Race, Discrimination, and Substance Use

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AN EXPLORATION OF THE ROLE OF DISCRIMINATION, MENTAL HEALTH, AND SUBSTANCE USE AMONG U.S. YOUNG AND OLDER ADULTS

DINA M. JONES, PHD, MPH

ABSTRACT

RACE, DISCRIMINATION, AND SUBSTANCE USE

By

DINA MARIE JONES, PhD, MPH

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Compared to Whites, Blacks in the U.S. have lower rates of substance use in adolescence, but similar rates in adulthood and greater substance use problems, morbidity, and mortality. Discrimination contributes to substance use, poor mental health, and health disparities among Blacks. Theoretically, those experiencing discrimination may use substances to cope with discrimination-related stress. However, updated research is needed to understand the discrimination-substance use relationship, potential moderators, and mediators. The purposes of the dissertation are to 1) provide an updated assessment of the relationship between discrimination/allostatic load (i.e. physiological weathering) and substance use, 2) investigate the role of psychological distress and positive wellbeing as mediators of the discrimination-substance use relationship, and 3) investigate the role of race/ethnicity, sex, and attribution to discrimination as moderators of these associations.

For study 1, logistic regression was used to examine associations between allostatic load and current alcohol use, marijuana use, and cigarette smoking among adults aged 20-59 and moderation effects by sex and race/ethnicity. For studies 2 and 3, multiple group moderated mediated structural equation modeling was used to examine the role of psychological distress and positive wellbeing as mediators of the discrimination-substance use relationship (alcohol, marijuana, other illicit drugs, cigarettes, and electronic nicotine delivery systems; study 3 includes alcohol, marijuana, and tobacco use) among adults aged 18-28. For study 2, moderation effects by sex and race (Black/White) were explored. For study 3, participants included Blacks only, and moderation effects were examined by sex and attribution to the discriminatory experiences (e.g., race vs. other reasons).

In study 1, the non-linear, non-monotonic allostatic load-substance use relationship was moderated by sex and race/ethnicity, wherein Black and White males were more likely to be current substance users, Hispanics were least likely, and a strong sex effect was observed among Blacks and less strongly among Whites. In studies 2 and 3, discrimination was directly and indirectly (through psychological distress and positive wellbeing) associated with substance use among Blacks, especially males, and among Whites. Study 3 indicated that racial discrimination specifically contributes to substance use among Black males in particular. Additional research is needed to inform prevention efforts.

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DINA MARIE JONES

PhD, GEORGIA STATE UNIVERSITY

MPH, UNIVERSITY OF MINNESOTA SCHOOL OF PUBLIC HEALTH
B.A., AGNES SCOTT COLLEGE

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ATLANTA, GEORGIA
30303

APPROVAL PAGE

RACE, DISCRIMINATION, AND SUBSTANCE USE

by

DINA MARIE JONES

Approved:

___Claire Adams Spears, PhD_______
Committee Chair

__Katherine Masyn, PhD______
Committee Member

__Kim Ramsey-White, PhD______
Committee Member

__Richard Rothenberg, MD______
Committee Member

__June 20th, 2019______________
Date

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Rest-in-peace Benjamin Alexander Jones-Fountain

Author’s Statement Page

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Dina Marie Jones

Dina Jones

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List of Abbreviations

ADD Health, National Longitudinal Study of Adolescent to Adult Health
CDS, Childhood Development Supplemental Study
EDD, EDS, Everyday discrimination scale
K-6, Kessler 6
MHC-SF, Mental Health Continuum Short Form
NESARC-III, National Epidemiologic Survey on Alcohol and Related Conditions-III
NHANES, National Health and Nutrition Examination Study
NSAL, National Survey of American Life
PSID, Panel Study of Income Dynamics
SES, socio-economic status
TAS, Transition Into Adulthood Supplemental Study
U.S., United States

Chapter 1: Literature Review and Statement of Purpose

(A) A COMPREHENSIVE REVIEW OF THE STUDENT'S AREA OF RESEARCH

Theoretical Frameworks

This dissertation and measure selection were guided by several theoretical frameworks including The Transactional Model of Stress and Coping, Minority Stress Model, and Intersectionality Theory. The Transactional Model of Stress and Coping posits that stressful experiences are person-environment transactions where the impact of an external stressor is mediated by 1) an individual's appraisal of the stressor and 2) the psychological, social, and cultural resources available to them.[1] Blacks face unique barriers and have fewer coping resources, thus within this context, it is plausible that Blacks with fewer coping resources or who experience serious psychological distress may be more likely to engage in substance use following an encounter with discrimination (that they appraise as stressful). Meanwhile, Minority Stress Theory, which is consistent with social stress discourse[2] and has generally been used to explain disparities among sexual and gender minorities, posits that minorities experience conflict with the social environment due to the juxtaposition of minority and dominant values.[3] Thus, within this context, it is likely that the conflict between Blacks and a discriminatory U.S. society could result in substantial stress and poor mental health. Lastly, Intersectionality Theory posits that the effects of sex/gender and race/ethnicity are non-additive such that the "intersections" of one's identity influences social position and the likelihood of being oppressed or priveledged.[4] The Environmental Affordances model is a recently developed theoretical framework which posits that "the motivation for and availability to engage in poor health behaviors as stress-coping or self-regulation strategies is influenced by social structures and contexts (e.g., poverty, segregation, access to goods) and that these social structures are in turn differentially distributed across racial groups." [5] Thus, within the context of these theoretical frameworks, it is likely that racial discrimination may affect Blacks differently from Whites, Hispanics, and persons from other racial/ethnic backgrounds due to cultural/ethnic differences in their coping resources or differential experiences of discrimination due to privilege. In summary, a person's intersectional identity influences their social structure, context, and environment (i.e. race/ethnicity, sex) which in turn influences the stressors that they are subjected to (i.e. discrimination) , their appraisal of stressors (i.e. stressful/not stressful), and the coping resources available to them (i.e. substance use with fewer coping resources).

Overview/Statement of Purpose

Historically, in the U.S., rates of licit and illicit substance use among Black youth have been lower than that of White and other minority youth,[6,7] and in adulthood, substance use rates have been similar among Blacks and Whites, since Blacks are more likely to initiate substance use closer to young adulthood (race-age cross-over effect).[7-10] However, in recent years, Black-White differences in substance use have narrowed across age categories[11,12] and more important, Blacks continue to suffer disproportionate rates of substance use problems and related morbidity and mortality.[13-21] Similarly, although Blacks are more likely to initiate substance use as adults, there is evidence to suggest that Blacks are less likely to receive "advantages" of late age initiation (i.e., in other populations later age of initiation of substance use is often associated with fewer substance-related problems).[22] For example, Blacks typically have lower rates of heavy drinking but are more likely to have alcohol-related injuries and problems, as well as social, legal, and work consequences compared to Whites at the lowest level of heavy drinking.[18,23]

Similarly, there is also a health disparities paradox such that Blacks and other racial/ethnic minorities exhibit disproportionately higher levels of a variety of negative physical health outcomes but lower rates of common mental health conditions such as depression and anxiety.[5] Previous research aimed at elucidating contributors to racial/ethnic substance use and health disparities has identified racial discrimination as a unique stressor that contributes to substance use,[20,24-33] chronic diseases and poor physical health, [26,34-40] and poor mental health among Blacks.[26,37,41-49] In theory, those who undergo experiences of discrimination may use substances as an avoidant coping mechanism in efforts cope with discrimination-related stress.[26,50] Discrimination is commonly assessed through everyday discrimination (e.g., using the Everyday Discrimination Scale)[48], a validated[51,52], reliable[51] scale designed to assess more chronic, routine interpersonal experiences of unfair treatment. Another common assessment is major discrimination (e.g., assessed with the Major Experiences of Discrimination Scale), which is also a valid, reliable scale designed to assess more acute instances of unfair treatment related to major life events.[53] However, it is important to note that everyday discrimination has been shown to have a stronger effect on mental and emotional health than major discrimination.[54,55]

Emerging adults (age 18-28) have higher rates of substance use disorders[11,56,57], face unique problems with substance use treatment[58], and are at higher risk for psychological disorders.[59,60] Moreover, Black emerging adults may be particularly at risk for every day discrimination-related issues and substance use[31,32,41,61-66] given recent, publicized social and political events (i.e. police shootings of unarmed Black youth and adults). However, most prior studies that have examined the role of discrimination on substance use, physical, and mental health utilized older data (< 2005). In addition, most prior studies have focused on older adults (40+) or youth (under 17), with few examinations being conducted specifically among young adults. Consequently, it is also important to examine these associations in this priority population using more recent data. The purposes of the dissertation are to 1) provide an updated assessment of the relationship between discrimination/allostatic load and substance use, 2) investigate the role of psychological distress and positive wellbeing (measures of psychological functioning) as mediators of the discrimination-substance use relationship, and 3) investigate the role of race/ethnicity, sex, and attribution to discrimination as effect measure modifiers of these associations.

A SUMMARY OF LIMITATIONS IN THIS BODY OF RESEARCH

Beyond the limitations already discussed in part A, there are several other limitations in the discrimination-health-substance use literature. An overwhelming majority of studies utilize data collected in the early 80s to early 2000s. Although the underlying processes of these relationships may have not changed over time, it is imperative that these relationships be assessed using more recent data to better assess the current impact of discrimination. Additionally, many of the studies that have examined the relationship between discrimination, mental health outcomes, and/or substance use among Blacks have utilized the same data source: The National Survey of American Life (NSAL), which notably is based on data collected from 2001-2003. Conversely, studies that have not utilized NSAL data are based on small sample sizes and are limited to certain geographic areas and are not nationally-representative.[18,25,30,62,63,67-73] Finally, many of the studies examining discrimination have focused on youth (17 and younger)[25,41,43,62,63,67,69,71,74-79] or older adults (40+) [38,52,54,55,80,81] with fewer examinations being conducted among young adults, a priority population that is particularly vulnerable to discrimination, substance use, and poor mental health.

Furthermore, additional, updated research is needed to better understand underlying processes of these associations -- specifically, *how* perceived discrimination creates risk for substance use directly or indirectly through psychological distress, and whether racial/ethnic differences persist. Few studies have focused on the priority population of Black emerging adults, who may be particularly vulnerable to discrimination and substance use. While a substantial amount of research has focused on discrimination and mental health outcomes, there is a dearth of information on psychological distress and the discrimination-substance use relationship specifically among Blacks, despite research indicating that Blacks experience serious psychological distress at a rate higher than Whites.[82-85]

(B) A DESCRIPTION OF HOW THE STUDENT'S RESEARCH CAN ENHANCE THE FIELD OF PUBLIC HEALTH

The dissertation research will help to fill several important research gaps as demonstrated in the study summaries below. Through Study 1, the dissertation research will help to better establish the relationship between high allostatic load and substance use as well as potential moderation of this association by sex and race/ethnicity, of which there is a dearth of related literature. Although prior studies have examined mental health conditions such as depression as mediators of the discrimination-substance use relationship[67,86], fewer studies have considered non-specific psychological distress, which may be a more appropriate measure of poor mental health among Blacks.[82,85,87] While there have been a few prior studies that have examined the relationship between discrimination, depression, and substance use[86,88], to the student's knowledge, no other previous study has simultaneously examined discrimination, substance use, and serious psychological distress as depicted here (Study 2).

