.46 (1.11, 1.91)	1.93 (1.39, 2.67)
Age (continuous)	1.21 (1.16, 1.26)	0.87 (0.81, 0.93)	1.06 (1.02, 1.10)	1.00 (0.95, 1.06)	1.05 (1.01, 1.09)	0.94 (0.89, 0.99)
Sex (ref: male)						
Female	0.65 (0.56, 0.75)	0.49 (0.39, 0.62)	0.68 (0.56, 0.83)	0.89 (0.74, 1.07)	0.34 (0.29, 0.41)	0.35 (0.28, 0.44)
Race/ethnicity (ref: NH White)						
Hispanic	0.64 (0.52, 0.79)	0.83 (0.58, 1.19)	1.20 (0.93, 1.55)	0.86 (0.66, 1.12)	0.71 (0.55, 0.91)	0.82 (0.63, 1.07)
NH Black	0.39 (0.30, 0.52)	0.75 (0.49, 1.13)	1.67 (1.22, 2.28)	1.15 (0.84, 1.58)	1.60 (1.23, 2.07)	0.64 (0.45, 0.90)
Another race/ethnicity	0.64 (0.46, 0.89)	0.83 (0.51, 1.34)	0.53 (0.36, 0.80)	0.93 (0.64, 1.35)	0.56 (0.39, 0.80)	0.73 (0.47, 1.14)
Sexual orientation status (ref: Heterosexual)						
Lesbian, gay, bisexual, or something else	1.79 (1.42, 2.26)	1.32 (0.79, 2.20)	1.87 (1.42, 2.47)	1.63 (1.31, 2.04)	1.81 (1.44, 2.28)	1.84 (1.38, 2.46)
Highest educational attainment (ref: some college or more)						
High school or less	1.79 (1.42, 2.26)	0.95 (0.74, 1.22)	1.30 (1.04, 1.62)	0.94 (0.78, 1.14)	1.52 (1.27, 1.82)	1.05 (0.84, 1.30)
Annual household income (ref: more than \$50,000)						
Less than \$50,000	1.71 (1.41, 2.07)	1.13 (0.84, 1.51)	1.31 (1.02, 1.67)	0.96 (0.79, 1.17)	1.18 (0.99, 1.40)	1.15 (0.90, 1.47)
Past 30-day externalizing problems scale (ref: low)						
Moderate (1-2)	0.92 (0.76, 1.11)	1.38 (1.06, 1.79)	1.09 (0.83, 1.42)	1.45 (1.17, 1.81)	0.98 (0.81, 1.19)	1.21 (0.94, 1.55)
High (3+)	1.03 (0.81, 1.31)	1.10 (0.73, 1.66)	1.53 (1.11, 2.11)	1.56 (1.14, 2.12)	1.15 (0.89, 1.50)	2.15 (1.56, 2.98)

Bolded text indicates statistical significance (p<0.05)

^aThe outcome referent group: never/former use of both tobacco and cannabis

^bOdds ratios (OR) and 95% confidence intervals adjusted for mean-centered age, sex, sexual orientation status, highest educational attainment, annual household income, and externalizing problems

Table D.4 Adjusted Multinomial Logistic Regression Associations Between Internalizing Problems and Latent Classes of Tobacco and Cannabis Use Stratified by Race/Ethnicity Among Youth After Further Disaggregating “Another Race/Ethnicity”

Stratified by Race/Ethnicity	Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Cigarettes only	ENDS only	Blunts only	Non-tobacco cannabis only	ENDS + cannabis vaping	Cigarettes + cigars + non-tobacco cannabis
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Hispanic youth, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	0.83 (0.29-2.34)	1.44 (0.51-4.02)	3.21 (1.75-5.87)	2.04 (1.35-3.08)	2.50 (1.09-5.74)	1.20 (0.48-3.01)
NH White youth, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	2.75 (1.82-4.16)	1.68 (1.08-2.60)	1.49 (0.85-2.63)	1.60 (1.12-2.28)	1.90 (1.18-3.06)	1.78 (0.90-3.54)
NH Black youth, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	2.96 (0.73-12.01)	--	1.18 (0.47-3.01)	2.50 (1.19-5.25)	1.33 (0.09-19.31)	0.93 (0.36-2.41)
NH Asian youth, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	--	--	--	--	--	--
Youth from another race/ethnicity, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	--	--	--	--	--	--