Moreover, previous studies of discrimination and substance use have been limited by small samples/convenience samples[89], non-spatially representative samples[66], or were exclusively comprised of youth samples[25,67]. The described studies will utilize nationally (or nearly nationally) representative data with large sample sizes and a substantial representation of Black participants. Moreover, Study 1 will utilize biological and interview data collected in 2007-2010 while Studies 2 and 3 will utilize data collected in 2017 among the priority population of young adults aged 18-28. Thus, the dissertation will not only be able to provide more generalizable results but a more updated assessment of the associations with an emphasis on the priority population of young adults. Using more recent data and an emphasis on exploring Black-White differences, this research may also provide insights regarding how the salience of current racial issues in U.S. society may contribute to the Black-White substance use race/age crossover effect. Moreover, this research will examine the role of potential moderators/buffers of the discrimination-substance use relationship, which could serve as foundational research for future studies and interventions.

Limitations of Other Datasets

The dissertation research will utilize secondary data and singular waves of NHANES and TAS data. The 2007-2010 waves of NHANES was selected due to the availability of data and the biomarkers of a recommended allostatic load equation.[90] Previous years of NHANES data would not provide the most recent assessment of the associations to be examined and later years of data did not include all of the necessary biomarkers. Similarly, only one year of TAS data will be utilized due to the relaunch of the TAS in 2017. Specifically, changes with the 2017 TAS sample and questionnaire limit comparisons with prior waves of TAS data. Other datasets, including the National Survey of American Life (NSAL), the National Longitudinal Study of Adolescent to Adult Health (Add Health), and the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III) were considered due to their inclusion of discrimination and substance use measures. Although the NSAL allows a deeper assessment of the processes behind the discrimination-substance use relationship, the NSAL is overrepresented in the literature and is based on data collected in 2001-2003. Given changes in the socio-political climate as well as changes in substance use rates and related risk perceptions, and increase in the U.S. Hispanic population, it is possible that the processes and associations may have changed over the past 15-17 years. Add Health did not include any of the proposed moderators, only included one discrimination measure, and did not have any measures of perceived stress/psychological distress, and NESARC-III only included items related to stressful life experiences and did not include measures of perceived stress/psychological distress. Thus, the TAS appears best suited to provide a timely answer the primary research question. Taken together, the study will provide important information regarding mechanisms underlying discrimination and substance use in a priority population. Lastly, the dissertation research will provide a foundation for my **long-term career goals,** which are to investigate the influence of intersectionality and related psychosocial stressors on substance use in minority communities and to develop evidence-based approaches to target substance use disparities among vulnerable populations.

STUDY SUMMARIES

Study 1 Summary: Allostatic Load and Substance Use among U.S. adults aged 18-69

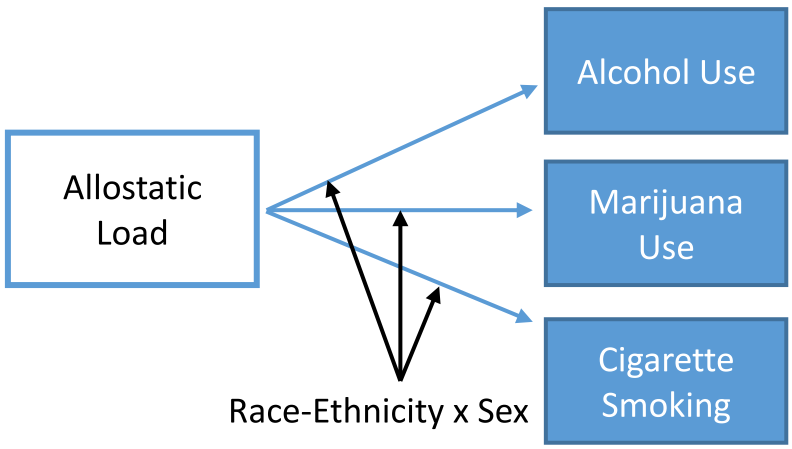


Figure 2: Study 1 Conceptual Model- Allostatic Load and Substance Use as moderated by race/ethnicity and sex

Study 1

Significance and Justification: Allostatic load (AL) can be explained as the physiological "wear and tear" on the body due to chronic stress. High AL is associated with numerous chronic diseases and mortality, is particularly prevalent among women and racial/ethnic minorities and has been partially attributed to discrimination and/or discrimination-related stress. However, there is a dearth of research on relationships between AL and substance use.

Research Questions: Is allostatic load associated with substance use among adults aged 20-59? Is this association moderated by race and/or sex?

Hypotheses: Allostatic load will be significantly, positively associated with each type of substance use among adults age 20-59. The allostatic load-substance use association will be moderated such that they will be stronger among African Americans and males as compared to Whites, Hispanics, and females.

Methods: Data will be drawn from the 2007-2008 and 2009-2010 National Health and Nutrition Examination - Survey (NHANES) to examine the association between AL scores, cigarette, alcohol, marijuana, and other illicit substance use. Nine widely used biomarkers of AL will be quantified to create an AL index.

Study 2 Summary: Discrimination, Mental Health, and Substance Use Among Young

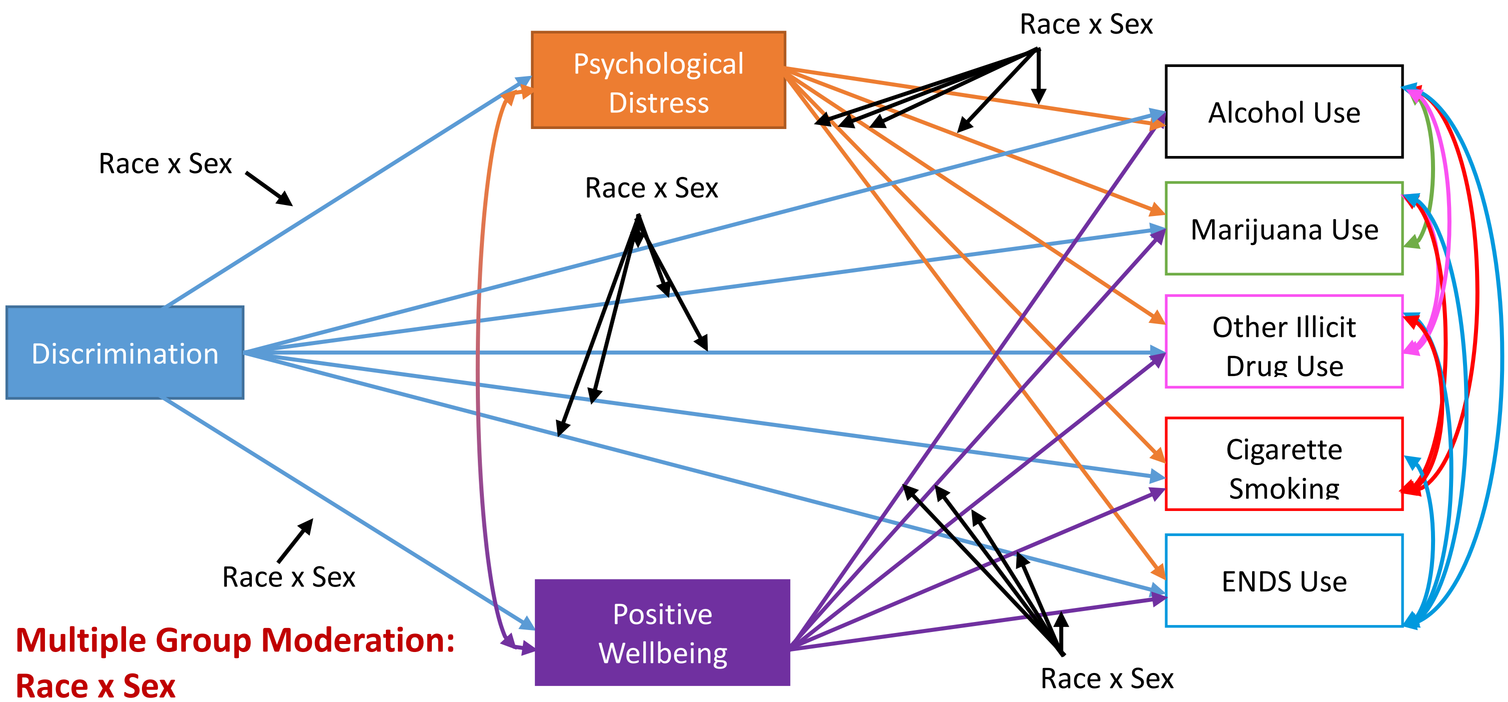


Figure 3: Study 2 Conceptual Model- Race and Sex as Moderators of Discrimination, Psychological Functioning, and Substance Use Relationship

Adults, 2017

Significance and Justification: Current substance use rates among African Americans are now similar to their White counterparts whereas in the past rates have typically been lower. Specifically, compared to Whites, substance use rates for Black adults were slightly higher or equal for past 30 day marijuana, cocaine, inhalant, cigar use and opioid misuse but lower for past 30 day use of alcohol and other tobacco products. Racial discrimination has also emerged in the literature as a salient stressor has been associated with greater substance use. The current socio-political climate warrants an updated examination of these associations.

Research Questions: Is racial discrimination, as measured by the everyday discrimination scale, associated with substance use among young adults aged 18-28 in 2017?

Is this association mediated by psychological distress as measured by the K-6 or positive wellbeing as measured by the MHC-SF? Do these associations differ by race/ethnicity and sex?

Hypotheses: Racial discrimination will be positively associated with substance use among young adults. Psychological distress and positive wellbeing will mediate this association and race/ethnicity and sex will moderate this association such that the influence of racial discrimination on substance use will be stronger among African Americans as compared to White males (v females). Additionally, these associations may differ by substance. given racial-ethnic differences in substance use prevalence (i.e. Compared to Whites, Blacks tend to have higher or more similar rates of combustible substances but lower rates of alcohol).

Methods: Data will be drawn from the 2017 wave of the Transition into Adulthood Supplement (TAS) of the Panel Study of Income Dynamics (PSID), the longest running longitudinal household study. Discrimination will be assessed by 7 of the 9 everyday discrimination scale items and modeled as a continuous measure. Psychological distress and positive wellbeing will be modeled as continuous measures. Substances examined include past 30 day/current use of alcohol, cigarettes, vaping, marijuana, and other illicit drugs.

Study 3 Summary: The Importance of Racial Attribution and Sex as Moderators of Discrimination and Substance Use among Young Adults

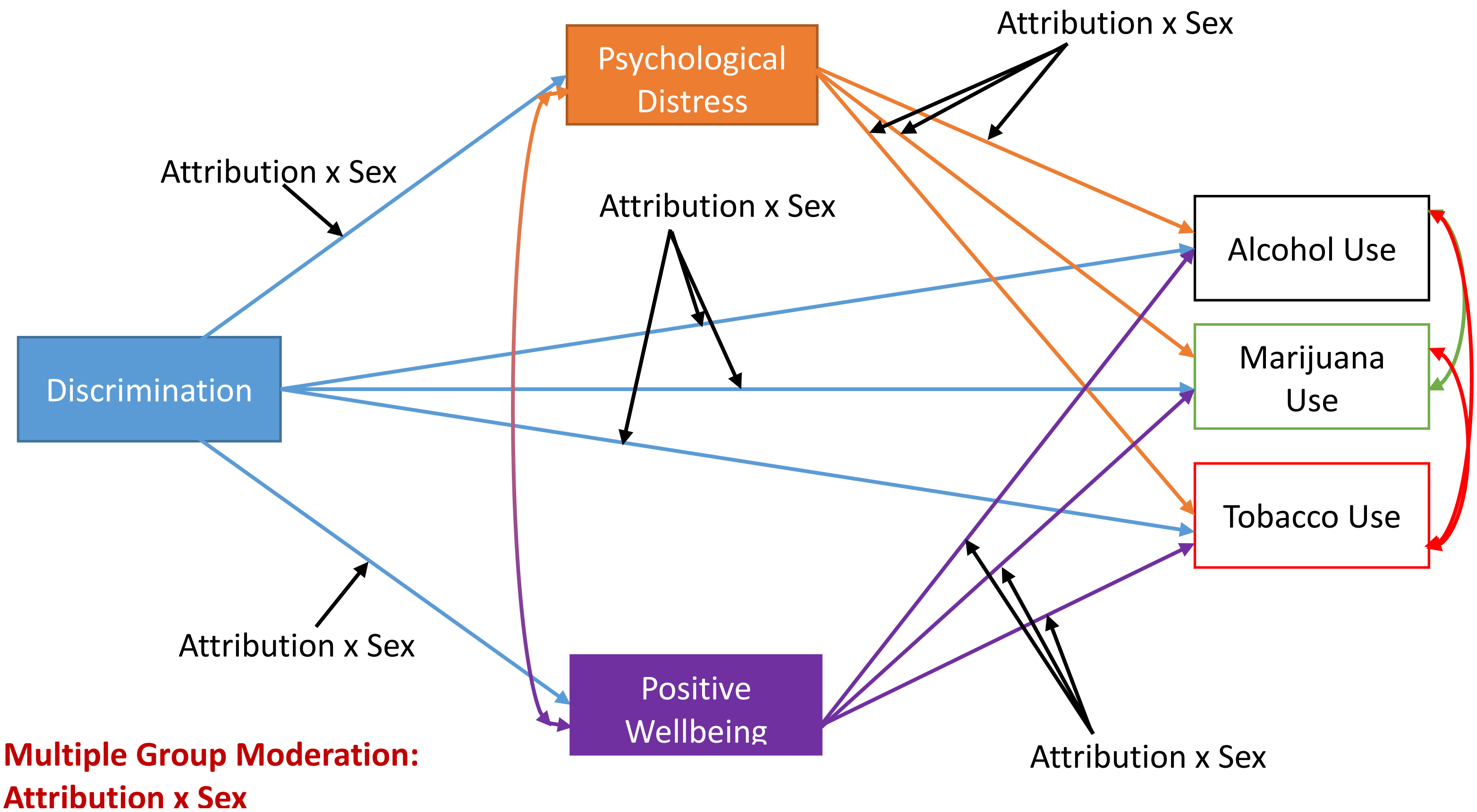


Figure 4: Study 3 Conceptual Model- Attribution to Discrimination and Sex as Moderators of Discrimination, Psychological Functioning, and Substance Use Relationship

Significance and Justification: Discrimination has been demonstrated as a harmful stressor on substance use; however, little is known about how the specific attribution to discrimination may affect this relationship. Racial discrimination is omnipresent in the current socio-political climate and recent studies show that young people may be disproportionately affected. as compared to non-racial forms of discrimination. The proposed examination could clarify the influence of discrimination attribution and could help to inform efforts to ameliorate the deleterious health effects of discrimination specifically among young people.

Research Questions: Does attribution and sex moderate the association between discrimination, psychological wellbeing, and substance use among young adults aged 18-28 in 2017?

Hypotheses: Psychological distress and positive wellbeing will mediate this association and attribution and sex will moderate the association between discrimination, psychological wellbeing, and substance use such that the influence of racial discrimination on substance use will be stronger among males and those who cite racial attributions and weaker among females and those who cite non-racial attributions.

Methods: Data will be utilized from the 2017 wave of the Transition into Adulthood Supplement of the Panel Study of Income Dynamics, the longest running longitudinal household study. Discrimination will be assessed using 7 of the 9 everyday discrimination scale items and modeled as a continuous measure. Psychological distress and positive wellbeing will be measured as continuous measures. Attribution will be assessed with individual self-reported items. Substances examined include past 30 day/current use of alcohol, marijuana, and tobacco (cigarettes and vaping).

Chapter 2: A National Examination of Allostatic Load and Substance Use by Race and Sex Among U.S. Adults Aged 20-59, 2007-2010

INTRODUCTION

Substance use is a major contributor to morbidity, mortality, lost productivity, and healthcare costs among U.S. adults.[13-15,21,91-98] Rates of substance use vary by race/ethnicity and sex with Whites and men historically having the highest rates of use[17,99,100]; however, over the past two decades substance use has risen among racial/ethnic minorities and women[11,99,101]. Similarly, racial-ethnic disparities, and to a lesser extent gender-based disparities, have persisted for chronic diseases and other physical health outcomes, including cardiovascular disease[95], all-cause mortality and mortality from heart disease, diabetes, HIV, and cerebrovascular disease[102], life expectancy[103], cancer incidence[104], as well as cancer survival and mortality[96,104]. Previous studies have utilized the concept of allostatic load, or the cumulative physiologic "weathering" to physiologic dysregulation, to help explain disparities in health risk behaviors and outcomes including substance use[105,106], physical inactivity[105,106], poor diet[106], mental health conditions[105,106], and cancer[107].

Specifically, allostatic load refers to the cumulative physiologic wear and tear on the body due to the body's efforts to maintain homeostasis as a result of repeated fluctuations of various physiologic systems (e.g., in response to perceived stressors) and/or chronic exposures to elevated levels of physiologic activity and changes in metabolism.[108] As explained by Seeman and colleagues, while short-term changes in the levels of physiologic activity are necessary for the body to respond successfully to stimuli (e.g., the fight or flight response to danger), long-term and/or inappropriately frequent or excessive responses of this nature can result in damage to the body's regulatory systems, ultimately producing disease and early health deterioration[108]. As such, the concept of allostatic load has emerged as a salient explanatory factor of racial-ethnic disparities in cardiovascular diseases, other chronic diseases, poor mental health, diminished longevity and mortality.[109-115]

High allostatic load appears to be significantly associated with older age[113,116], low socio-economic status (SES) [117], lower levels of educational attainment[113], and racial/ethnic minority status[113] (particularly African Americans[110,118-120]) and gender (higher allostatic load among women[110,118]). While the positive relationship between allostatic load and age is attributable to the physiological decline associated with aging[116], the relationship between allostatic load, low SES, race/ethnicity and gender/sex has largely been explained through a psychosocial framework. As posited by McEwen, experience with environmental stressors contributes to high allostatic load, and this relationship is modified by person-level differences (e.g. genetics, life experiences), differences in the perception of environmental stressors (e.g. view as negative/positive, stressful/not stressful), and differences in behavioral/lifestyle responses (e.g. positive health behaviors such as exercise vs. health risk behaviors such as substance use).[120,121] Thus, it is possible that the increased allostatic load found among vulnerable populations is attributable to differences in life experiences such as financial hardship and discrimination, differences in behavioral/lifestyle responses such as higher rates of physical inactivity and substance use, as well as differences in the perception of environmental stressors. Similarly, previous studies have noted that the stark racial-ethnic differences in allostatic load and the overall relationship between high allostatic load and negative health are not entirely explained by differences in SES[120] and are instead thought to capture the influence of other stressors such as discrimination, given that more frequent occurrences of perceived discrimination are associated with higher allostatic load.[119,122-124]

Numerous studies suggest that higher allostatic load is associated with greater likelihood of cardiovascular and other chronic diseases as well as mortality and poor mental health.[109-115] However, the relationship between allostatic load and substance use is understudied, with substance use behaviors only being examined as control variables[125] if at all. Given the well-established relationship between higher stress and greater substance use,[126] a positive association between allostatic load and substance use would make sense, possibly reflecting substance use in attempt to cope with stress. Indeed, research has demonstrated relationships between higher levels of distress and emotional, physiological, and chronic stress with decreased behavioral control and increased risk of maladaptive coping behaviors such as substance use.[127-132] Furthermore, Cohen and colleagues posited that environmental stress contributes to increased psychological distress and encourages maladaptive coping behaviors, which in turn can lead to long-term physiologic changes that increase allostatic load and physiological dysfunction.[133] Yet, it is important to note that the relationship between allostatic load and substance use is likely reciprocal wherein high allostatic load contributes to substance use behaviors and substance use behaviors contributes to high allostatic load. However, of the few available studies directly examining the association between allostatic load and substance use, findings have been mixed. Although there is little research on allostatic load and marijuana use, allostatic load has been linked to cigarette smoking[105,122,134,135] and alcohol use[105,106,136], but often with studies noting a negative relationship such that higher allostatic load was associated with lower likelihood or less frequent substance use. Reasons for a potential negative association between allostatic load and substance use are unclear.

Furthermore, it will be important to understand whether associations between allostatic load and substance use differ by race/ethnicity and gender. For example, some research suggests that African Americans may be particularly likely to use avoidant coping strategies such as substance use in response to stress and as a contributor to poor mental health.[32,81,105,137-143] A recent study of the effects of coping style on allostatic load among African Americans found that women who reported higher avoidant coping styles had significantly higher allostatic load scores compared to those who did not, while no association was found among men following adjustment for substance use and other participant characteristics.[138] Similarly, some research further suggests that the allostatic load-substance use relationship may differ by race/ethnicity. For example, Rodriquez et al.'s study of 40-79-year-old U.S. adults (drawn from 2005-2012 NHANES data) found that among African Americans, greater allostatic load was associated with lower odds of current cigarette smoking (AOR: 0.89) and past-year excessive or binge drinking (AOR: 0.88). Among Latino and White participants, greater allostatic load was also associated with lower odds of past year excessive or binge drinking (Latinos AOR: 0.92; Whites AOR: 0.91), but to a lesser degree. However, allostatic load was not associated with current cigarette smoking among Latinos or Whites. [105] These findings are especially important to note as African Americans and other racial/ethnic minorities are more likely than Whites to suffer from substance use related problems and related morbidity and mortality despite generally lower rates of substance use.[14,18-22,144] Accordingly, it is important to not only examine the relationship between allostatic load and substance use overall but to consider potential differences in this relationship among racial/ethnic minorities, particularly Blacks, and women.

Thus, the goals of this study were to assess associations between substance use and allostatic load and to examine potential racial/ethnic or sex differences in these associations. We aimed to answer the following research questions: 1) Is allostatic load associated with substance use (cigarette smoking, alcohol use, and marijuana use) among adults aged 20-59? and 2) Are these associations moderated/modified by race/ethnicity and sex? We hypothesized that allostatic load would be positively associated with each type of substance use, especially combustible products, and that the associations would be stronger among African Americans and males as compared to Whites, Hispanic, and females.

METHODS

<u>Data and Population</u>

We utilized data from the 2007-2008 and 2009-2010 waves of the National Health and Nutrition Examination Survey (NHANES). NHANES surveys are conducted by the National Center for Health Statistics and are based on stratified, multistage probability samples to allow for national estimates of health and nutritional status for the non-institutionalized, civilian US population. NHANES data is collected through questionnaires for several health and social conditions as well as clinical examinations involving several anthropologic and laboratory measures. Our analytic sample included 2,406 adults aged 20-59 who had complete data for all measures included in our allostatic load algorithm (see below), cigarette smoking, past month marijuana use, frequency of alcohol use in the past year, and demographic measures, which included a total 1,164 from the 2007-2008 survey and 1,242 participants from the 2009-2010 survey. Data related to marijuana use was only collected among participants aged 18-59, which informed our decision to impose the upper bound of 59 for the age range of the analytic sample as compared to the upper bound of 80+ from the overall sample. Similarly, participants aged 18-19 were given a separate survey than adults aged 20 and older (in terms of questions regarding alcohol use and demographics). To allow for consistent measures, we imposed a lower bound of 20 for the age range of the analytic sample.