Bolded text indicates statistical significance (p<0.05)
Dashes indicate a lack of model convergence
^aThe outcome referent group: never/former use of both tobacco and cannabis
^bOdds ratios (OR) and 95% confidence intervals adjusted for mean-centered age, sex, sexual orientation status, highest parental educational attainment, and annual household income

Table D.5 Adjusted Multinomial Logistic Regression Associations Between Externalizing Problems and Latent Classes of Tobacco and Cannabis Use Stratified by Race/Ethnicity Among Youth After Further Disaggregating “Another Race/Ethnicity”

Stratified by Race/Ethnicity	Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Cigarettes only	ENDS only	Blunts only	Non-tobacco cannabis only	ENDS + cannabis vaping	Cigarettes + cigars + non-tobacco cannabis
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Hispanic youth, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	0.83 (0.29-2.34)	1.44 (0.51-4.02)	3.21 (1.75-5.87)	2.04 (1.35-3.08)	2.50 (1.09-5.74)	1.20 (0.48-3.01)
NH White youth, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	2.75 (1.82-4.16)	1.68 (1.08-2.60)	1.49 (0.85-2.63)	1.60 (1.12-2.28)	1.90 (1.18-3.06)	1.78 (0.90-3.54)
NH Black youth, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	2.96 (0.73-12.01)	--	1.18 (0.47-3.01)	2.50 (1.19-5.25)	1.33 (0.09-19.31)	0.93 (0.36-2.41)
NH Asian youth, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	--	--	--	--	--	--
Youth from another race/ethnicity, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	--	--	--	--	--	--

Bolded text indicates statistical significance (p<0.05)
Dashes indicate a lack of model convergence
^aThe outcome referent group: never/former use of both tobacco and cannabis
^bOdds ratios (OR) and 95% confidence intervals adjusted for mean-centered age, sex, sexual orientation status, highest parental educational attainment, and annual household income

Table D.6 Adjusted Multinomial Logistic Regression Associations Between Internalizing Problems and Latent Classes of Tobacco and Cannabis Use Stratified by Race/Ethnicity Among Young Adults After Further Disaggregating “Another Race/Ethnicity”

Stratified by Race/Ethnicity	Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Cigarettes only	ENDS only	Blunts only	Other cannabis only	Cigarettes + cigars	Cigarettes + ENDS + cannabis vaping
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Hispanic young adults, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	2.66 (1.79, 3.96)	1.59 (0.90, 2.84)	2.12 (1.40, 3.22)	1.83 (1.23, 2.71)	1.36 (0.86, 2.13)	1.79 (1.06, 3.01)
NH White young adults, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	1.53 (1.19, 1.97)	1.75 (1.14, 2.70)	1.92 (1.33, 2.78)	1.84 (1.34, 2.51)	1.82 (1.32, 2.50)	2.79 (2.07, 3.77)
NH Black young adults, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	1.13 (0.61, 2.11)	2.16 (0.73, 6.37)	1.61 (0.97, 2.65)	1.40 (0.77, 2.54)	0.97 (0.60, 1.57)	2.09 (0.98, 4.47)
NH Asian young adults, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	--	--	--	--	--	--
Young adults from another race/ethnicity, past 30-day internalizing problems scale (ref: low/moderate)						
High (3+)	1.33 (0.60, 2.95)	0.89 (0.23, 3.46)	2.00 (0.79, 5.07)	1.91 (0.89, 4.09)	1.94 (0.90, 4.16)	2.54 (0.89, 7.25)

Bolded text indicates statistical significance (p<0.05)

Dashes indicate a lack of model convergence

^aThe outcome referent group: never/former use of both tobacco and cannabis

^bOdds ratios (OR) and 95% confidence intervals adjusted for mean-centered age, sex, sexual orientation status, highest parental educational attainment, and annual household income