Allostatic Load Measure

To measure allostatic load, we adapted the widely used algorithm used by Geronimus et al.[110], who adapted Seeman et al.'s[108] model for use with NHANES data. Under the original Geronimus[90,110] algorithm, allostatic load is measured through 10 biomarkers: systolic and diastolic blood pressure, body mass index (obtained from physical examination data), albumin, creatinine clearance, triglycerides, glycated hemoglobin, homocysteine, total cholesterol, and C-reactive protein (collected through laboratory blood samples). However, due to our goal of providing the most recent estimates of the allostatic load-substance use association and data availability, the allostatic load algorithm used in this study did not include homocysteine. Thus, the allostatic load algorithm used in this study was based on 9 biomarkers: systolic and diastolic blood pressure, body mass, albumin, creatinine clearance, triglycerides, glycated hemoglobin, total cholesterol, and C-reactive protein.

Following a standard approach[90,108,110,145], we empirically determined the high-risk threshold of each biomarker based on their respective sample distributions. Specifically, participants with a biomarker beyond the threshold of < 25th percentile for creatinine clearance and albumin and >75th percentile for the remaining biomarkers received a point for that specific biomarker. The points were then summed to obtain the allostatic load score, with a maximum possible score of 9. In the NHANES pooled 2007-2010 sample, high risk thresholds were: albumin, 4.0 g/dL; creatinine clearance, 74.0 mg/dL; BMI, 32.38; C-reactive protein, 0.43 mg/dL; diastolic blood pressure, 78 mm HG; glycated hemoglobin, 5.7%; systolic blood pressure, 126 mm HG; total cholesterol, 220 mg/dL; and triglycerides, 159 mg/dL Participants on medication for diabetes, hypertension, or hyperlipidemia were assigned a point for glycated hemoglobin, blood pressure, or total cholesterol, respectively.

<u>Substance Use Measures</u>

Participants' use of cigarettes, alcohol, and marijuana was determined based on NHANES questionnaire data.

Past Month Marijuana Use

Respondents were asked, “Have you ever (even once) used marijuana or hashish?”. Those who responded ‘yes’ were asked “How long has it been since you last used marijuana or hashish?” Those who reported use in the past 1 month/ 4 weeks/ 30 days were classified as past month users.

Cigarette Smoking Status

Ever cigarette smoking was assessed by asking respondents, “Have you smoked at least 100 cigarettes in your entire life?”. Those who answered ‘yes’ were classified as ever cigarette smokers and those who answered ‘no’ were classified as never cigarette smokers. Ever cigarette smokers were subsequently asked, “Do you now smoke cigarettes every day, some days, or not at all?”. Those who reported smoking cigarettes ‘every day’ or ‘some days’ were classified as current cigarette smokers while those who answered ‘not at all’ were classified as former cigarette smokers. Cigarette smoking dependence was assessed among current smokers through three items including time to first cigarette and average number of cigarettes smoked per day (CPD) from the Fagerstrom Test for Nicotine Dependence. Time to First Cigarette was assessed by asking daily current smokers, “How soon after you wake up do you smoke? Would you say…” with response options including “within 5 minutes”, “from 6 to 30 minutes”, “from note than 30 minutes to 1 hour”, or “more than 1 hour?”. All current smokers were asked CPD (“During the past 30 days, on the days that you smoked, how many cigarettes did you smoke per day?”) and the number of days that they smoked during the past 30 days.

Past Year Alcohol Use Status

Respondents were asked, “In your entire life, have you had at least 12 drinks of any type of alcoholic beverage?” Those who answered yes were subsequently asked, “In the past 12 months, how often did you drink any type of alcoholic beverage? (How many days per week, per month, or per year did you drink?)”. Past year alcohol use status was categorized into 5 levels: daily drinking, weekly drinking, monthly drinking, less than monthly drinking, and never drinkers. Those who reported drinking 7 days in the past week, 30 days in the past month, or 365 days in the past year were classified as daily drinkers; those who reported drinking less than 7 days in the past week or between 4-29 days in the past month were classified as weekly drinkers; those who reported drinking 3 days or less in the past month or 12 or more days in the past year were classified as past month drinkers; those who reported having ever drank alcohol but not in the past week, month, or less than 12 days in the year were classified as less than monthly drinkers; and those who reported never having a drink in their lifetime were classified as never drinkers. Past year alcohol dependence was assessed by asking past year drinkers the following item, “In the past 12 months, on those days that you drank alcoholic beverages, on the average, how many drinks did you have?” and participants were provided a standard definition of 1 alcoholic drink.

Participant Characteristics

Participant characteristics of sex, age, race/ethnicity, education level (4 levels: less than high school, high school/GED, some college, ≥ college degree), and poverty level (based on poverty income ratio; 2 levels: below the poverty level, at or above the poverty level) were obtained from NHANES questionnaire data and were included as control and moderator (sex and race/ethnicity) variables in analyses.

Analyses

SAS 9.4 was used to obtain weighted point estimates and 95% confidence intervals for variables of interest using the complex survey procedures to account for the strata, clustering, and sample weights associated with NHANES data. Firstly, analyses were conducted to determine the most appropriate specification of allostatic load for the data. Specifically, several nested likelihood ratio tests were conducted to evaluate three specifications for allostatic load as a continuous variable, dichotomous/binary variable (another commonly specification in previous studies[106,110,146]), or as a categorical variable (with each level represented as dummy variables) (Table A1). Specifically, reduced nested models were represented with allostatic load score as a continuous and dichotomous/binary while complete models were represented with allostatic load score as categorical variables with levels ranging from 0 to 9, 0 to 8 or greater, 0 to 7 or greater, and 0 to 6 or greater where a score of 0 as the reference. Ultimately, it was determined that allostatic load was best represented as a 7-level categorical variable ranging from level 0 to level 6 or greater.

Multivariable generalized linear models were conducted with the proportional cumulative odds assumption checked for non-binary outcomes (i.e. cigarette smoking status and alcohol use status) to predict past month marijuana, past month cigarette smoking, and alcohol use from allostatic load and demographic characteristics (sex, age, race/ethnicity, education level, and poverty level) following univariate analyses, bivariate analyses, and unadjusted regression. Additionally, to determine potential differences in the association between allostatic load and substance use by sex and race/ethnicity, several regression models with interaction terms (allostatic load x race/ethnicity, allostatic load x sex, race/ethnicity x sex, and allostatic load x race/ethnicity x sex) were tested. All regression models that included interaction terms were adjusted for all other sociodemographic characteristics including age, education level, and poverty level.

As shown in Table A2 in the appendix, a total of 7 models were conducted for each substance use outcome: model 1-allostatic load only/unadjusted regression model; model 2-allostatic load as primary predictor adjusted for all sociodemographic characteristics; model 3-allostatic load x race/ethnicity two-way interaction; model 4- allostatic load x sex two-way interaction; model 5- race/ethnicity x sex two-way interaction; model 6- all two-way interaction terms; model 7- allostatic load x race/ethnicity x sex three-way interaction and all two-way interaction terms. Significant three-way interactions between allostatic load, race/ethnicity, and sex were found with all substance use outcomes, following adjustment for sociodemographic characteristics. Thus, the results from the final models (model 7) are the focus of the results section although results of all models can be found in Table A2.

RESULTS

Univariate/ Bivariate Analyses

Univariate statistics for allostatic load, all substance use outcomes, and demographic characteristics are presented in Table 1. Overall, allostatic load scores ranged from 0 to 9. Most participants were non-Hispanic White, followed by Hispanics and non-Hispanic Blacks, and there was a slightly higher proportion of males than females. Around one quarter of participants were current cigarette smokers, one fifth were former cigarette smokers, and over half were never cigarette smokers, while only 13% reported past month marijuana use. Less than 5% reported daily drinking, over 40% reported weekly drinking, around one-fifth reported monthly or less than monthly drinking, and around one-seventh reported never drinking (Table 1).

The prevalence of substance use by sociodemographic characteristics is reported in Table 2. Younger participants, those with less education, and those with an income below the poverty level were more likely to be current smokers and marijuana users. Older participants, those with at least a college degree, and with an income at or above the poverty level were more likely be daily or weekly drinkers in the past year. Several differences were also found by sex wherein males were more likely to report past month marijuana use and daily and weekly drinking compared to females. Regarding race/ethnicity, non-Hispanic Blacks were most likely to be current cigarette smokers, non-Hispanic Whites were more likely to be former smokers, and Hispanics were more likely to be never smokers. Compared to non-Hispanic Whites, Non-Hispanic Blacks were also more likely, and Hispanics were less likely to be current marijuana users. Non-Hispanic Whites were more likely to be weekly drinkers compared to Hispanics.

Additionally, on average, Black (t (32) = 4.98, p<.0001) and White (t (32) = 5.37, p<.0001) current smokers smoked 6-7 more days in the past 30 days and smoked more cigarettes per day (Black: t (32)= 2.59, p = .0144; White: t (32)= 6.63, p<.0001) compared to Hispanic smokers. Similarly, Black and White smokers were more likely to have a short (< 5 min) time to first cigarette than Hispanics. Similarly, on average, Hispanic and male drinkers consumed 1-2 more drinks during drinking sessions than their Black (t (32) = -5.10, p<.0001) White (t (32)= -6.32, p<.0001), and female counterparts (t (32)= -8.35, p<.0001), respectively (data not shown). Sociodemographic characteristics by allostatic load score are presented in Table 3. Older participants, females, and those with less than a college education were more likely to have a higher allostatic load.

Regression Analyses

Results of the likelihood ratio tests are presented in Table S1, which indicated that models specifying allostatic load as continuous or dichotomous were significantly worse than models with allostatic load as a categorical variable (represented with dummy variables for each level of allostatic load). However, the model predicting alcohol use status from allostatic load specified as a 10-level categorical variable (range 0 – 9) did not converge due to the lack of variance in alcohol use status/insufficient sample size at higher levels of allostatic load. Thus, a series of likelihood ratio tests were also performed comparing models with different combinations of scores 6 through 9 of allostatic load collapsed (Table S1). Given the model convergence issue and likelihood ratio tests, allostatic load was specified as a 7-level categorical variable ranging from level 0 to level 6 or greater in all presented models. Additionally, regression models with cigarette smoking and alcohol use status as the outcome were originally specified as ordinal regression models; however, the proportional odds assumption was violated ($ps < 0.05$) and multinomial regression was performed in the final models.

Unadjusted and Adjusted Simple Models

Findings from the unadjusted logistic regression analyses of associations between allostatic load and substance use varied by outcome. An association was found between allostatic load score and cigarette smoking status as well as alcohol use status in unadjusted analyses. However, allostatic load score was not associated with past month marijuana use. Following adjustment for all sociodemographic characteristics (viz. sex, race/ethnicity, age, poverty level, and level of education), allostatic load was no longer a significant predictor of cigarette smoking status but remained significantly associated with alcohol use status.