Table D.7 Adjusted Multinomial Logistic Regression Associations Between Externalizing Problems and Latent Classes of Tobacco and Cannabis Use Stratified by Race/Ethnicity Among Young Adults After Further Disaggregating “Another Race/Ethnicity”

Stratified by Race/Ethnicity	Past 30-Day Tobacco and Cannabis Use Classes ^a					
	Cigarettes only	ENDS only	Blunts only	Other cannabis only	Cigarettes + cigars	Cigarettes + ENDS + cannabis vaping
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Hispanic young adults, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	1.74 (1.19-2.55)	1.08 (0.55-2.13)	2.08 (1.29-3.35)	1.30 (0.84-2.01)	1.31 (0.82-2.10)	2.65 (1.60-4.37)
NH White young adults, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	1.23 (0.93, 1.64)	1.01 (0.63, 1.63)	1.82 (1.26, 2.63)	1.40 (0.98, 2.00)	1.43 (1.06, 1.93)	2.53 (1.75, 3.67)
NH Black young adults, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	1.47 (0.84, 2.58)	3.28 (1.08, 9.99)	2.01 (1.24, 3.25)	2.18 (1.12, 4.25)	1.02 (0.56, 1.85)	2.66 (1.22, 5.80)
NH Asian young adults, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	--	--	--	--	--	--
Young adults from another race/ethnicity, past 30-day externalizing problems scale (ref: low/moderate)						
High (3+)	0.87 (0.39, 1.97)	0.68 (0.18, 2.51)	1.42 (0.38, 5.26)	0.80 (0.27, 2.39)	1.47 (0.61, 3.56)	1.84 (0.78, 4.35)

Bolded text indicates statistical significance (p<0.05)

Dashes indicate a lack of model convergence

^aThe outcome referent group: never/former use of both tobacco and cannabis

^bOdds ratios (OR) and 95% confidence intervals adjusted for mean-centered age, sex, sexual orientation status, highest parental educational attainment, and annual household income

Appendix E Chapter 6

Appendix for Chapter 6: Negative Affect About Social Problems and Tobacco and Cannabis Use Outcomes Among Young Adults in Los Angeles, California

Table E.1 Results from Two-Way Interactions Between Factor Scores and Race/Ethnicity in Adjusted Models Examining Associations Between Factor Scores at Wave 10 and Past 30-Day Tobacco and Cannabis Use at Wave 11

	Past 30-Day Nicotine and Cannabis Use (Wave 11)					
	Exclusive Tobacco		Exclusive Cannabis		Dual Tobacco and Cannabis	
	F ^a	P-value	F ^a	P-value	F ^a	P-value
Factor 1 ^b *race/ethnicity	9.37	0.10	7.39	0.19	4.54	0.47
Factor 2 ^c *race/ethnicity	7.14	0.21	4.02	0.55	3.01	0.70
Factor 3 ^d *race/ethnicity	10.10	0.07	6.05	0.30	7.12	0.21
Factor 4 ^e *race/ethnicity	2.18	0.82	4.18	0.52	1.39	0.93

Factor scores are continuous; race/ethnicity referent: NH White

Bolded text indicates statistical significance (p<0.05)

^a Joint F-test for interaction

^b Distressed (i.e., concerned, worried, and stressed) about community police brutality

^c Distressed (i.e., concerned, worried, and stressed) about societal shootings/violence

^d Distressed (i.e., concerned, worried, and stressed) about societal discrimination

^e Stressed about community police brutality, societal shootings/violence, and societal discrimination

Table E.2 Weighted Prevalence of Participant Characteristics by Exclusive and Dual Tobacco and Cannabis Use

Participant Characteristics	Past 30-Day Tobacco and Cannabis Use (Wave 11)				P-value ^a
	Never/Former (n=1127)	Exclusive Tobacco (n=131)	Exclusive Tobacco (n=443)	Dual Tobacco and Cannabis (n=274)	
Age (Wave 11)					0.12
20-21	749 (66.5)	74 (56.5)	299 (67.5)	182 (66.4)	
22-23	378 (33.5)	57 (43.5)	144 (32.5)	92 (33.6)	
Sex (Wave 11), n (%)					<0.001
Female	698 (61.9)	59 (45.0)	294 (66.4)	156 (56.9)	
Male	429 (38.1)	72 (55.0)	149 (33.6)	118 (43.1)	
Race/ethnicity (Wave 11), n (%)					<0.001
Hispanic	511 (45.3)	53 (40.5)	228 (51.5)	126 (46.0)	
Non-Hispanic White	172 (15.3)	26 (19.9)	69 (15.6)	49 (17.9)	
Non-Hispanic Black	43 (3.8)	9 (6.9)	22 (5.0)	7 (2.6)	
Non-Hispanic Asian	246 (21.8)	18 (13.7)	53 (12.0)	41 (15.0)	
Non-Hispanic multiracial	78 (6.9)	9 (6.8)	41 (9.3)	20 (7.3)	
Another race/ethnicity	77 (6.8)	16 (12.2)	30 (6.8)	31 (11.3)	
Sexual orientation status (Wave 11), n (%)					<0.001
Heterosexual	900 (79.9)	106 (80.9)	309 (69.8)	181 (66.1)	
LGBTQ+	227 (20.1)	25 (19.1)	134 (30.2)	93 (33.9)	
Highest educational attainment (Wave 11), n (%)					0.58
High school grad or less	275 (24.4)	28 (21.4)	99 (22.4)	58 (21.2)	
Some college or more	852 (75.6)	103 (78.6)	344 (77.6)	216 (78.8)	
Personal financial status (Wave 11), n (%)					0.004
Do not meet basic expenses	44 (3.9)	10 (7.6)	27 (6.1)	19 (6.9)	
Just meet basic expenses	262 (23.3)	26 (19.9)	114 (25.7)	75 (27.4)	
Meet needs with a little left	333 (29.5)	38 (29.0)	156 (35.2)	80 (29.2)	
Live comfortably	488 (43.3)	57 (43.5)	146 (33.0)	100 (36.5)	
Factor scores (Wave 10) (mean ± SD)					
Factor 1 ^b	-0.09 ± 1.01	-0.35 ± 1.08	0.24 ± 0.92	0.25 ± 0.90	<0.001
Factor 2 ^c	-0.04 ± 1.00	-0.17 ± 1.05	0.16 ± 0.96	0.09 ± 0.98	0.001
Factor 3 ^d	-0.04 ± 0.99	-0.22 ± 0.98	0.20 ± 0.98	0.07 ± 1.04	0.001
Factor 4 ^e	-0.08 ± 1.01	-0.05 ± 0.97	0.12 ± 1.00	0.14 ± 1.02	<0.001

^a Chi-square test of independence comparing distributions of participant characteristics by tobacco and cannabis use

^b Distressed (i.e., concerned, worried, and stressed) about community police brutality

^c Distressed (i.e., concerned, worried, and stressed) about societal shootings/violence

^d Distressed (i.e., concerned, worried, and stressed) about societal discrimination

^e Stressed about community police brutality, societal shootings/violence, and societal discrimination

Table E.3 Weighted Prevalence of Past 30-Day Individual Tobacco and Cannabis Use Variables at Wave 11

Cigarette use	
Never/former	1857 (94.0)
Past 30-day use	117 (5.9)
Missing	1 (0.1)
Electronic nicotine delivery systems (ENDS) use	
Never/former	1653 (83.7)
Past 30-day use	322 (16.3)
Missing	2 (0.1)
Other combustible tobacco product use ^a	
Never/former	1884 (95.4)
Past 30-day use	91 (4.6)
Missing	0 (0.0)
Smoking cannabis	
Never/former	1425 (72.2)
Past 30-day use	550 (27.8)
Missing	0 (0.0)
Blunt use	
Never/former	1647 (83.4)
Past 30-day use	328 (16.6)
Missing	0 (0.0)
Vaping cannabis	
Never/former	1514 (76.7)
Past 30-day use	459 (23.2)
Missing	2 (0.1)
Other cannabis ^b	
Never/former	1507 (76.3)
Past 30-day use	468 (23.7)
Missing	0 (0.0)