Interaction Terms

Three-way Interaction Term: Allostatic Load x Race/Ethnicity x Sex

The results of models with only two-way interactions will not be presented as the three-way interaction terms were significant in each model. Figure 1A shows the overall three-way interaction for past marijuana use and Figures 1B and 1C/Table 5 depict the probability of past month marijuana use by allostatic load and race/ethnicity separately for females and males, respectively. In general, there appeared to be a non-linear relationship between allostatic load and marijuana use. The probability of past month marijuana use in order of highest to lowest was among Black males, Black females, White males, White females, followed by Hispanic males, and Hispanic females (Figure 1A). Moreover, there appeared to be a strong sex effect among Blacks and to a lesser extent Whites, wherein males generally had a higher probability of past month marijuana use than females across all values of allostatic load. However, no sex effect was observed among Hispanics (Figure 1A/Table 5).

As shown in Figure 1B/Table 5, among Black females a higher probability of marijuana use was observed at low to moderate allostatic load scores, but a lower probability was observed at the highest score (≥ 6) which was among the lowest probability across all groups. Conversely, White and especially Hispanic females generally had a low probability across all allostatic load scores; however, Black and particularly White females had a slightly higher probability at a score of 4 where Hispanic females had a lower probability. As shown in Figure 1C, pattern of the probability of past month marijuana use observed among males was similar to the pattern observed among females, although there were fewer consistencies among Black males. Specifically, among Black males the probability of past month marijuana use fluctuated across allostatic load scores with a higher probability observed at scores of 0, 3, 5, and 6 and lower probabilities at 1, 2, 4. Conversely, White and Hispanic males had relatively moderate and low probability of marijuana use, respectively, across allostatic load scores. Whites had a notably lower probability at a score of 4 while Hispanics had a higher probability at a score of (≥ 6), similar to Hispanic females.

Figure 2A shows the overall three-way interaction for current cigarette smoking and Figures 2B and 2C/Table 6 depict the probability of current cigarette smoking by allostatic load and race/ethnicity separately for females and males, respectively. In general, there appeared to be a non-linear relationship between allostatic load and current cigarette smoking. The probability of current cigarette smoking in order of highest to lowest was among White males, Black males, White females, Black females, followed by Hispanic females, and Hispanic males (Figure 2A/Table 6). Moreover, there appeared to be a strong sex effect among Blacks and to a lesser extent Whites at allostatic load scores of 5 and ≥ 6, wherein males generally had a higher probability of past month marijuana use than females. However, the probability of current smoking was generally similar for Hispanic males and females (Figure 2A/Table 6).

As shown in Figure 2B/Table 6, the association between allostatic load score and the probability of current cigarette smoking was generally similar among Black and White females wherein a higher probability of current smoking was observed at low to moderate allostatic load scores and a lower probability was observed at higher allostatic load scores of 5 and ≥ 6. One notable difference was observed at allostatic load value 2 where Black females had a substantially lower probability of current smoking than observed at other scores. Conversely, Hispanic females generally had a lower, somewhat consistent probability across all values of allostatic load score and had a higher probability of current smoking compared to Black females at the highest allostatic load score of ≥ 6. As shown in Figure 2C/Table 6, the probability of current smoking was somewhat consistent across allostatic load scores among White and Hispanic males, although a higher probability was generally observed at the highest allostatic load score of ≥ 6. However, the relationship was less consistent among Black males, wherein a higher probability was observed at scores of 0, 3, and 6 with a lower probability observed at scores of 1, 2, 4, and 5.

Figure 3A shows the overall three-way interaction for daily or weekly drinking as it may reflect “current” drinking patterns more accurately than past month drinking and Figures 3B and 3C/Table 7 depict the probability of daily or weekly drinking by allostatic load and race/ethnicity separately for females and males, respectively. In general, there appeared to be a non-linear relationship between allostatic load and alcohol use. The probability of daily or weekly drinking in order of highest to lowest was among Black males, White males, Hispanic males, White females, followed by Black females and Hispanic females (Figure 3A/Table 7). Moreover, there appeared to be a strong sex effect among Blacks, Whites, and Hispanics, wherein males had a higher probability of daily or weekly drinking than females across allostatic load scores.

As shown in Figure 3B/Table 7, among Black females, the probability of daily or weekly drinking was notably lower at a score of 2 and a substantially lower probability at a score of 5. Similarly, among White females, the probability was somewhat consistent across allostatic load scores but with a notably higher probability at a score of 4 and a notably lower probability at a score of ≥ 6. Additionally, White females had the lowest probability of daily or weekly drinking at allostatic load scores of 6 or greater despite having a higher probability than Black and especially Hispanic females at other scores. Among Hispanic females, there was a substantially higher probability at the highest allostatic load score of ≥ 6 (as compared to Black and White females), miniscule probability at a score of 5, and a noticeably higher probability of daily or weekly drinking at a scores of 0 and 1 compared to scores 2, 3, and 4.

As shown in Figure 3C/Table 7, among Black males, the highest probability of daily or weekly drinking was observed at moderate (4 or 5) allostatic load scores which were substantially higher than the probability observed at low (0-3) and high (≥ 6) scores. Among White males, a higher probability was observed at scores of 4 and ≥6 with lower probability observed elsewhere and among Hispanic males, the probability was substantially higher at an allostatic load score of 3, and notably higher at scores of 5 and ≥ 6 with relatively consistent probabilities elsewhere (particularly for daily drinking).

DISCUSSION

Our study evaluated the relationship between allostatic load and three substance use outcomes including past month marijuana use, cigarette smoking status, and alcohol use status overall and by race/ethnicity and sex among U.S. adults aged 20-59. We found a non-linear relationship and statistically significant three-way interactions between allostatic load, race/ethnicity, and sex in predicting all three substance use outcomes. Consistent with our hypothesis, we found differences in the relationship between allostatic load and substance use by race/ethnicity and sex; However, we also observed a nonmonotonic relationship between allostatic load and substance use which was unexpected and not consistent with our hypothesis.

Generally, Black and White males were most likely to report current substance use across all allostatic load scores and substances. Moreover, a strong sex effect was present, particularly among Blacks, where females had a substantially lower probability of substance use. White and Black females generally had a somewhat consistent probability of substance use at low and moderate allostatic load scores but a lower probability at high scores (5 and ≥6). Hispanic males and females typically were the least likely to be current substance users but often had higher probability of current substance users at high allostatic load scores surpassing their counterparts (particularly Black females).

Previous studies examining allostatic load have generally established that women[106,113,147] and racial/ethnic minorities[110,112,118,119,122,148] are more likely to have high allostatic load, potentially due to higher levels of stress such as sexism or racial discrimination. Given that stress is a strong trigger for substance use[126] and high allostatic load is thought to reflect high levels of stress[105,113,123,149], researchers have hypothesized a positive association between high allostatic load and substance use[121,150]. However, findings have been mixed[122] regarding the association between allostatic load and substance use. Moreover, few studies have assessed whether race/ethnicity and/or sex moderate the association between allostatic load and health outcomes. Overall, the literature related to allostatic load and substance use is scant and of available studies, most examined substance use measures as covariates rather than as primary outcomes. Additionally, if the three-way interactions were not included in the current study, the results would have suggested that there was not a relationship between allostatic load and cigarette smoking, or marijuana use and that the relationships did not vary by race/ethnicity or sex. Instead, the three-way interactions suggested more complex associations between allostatic load and substance use depending on both race/ethnicity and sex. Although we offer several potential explanations for these findings, continued research is needed to more fully understand how and why the associations between allostatic load and substance use might differ for people from various backgrounds.

Overall, our prevalence estimates by race/ethnicity and sex were consistent with other national estimates with males, Whites, and Blacks more likely to be current substance users than their female and Hispanic counterparts.[151-154] However, we found differences in the association between allostatic load and substance use by race/ethnicity and sex. Although several studies have found mixed or a null association between allostatic load and substance use measures[135,155,156], some have observed a negative relationship, several of which were statistically significant regarding cigarette smoking[146] as well as alcohol use[148,155,157]. This is somewhat consistent with our findings among Black and White females wherein higher probabilities of substance use were generally observed at lower allostatic load scores.

However, among Hispanics we found a higher probability of substance use at the highest allostatic load score, although, notably, Hispanics, especially males, had higher probability of daily/weekly drinking across allostatic load scores. Compared to their Black and White counterparts, Hispanics in this study reported less substance use and were generally less likely to be current substance users across all allostatic load scores. Previous studies suggest that Hispanics may be less likely to utilize substances as a mechanism for coping with stress[158,159] and that Hispanic culture is associated with a less favorable view towards substance use as compared to dominant U.S. culture.[159-163] Thus, it is plausible that low-to-moderate physiological stress is less likely to trigger substance use among Hispanics but that coping related substance use is more apparent at very high levels of physiological stress. Additionally, as posited by Evans and colleagues[164], it is possible that Whites, who tend to be less socioeconomically disadvantaged than their Black counterparts, may be less likely to view their substance use as problematic due to their more privileged circumstances while being able to sustain their substance use due to their greater means. Additionally, there is some evidence that substance use is more stigmatized in certain racial/ethnic minority communities than in the White community. [18,162,165]

Moreover, the notably higher probability of weekly or daily drinking among Hispanics (relative to the low probability for cigarette smoking and marijuana use) and generally high probability of substance use among Blacks and Whites could be at least partially related to differences in substance use dependence/intensity. For example, although Hispanics consumed alcohol less regularly in the past year, Hispanics consumed a significantly greater number of drinks during drinking sessions on average than Blacks and Whites. Additionally, Black and White participants had significantly greater cigarette dependence than Hispanics. Thus, it is possible that the low probability of marijuana and cigarette observed among Hispanics not only reflects low prevalence but less dependence while the notably higher probability of drinking reflected the greater dependence among Hispanics in spite of the generally lower use prevalence. Future research is needed to further investigate the relationship between allostatic load and various substance use outcomes including dependence and intensity.

Across substances, a strong sex effect was observed wherein males were more likely to be current substance users than their female counterparts (particularly among Blacks), which is consistent with previous studies.[151-154,166] Lower rates of substance use among women may be partially attributed to harsher social stigma towards substance use[165] and because females are more likely to be primary caregivers as compared to males[167]. Moreover, there may be specific cultural factors that contributed to the large differences in substance use rates by sex, especially for Blacks. As posited and extensively discussed by Zapolski and colleagues, the stark difference in substance use between Black males and Black females may be attributed to a difference in standard life reinforcers (SLRs), or a basic set of rewarding circumstances or experiences that persons strive for including housing, economic security, work opportunity, knowledge, and relationships.[18] Black Americans, particularly Black males, experience greater poverty[168] and have higher unemployment rates[169] and less education[170], in addition to disproportionate incarceration rates[171,172] and racial discrimination.[24,72,139,141,156,173,174] Thus, it is plausible that Black males have reduced access to other sources of reinforcement such as financial stability and social support services compared to Whites and Black females. Zapolski and colleagues posited that Black males may be particularly likely to use substances given the lack of availability of alternative sources of reinforcement and because they have fewer immediate consequences (i.e. do not have a job that they can lose due to their substance use; are not sole/primary caregivers) given the lack of SLRs available to them (i.e. there are fewer disincentives to use substances). Conversely, although Black females may be similarly disadvantaged as Black males, Black females are more likely to be head of households in the African American community[175], primary caregivers of children (both biological and non-biological)[176,177] and to utilize social support services[178,179]. Additional studies are needed to identify potential protective factors of the allostatic load-substance use relationship, particularly for Black males. Moreover, it may be beneficial for future substance interventions targeted to Black Americans to aim to increase participants SLRs. Furthermore, it could be beneficial for substance use interventions to address or support participants with socioenvironmental stressors such as adequate housing and employment.