^a Other combustible tobacco products include cigars, cigarillos/little cigars, and hookah

^b Other cannabis includes dabbing cannabis concentrates and ingesting cannabis via food or drink

Table E.4 Unrotated Exploratory Factor Analysis of Nine Social Problem Items at Wave 10

Factor	Eigenvalue ^a	Difference ^b	Percent Variance ^c	Cumulative Percent Variance ^d
1	7.131	6.394	0.839	0.839
2	0.737	0.313	0.087	0.926
3	0.424	0.150	0.050	0.975
4	0.273	0.239	0.032	1.008
5	0.035	0.053	0.004	1.012
6	-0.019	0.003	-0.002	1.009
7	0.022	0.006	-0.003	1.007
8	-0.028	0.001	-0.003	1.004
9	-0.029	--	-0.004	1.000

^a The total variance accounted by each factor; the sum of all eigenvalues equals the total number of variables

^b The difference between k and k+1 factors

^c The percentage of variance captured by the factor

^d The cumulative percentage of variance captured by the factor and all preceding factors

Table E.5 Adjusted Logistic Regression Examining Associations Between Factor Scores at Wave 10 and Each Individual Substance Use Outcome at Wave 11

	Factor Scores (Wave 10) ^a			
	Factor 1 ^b	Factor 2 ^c	Factor 3 ^d	Factor 4 ^e
	OR (95% CI) ^f	OR (95% CI) ^f	OR (95% CI) ^f	OR (95% CI) ^f
Past 30-day tobacco and cannabis use (Wave 11) ^g				
Cigarette use	0.95 (0.78-1.16)	0.88 (0.72-1.08)	0.93 (0.75-1.13)	1.06 (0.86-1.29)
Electronic nicotine delivery systems (ENDS) use	1.16 (1.02-1.32)	1.06 (0.93-1.21)	0.98 (0.86-1.12)	1.23 (1.08-1.41)
Other combustible tobacco product use ^h	0.98 (0.79-1.22)	0.97 (0.78-1.21)	0.90 (0.71-1.13)	0.96 (0.77-1.20)
Smoking cannabis	1.38 (1.23-1.54)	1.09 (0.98-1.22)	1.11 (1.00-1.23)	1.15 (1.04-1.28)
Blunt use	1.44 (1.25-1.65)	1.17 (1.03-1.33)	1.12 (0.99-1.27)	1.12 (0.99-1.28)
Vaping cannabis	1.38 (1.23-1.56)	1.16 (1.03-1.30)	1.21 (1.08-1.36)	1.16 (1.04-1.30)
Other cannabis use ⁱ	1.32 (1.17-1.49)	1.14 (1.01-1.28)	1.12 (1.004-1.26)	1.20 (1.07-1.35)

Bolded text indicates statistical significance (p<0.05)

^a Each factor represents a separate model

^b Distressed (i.e., concerned, worried, and stressed) about community police brutality

^c Distressed (i.e., concerned, worried, and stressed) about societal shootings/violence

^d Distressed (i.e., concerned, worried, and stressed) about societal discrimination

^e Stressed about community police brutality, societal shootings/violence, and societal discrimination

^f Odds ratios (OR) and 95% confidence intervals adjusted for age, sex, race/ethnicity, sexual orientation identity, highest educational attainment, and personal financial status

^g The outcome referent group: never/former use of each substance; each outcome represents a separate model

^h Other combustible tobacco products include cigars, cigarillos/little cigars, and hookah

ⁱ Other cannabis includes dabbing cannabis concentrates and ingesting cannabis via food or drink

Table E.6 Adjusted Multinomial Logistic Regression Using Indexes and a Summary Scale Instead of Factor Scores