Limitations

This study has several limitations. Firstly, this study utilized two waves of cross-sectional NHANES data and is subject to the inherent limitations of cross-sectional data including inability to make conclusions about temporality or causality. It is important to note that substances such as alcohol, tobacco, and marijuana can induce both psychological (and to a lesser extent physiological stress)[180-184] as well as physiological stress.[108] Additional research, including longitudinal studies, is needed to further understand the reciprocal, bi-directional relationship between allostatic load and substance use, as well as the underlying mechanisms in diverse populations.

Moreover, there has yet to be a consensus on which biomarkers are needed to create, measure, or statistically analyze an allostatic load index.[113,185] A strength of the present study is our empirically supported specification of allostatic load as we tested both continuous and categorical specifications of allostatic load and our findings highlighted the need for non-linear examinations of allostatic load and substance use. Additionally, in the present study there is evidence that race/ethnicity and sex undoubtedly shape individuals' lived experiences and reactions to stress, which in turn may influence their substance use. However, we were unable to assess the role of other potentially important factors such as substance use motivations, social support, cultural norms of substance use, mental health outcomes, or measures of substance use dependence and abuse on the allostatic load-substance use relationship. Nevertheless, the present study is a novel examination of the relationship between allostatic load and substance use that takes into account more complex associations by both race/ethnicity and sex and is one of the first studies to examine the relationship between allostatic load and marijuana use.

CONCLUSIONS

The present study suggests that the relationship between allostatic load and current use of marijuana, cigarettes, and alcohol differs substantially by race/ethnicity and sex. The relationship between high allostatic load and substance use was stronger among Black, and to a lesser extent White, males as compared to their female and Hispanic counterparts. Future research is needed to further understand the role of allostatic load in creating risk for substance use (or vice versa) among diverse populations, as well as the influence of social, economic, and cultural factors that might mediate or moderate this relationship.

Table 1: Univariate Statistics of Substance Use Outcomes, Allostatic Load Score, and Demographic Characteristics Among U.S. Adults Age 20-59, 2007-2010

	% (n) or M (SD)
SUBSTANCE USE MEASURES	
Past Year Alcohol Use Status	
Daily Drinker	3.4 (78)
Weekly Drinker	40.4 (785)
Monthly Drinker	22.3 (485)
Less Than Monthly Drinker	19.9 (477)
Never Drinker	14.0 (354)
Cigarette Smoking Status	
Current Smoker	25.5 (605)
Former Smoker	22.5 (446)
Never Smoker	52.0 (1128)
Past 30 Day Marijuana Use	
Yes	13.0 (295)
No	87.0 (1884)
Allostatic Load	
0	19.4 (397)
1	25.8 (531)
2	20.0 (431)
3	13.9 (315)
4	9.9 (225)
5	6.3 (150)
6	2.9 (77)
7	1.2 (37)
8	0.5 (15)
9	0.02 (1)
DEMOGRAPHIC CHARACTERISTICS	
Age	39.7 (11.3)
Sex	
Male	52.8 (1134)
Female	47.2 (1045)
Race/Ethnicity	
White, NH	74.8 (1103)
Black, NH	10.9 (386)
Hispanic	14.3 (690)
Education Level	
Less than HS	16.1 (530)
HS/GED	22.7 (512)
Some College	31.4 (657)
College Degree+	29.7 (480)
Poverty Level	
Below Poverty Level	14.2 (477)
At or Above Poverty Level	85.8 (1702)

CI, confidence interval, NH, non-Hispanic, HS, high school, GED, general education diploma.

Table 2: Demographic Characteristics by Substance Use Behaviors Among U.S. Adults Aged 20-59, 2007-2010

	Cigarette Smoking Status			Past Month Marijuana Smokers	Alcohol Use				
N=2269	Current n=605	Former n=446	Never n=1128	n=295	Daily Drinker n=78	Weekly Drinker n=785	Monthly Drinker n=485	Less than Monthly Drinker n=477	Never Drinker n=354
	% (n) or M (SD)	% (n) or M (SD)	% (n) or M (SD)	% (n) or M (SD)	% (n) or M (SD)	% (n) or M (SD)	% (n) or M (SD)	% (n) or M (SD)	% (n) or M (SD)
Demographic Characteristics									
Age	38.2 (11.1)	43.5 (10.9)	38.9 (11.2)	33.5 (11.0)	45.3 (9.6)	38.9 (11.3)	37.9 (11.2)	39.6 (11.3)	43.9 (10.3)
Sex				***			***		
Male	26.3 (323)	23.4 (258)	50.3 (553)	16.1 (183)	4.7 (56)	45.4 (488)	22.2 (253)	13.4 (161)	14.4 (176)
Female	24.5 (282)	21.6 (188)	53.9 (575)	9.6 (112)	2.0 (22)	34.9 (297)	22.4 (232)	27.2 (316)	13.5 (178)
Race/Ethnicity	***			***			*		
White, NH	25.7 (348)	24.9 (263)	49.4 (492)	12.3 (154)	3.6 (43)	42.8 (440)	21.1 (224)	18.9 (222)	13.5 (174)
Black, NH	30.8 (120)	11.0 (43)	58.2 (223)	24.0 (91)	2.9 (13)	37.6 (147)	24.4 (90)	21.2 (78)	14.0 (58)
Hispanic	20.0 (137)	19.1 (140)	60.9 (413)	8.0 (50)	2.9 (22)	30.2 (198)	26.5 (171)	24.0 (177)	16.4 (122)
Education Level	***			***			***		
Less than HS	43.5 (214)	20.3 (100)	36.1 (216)	17.4 (78)	3.2 (21)	34.3 (164)	20.7 (103)	21.9 (124)	19.8 (118)
HS/GED	37.3 (189)	19.1 (94)	43.6 (229)	17.4 (87)	2.8 (19)	35.0 (172)	18.5 (98)	23.6 (122)	20.1 (101)
Some College	22.0 (155)	26.3 (153)	51.7 (349)	13.0 (92)	2.5 (16)	38.8 (228)	24.2 (163)	23.5 (167)	11.0 (83)
≥College Degree	10.2 (47)	22.3 (99)	67.4 (334)	7.2 (38)	5.0 (22)	49.5 (221)	23.9 (121)	12.2 (64)	9.4 (52)
Poverty Level	***			***			**		
Below Poverty Level	46.3 (219)	15.2 (78)	38.5 (180)	23.6 (96)	3.3 (17)	32.1 (141)	19.6 (92)	26.8 (128)	18.1 (99)
At or Above Poverty Level	22.0 (386)	23.7 (368)	54.2 (948)	11.2 (199)	3.4 (61)	41.8 (644)	22.7 (393)	18.8 (349)	13.3 (255)
		***		**		***	***	*	
Continuous AL	2.08 (1.9)	2.37 (1.9)	1.97 (1.8)	1.84 (1.7)	2.22 (1.7)	1.96 (1.7)	1.80 (1.6)	2.31 (2.0)	2.56 (2.0)
Categorical AL							***		
0	26.0 (109)	17.1 (66)	56.9 (222)	16.1 (71)	2.1 (9)	45.6 (156)	25.2 (106)	18.2 (82)	8.9 (44)
1	24.0 (134)	21.5 (97)	54.5 (300)	14.1 (79)	3.6 (20)	41.4 (209)	24.2 (130)	20.1 (111)	10.7 (61)
2	29.2 (132)	19.6 (80)	51.2 (219)	11.8 (48)	3.8 (13)	39.3 (151)	23.4 (101)	15.2 (84)	18.3 (82)
3	23.2 (89)	27.6 (75)	49.2 (151)	11.5 (43)	4.3 (16)	34.4 (103)	23.2 (69)	24.2 (69)	14.0 (58)
4	26.3 (67)	28.0 (58)	45.6 (100)	11.2 (24)	4.2 (11)	48.3 (87)	17.4 (43)	16.8 (52)	13.3 (32)
5	21.3 (33)	29.1 (39)	49.6 (78)	12.8 (20)	-	31.9 (43)	17.6 (26)	24.0 (33)	24.9 (44)
6	20.4 (20)	27.5 (20)	52.1 (37)	-	6.8 (5)	30.4 (25)	9.9 (6)	33.5 (28)	19.5 (13)
7	25.5 (13)	31.5 (7)	43.0 (17)	20.0 (6)	-	26.9 (8)	-	45.0 (14)	19.9 (11)
8	68.3 (8)	-	-	-	-	-	-	-	39.7 (8)
9	-	-	-	-	-	-	-	-	-

CI, confidence interval, NH, non-Hispanic, HS, high school, GED, general education diploma, AL, allostatic load. Dashes represent an insufficient sample size (n < 5). * p< .05, ** p<.01, *** p<.001. Unweighted n and weighted row percent are reported.

Table 3: Demographic Characteristics by Allostatic Load Score Among U.S. Adults Aged 20-59, 2007-2010

	Allostatic Load Score									
	0	1	2	3	4	5	6	7	8	9
	% (95% CI) or M (SE)	% (95% CI) or M (SE)	% (95% CI) or M (SE)	% (95% CI) or M (SE)	% (95% CI) or M (SE)	% (95% CI) or M (SE)	% (95% CI) or M (SE)	% (95% CI) or M (SE)	% (95% CI) or M (SE)	% (95% CI) or M (SE)
CHARACTERISTIC										
Age	33.2 (9.9)	37.3 (11.3)	40.6 (10.9)	43.0 (10.7)	44.1 (10.2)	47.0 (9.7)	47.1 (8.7)	48.9 (7.6)	49.1 (4.6)	-
Sex										
Female	43.6 (181)	52.7 (269)	41.9 (188)	45.6 (153)	39.6 (98)	56.9 (80)	65.7 (46)	57.1 (18)	69.5 (11)	-
Race/Ethnicity										
White, NH	75.9 (209)	76.4 (279)	76.1 (220)	72.3 (147)	71.9 (109)	75.4 (80)	65.2 (27)	76.8 (23)	78.9 (9)	-
Black, NH	9.0 (61)	9.3 (80)	9.3 (70)	12.7 (63)	16.9 (58)	13.2 (29)	13.9 (16)	13.4 (7)	-	-
Hispanic	15.1 (127)	14.3 (172)	14.6 (141)	15.0 (105)	11.1 (58)	11.4 (41)	20.8 (34)	9.9 (7)	16.2 (5)	-
Education Level										
Less than HS	14.8 (87)	13.4 (111)	15.3 (103)	18.0 (90)	18.3 (58)	22.5 (42)	18.9 (22)	26.8 (11)	23.8 (6)	-
HS/GED	19.1 (83)	22.1 (118)	25.4 (113)	21.0 (67)	22.3 (50)	31.2 (46)	19.9 (17)	26.1 (13)	50.1 (5)	-
Some College	29.6 (116)	31.9 (169)	31.7 (121)	27.5 (86)	36.0 (76)	32.8 (47)	37.4 (27)	32.0 (10)	-	-
College Degree+	36.5 (111)	32.6 (133)	27.6 (94)	33.5 (72)	23.5 (41)	13.6 (15)	23.8 (11)	-	-	-
Poverty Level										
Below Poverty Level	14.3 (89)	13.3 (104)	13.9 (89)	14.9 (74)	14.4 (51)	13.3 (31)	15.3 (19)	20.7 (11)	33.6 (8)	-

Weighted column percent are reported.