	Past 30-Day Tobacco and Cannabis Use (Wave 11) ^a		
	Exclusive Tobacco	Exclusive Cannabis	Dual Tobacco and Cannabis
	OR (95% CI) ^b	OR (95% CI) ^b	OR (95% CI) ^b
Exposure Indexes (Wave 10) ^c			
Distressed about police brutality (range 0-4) ^d	0.90 (0.78-1.03)	1.27 (1.16-1.39)	1.34 (1.20-1.50)
Distressed about shootings/violence (range 0-4) ^e	1.00 (0.86-1.16)	1.20 (1.09-1.31)	1.18 (1.06-1.33)
Distressed about discrimination (range 0-4) ^f	0.94 (0.81-1.10)	1.19 (1.09-1.30)	1.12 (1.01-1.25)
Stressed about police brutality, shootings/violence, and discrimination (range 0-4) ^g	0.97 (0.83-1.14)	1.24 (1.13-1.37)	1.27 (1.13-1.43)
Exposure Summary Scale ^h	0.93 (0.78-1.09)	1.29 (1.16-1.43)	1.28 (1.13-1.45)

Bolded text indicates statistical significance (p<0.05)

^a The outcome referent group: never/former use of both tobacco and cannabis

^b Adjusted odds ratios (OR) and 95% confidence intervals adjusted for age, sex, race/ethnicity, sexual orientation identity, highest educational attainment, and personal financial status

^c Indexes created to mirror factor scores generated by factor analysis

^d (Concerned about police brutality + worried about police brutality + stressed about police brutality)/3

^e (Concerned about shootings/violence + worried about shootings/violence + stressed about shootings/violence)/3

^f (Concerned about discrimination + worried about discrimination + stressed about discrimination)/3

^g (Stressed about police brutality + stress about shootings/violence + stress about societal discrimination)/3

^h (Concerned about police brutality + worried about police brutality + stressed about police brutality + concerned about shootings/violence + worried about shootings/violence + stressed about shootings/violence + concerned about discrimination + worried about discrimination + stressed about discrimination)/9

Table E.7 A Comparison of Study Sample Sociodemographic Characteristics Between Respondents Loss-To-Follow-Up from Waves 10 to 11 and the Analytic Sample

	Waves 10-11 Loss-To-Follow-Up (n=312) ^a	Analytic Sample (n=1975) ^b	P-value ^c
Age, mean ± SD	21.23 ± 0.40	21.17 ± 0.40	0.014
Sex, n (%)			<0.001
Female	126 (45.5)	1203 (61.0)	
Male	151 (54.5)	768 (39.0)	
Race/ethnicity, n (%)			0.50
Hispanic	151 (58.6)	918 (46.5)	
NH White	52 (16.7)	316 (16.0)	
NH Black	12 (3.9)	81 (4.1)	
NH Asian	45 (14.5)	358 (18.1)	
NH multiracial	20 (6.4)	148 (7.5)	
Another race/ethnicity	31 (10.0)	154 (7.8)	
Sexual orientation status, n (%)			0.09
Heterosexual	225 (81.8)	1518 (77.3)	
LGBTQ+	50 (18.2)	447 (22.7)	
Highest educational attainment, n (%)			0.62
High school grad or less	78 (28.3)	528 (26.8)	
Some college or more	198 (71.7)	1440 (73.2)	
Personal financial status, n (%)			0.10
Do not meet basic expenses	12 (4.4)	60 (3.1)	
Just meet basic expenses	72 (26.3)	407 (20.7)	
Meet needs with a little left	77 (28.1)	602 (30.7)	
Live comfortably	113 (41.2)	895 (45.6)	

^a Missing values for each variable: age (n=0), sex (n=35), race/ethnicity (n=1), sexual orientation status (n=37), highest educational attainment (n=36), and financial status (n=38)

^b Missing values for each variable: age (n=2), sex (n=4), race/ethnicity (n=0), sexual orientation status (n=10), highest educational attainment (n=7), and financial status (n=11)

^c Student's t-tests (continuous variables) and chi-square tests of independence (categorical variables) comparing distributions between the sample of respondents who were loss-to-follow-up between Waves 10 and 11 to the analytic sample; missing values not included in the calculations

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