Table 4: Final Model (Model 7) Main Effects and Joint Test Interaction Regression Estimates by Substance Use Outcome

Outcome		AL	Race/Ethnicity	Sex	AL*Sex	AL*Race/Ethnicity	Race/Ethnicity *Sex	AL*Race/Ethnicity*Sex
Alcohol Use Status	Wald $\chi^{2,}$ df, p	**31020.17, 24, <.0001**	**1165.31, 8, <.0001**	6.90, 4, 0.14	**6699.44, 24, <.0001**	**40260.71, 32, <.0001**	**122.32, 8, <.0001**	**244730.52, 33, <.0001**
Cigarette Smoking Status	Wald $\chi^{2,}$ df, p	20.72, 12, .05	5.34, 4, 0.25	0.86, 2, 0.65	7.38, 12, 0.83	34.50, 24, .08	4.94, 4, 0.29	**1125.58, 24, <.0001**
Past Month Marijuana Use	Wald $\chi^{2,}$ df, p	3.21, 6, 0.78	**9.83, 2, 0.0073**	3.76, 1, 0.05	9.52, 6, 0.15	12.78, 12, 0.39	1.96, 2, 0.38	**266.04, 12, <.0001**

AL, allostatic load, df, degrees of freedom. Regression estimates were from a joint test which is a test that all the parameters associated with that effect are zero. Boldface indicates statistical significance at the p< 0.05 level. Model also adjusted for age, education, and poverty level.

Figure 1A: Probability of Past Month Marijuana Use by Allostatic Load, Race/Ethnicity, and Gender

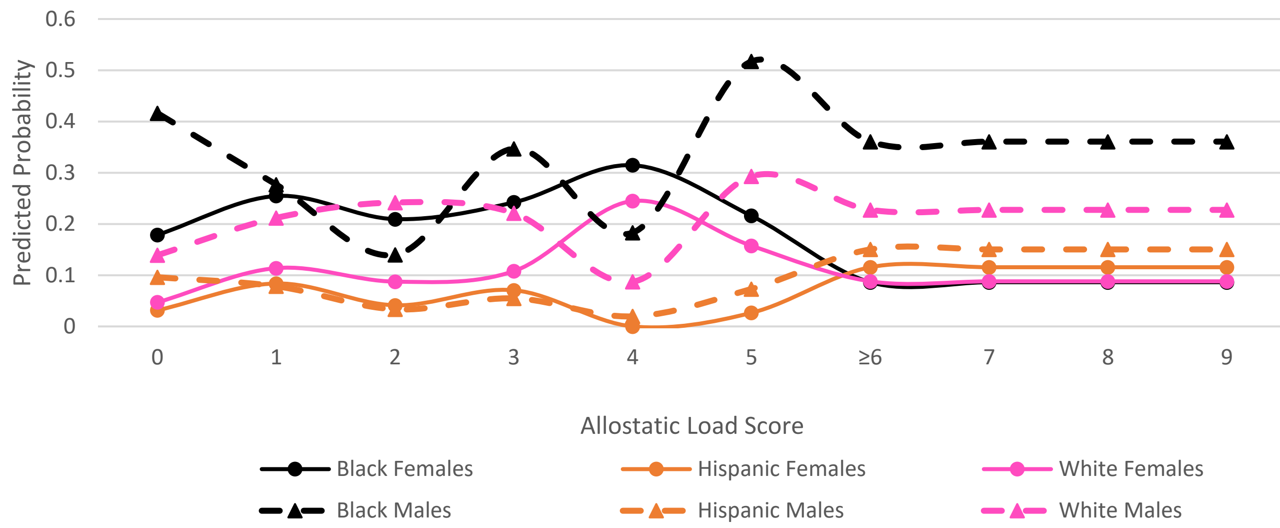
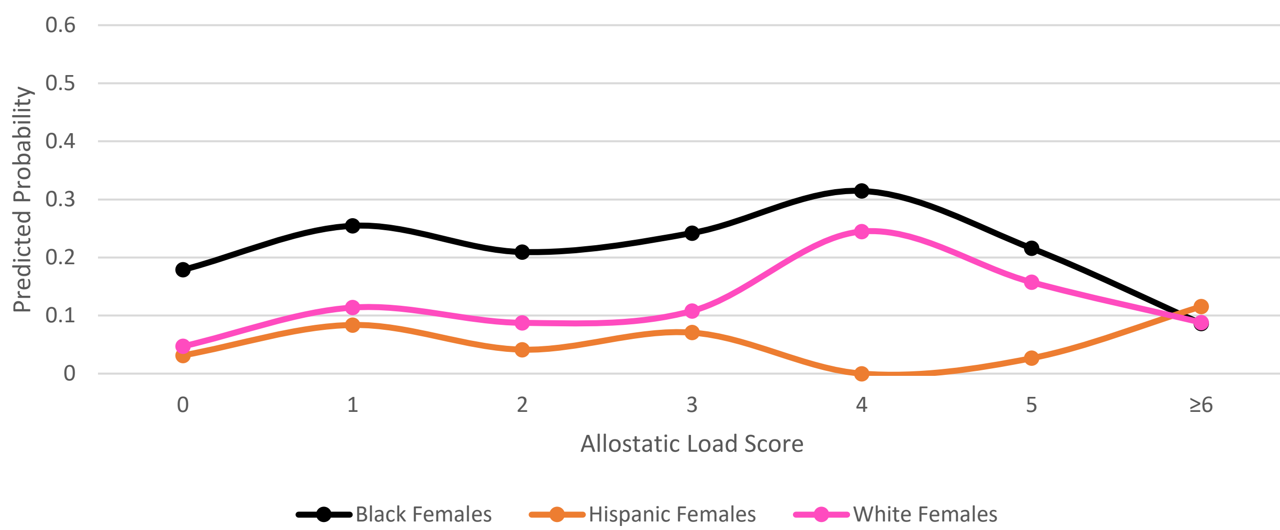


Figure 1B: Probability of Past Month Marijuana Use by Allostatic Load and Race/Ethnicity Among Women



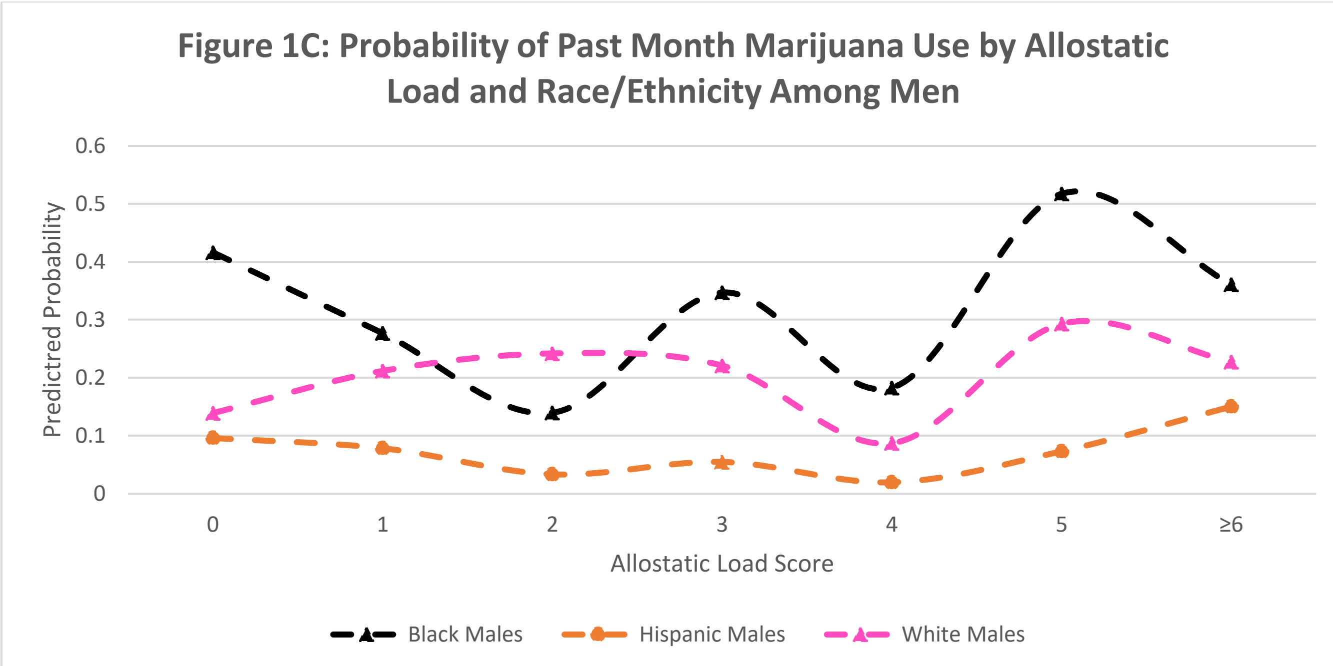


Figure 1C: Probability of Past Month Marijuana Use by Allostatic Load and Race/Ethnicity Among Men
0.6
0.5
0.4
0.3
0.2
0.1
0
Predictred Probability
0
1
2
3
4
5
≥6
Allostatic Load Score
Black Males
Hispanic Males
White Males

Table 5a. Model Estimated Probability of Past Month Marijuana Use by Allostatic Load Score, Race/Ethnicity, and Sex

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Past Month Marijuana Use Model Estimated Probability					
0	0.42	0.18	0.14	0.05	0.10	0.03
1	0.28	0.25	0.21	0.11	0.08	0.08
2	0.14	0.21	0.24	0.09	0.03	0.04
3	0.35	0.24	0.22	0.11	0.05	0.07
4	0.18	0.31	0.09	0.24	0.02	0.00
5	0.52	0.22	0.29	0.16	0.07	0.03
6+	0.36	0.09	0.23	0.09	0.15	0.12
Min Probability	0.02	0.02	0.02	0.02	0.02	0.02
Max Probability	0.52	0.52	0.52	0.52	0.52	0.52

Table 5b. Model Estimated Risk Ratio of Past Month Marijuana Use by Allostatic Load Score, Race/Ethnicity, and Sex

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Past Month Marijuana Use Model Estimated Risked Risk Ratio					
0	REF	REF	REF	REF	REF	REF
1	0.66	1.42	1.52	2.42	0.82	2.67
2	0.34	1.17	1.74	1.86	0.35	1.31
3	0.83	1.35	1.59	2.30	0.57	2.25
4	0.44	1.76	0.63	5.21	0.20	0.00
5	1.24	1.21	2.11	3.35	0.76	0.84
6+	0.87	0.48	1.64	1.87	1.56	3.68
Min Risk Ratio	0	0	0	0	0	0
Max Risk Ratio	5.21	5.21	5.21	5.21	5.21	5.21

Min, minimum, max, maximum. Table 6 is a heat map with deeper shades representing a higher predicted probability and less saturated shades representing a lower predicted probability.

Figure 2A: Probability of Current Cigarette Smoking by Allostatic Load, Race/Ethnicity, and Gender

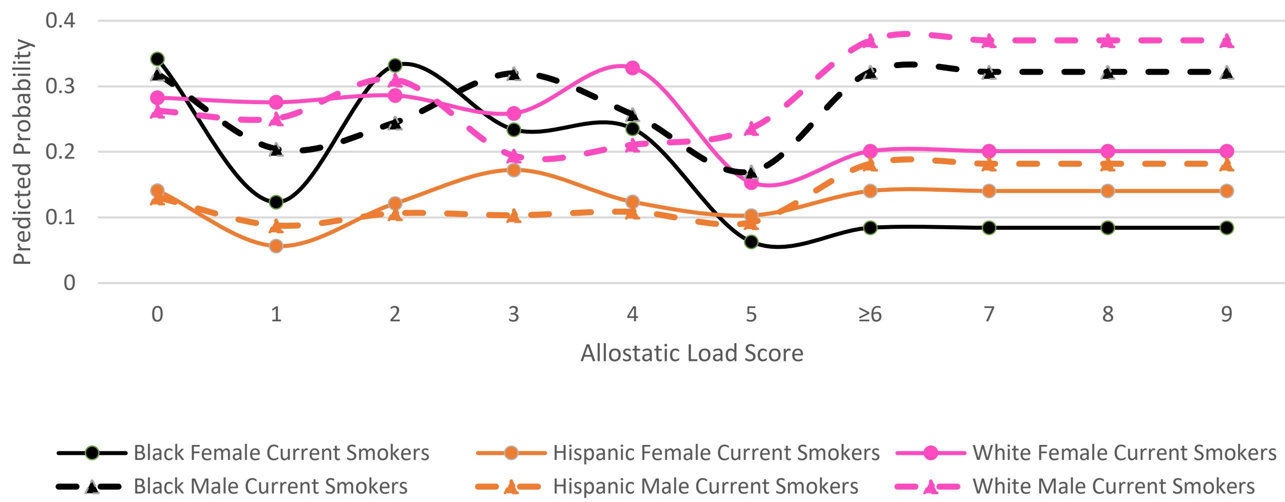
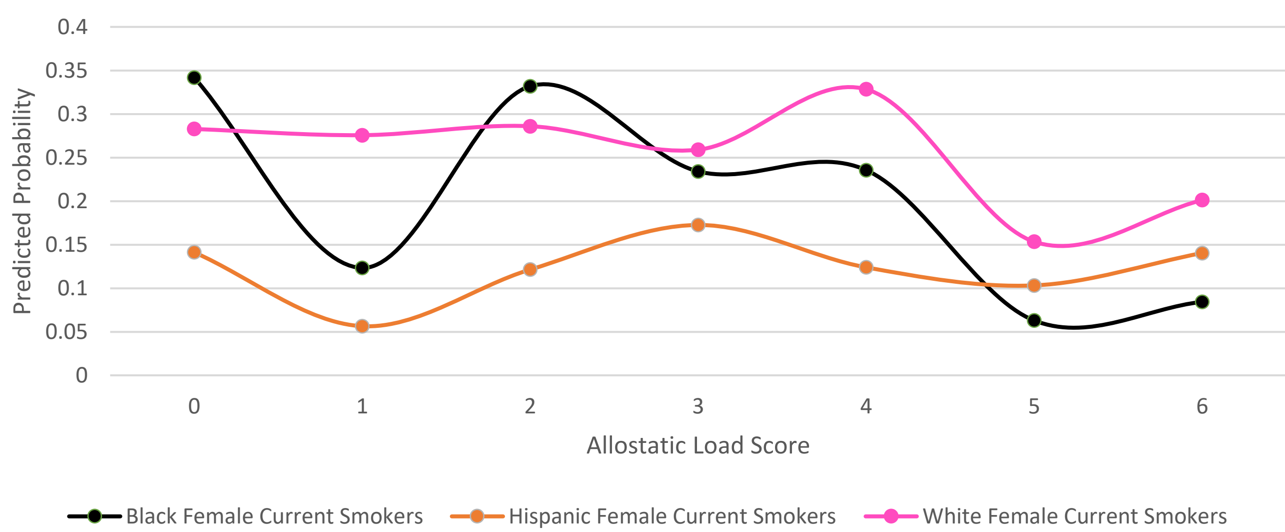


Figure 2B: Probability of Current Cigarette Smoking by Allostatic Load and Race/Ethnicity Among Women



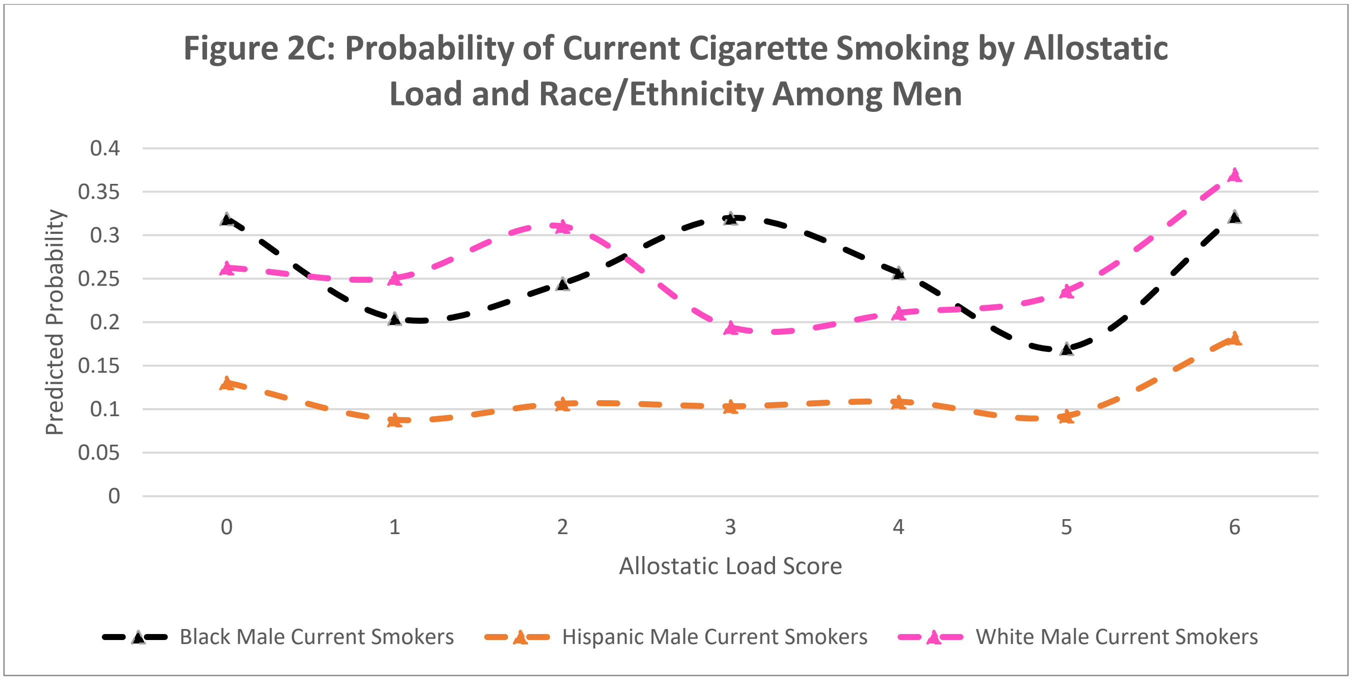


Figure 2C: Probability of Current Cigarette Smoking by Allostatic Load and Race/Ethnicity Among Men
Predicted Probability
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
1
2
3
4
5
6
Allostatic Load Score
Black Male Current Smokers
Hispanic Male Current Smokers
White Male Current Smokers

Table 6a. Model Estimated Probability of Being a Current Cigarette Smoker Status by Allostatic Load Score, Race/Ethnicity, and Sex

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Current Smoker Predicted Probability					
0	0.32	0.34	0.26	0.28	0.13	0.14
1	0.20	0.12	0.25	0.28	0.09	0.06
2	0.24	0.33	0.31	0.29	0.11	0.12
3	0.32	0.23	0.19	0.26	0.10	0.17
4	0.26	0.24	0.21	0.33	0.11	0.12
5	0.17	0.06	0.24	0.15	0.09	0.10
6+	0.32	0.08	0.37	0.20	0.18	0.14
Min Probability	0.06	0.06	0.06	0.06	0.06	0.06
Max Probability	0.37	0.37	0.37	0.37	0.37	0.37

Table 6b. Model Estimated Probability of Being a Current Cigarette Smoker Status by Allostatic Load Score, Race/Ethnicity, and Sex

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Current Smoker Predicted Risk Ratio					
0.00	REF	REF	REF	REF	REF	REF
1.00	0.64	0.36	0.96	0.97	0.67	0.40
2.00	0.77	0.97	1.18	1.01	0.81	0.86
3.00	1.00	0.68	0.74	0.92	0.79	1.22
4.00	0.81	0.69	0.80	1.16	0.83	0.88
5.00	0.53	0.18	0.90	0.54	0.71	0.73
6+	1.01	0.25	1.41	0.71	1.39	0.99
Min Risk Ratio	0.18	0.18	0.18	0.18	0.18	0.18
Max Risk Ratio	1.41	1.41	1.41	1.41	1.41	1.41

Table 7 is a heat map with deeper shades representing a higher predicted probability and less saturated shades representing a lower predicted probability.

Figure 3A: Probability of Alcohol Use Status by Allostatic Load, Race/Ethnicity, and Gender

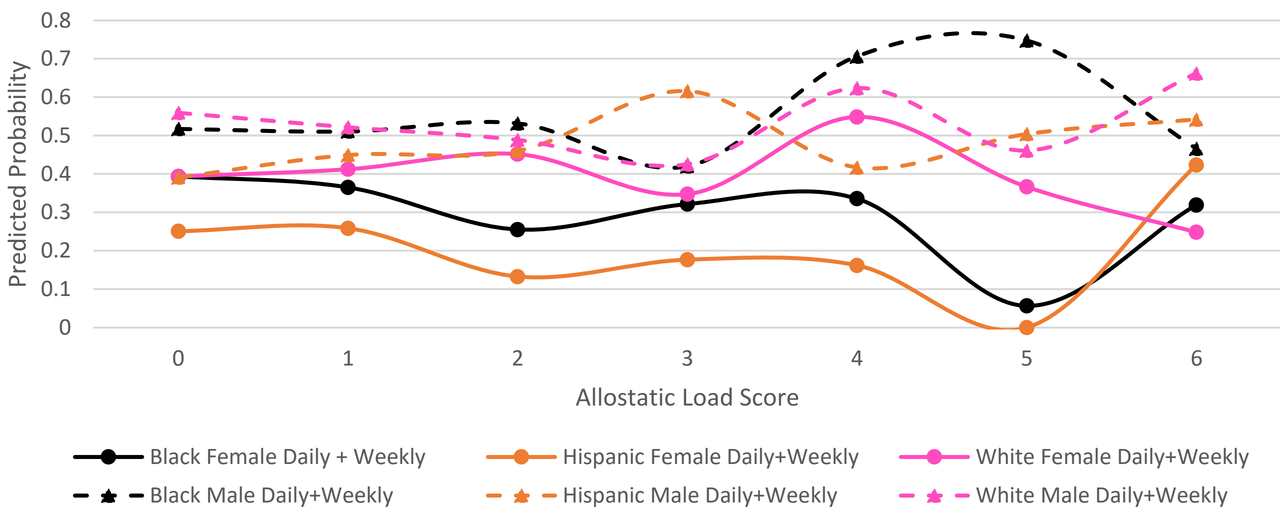
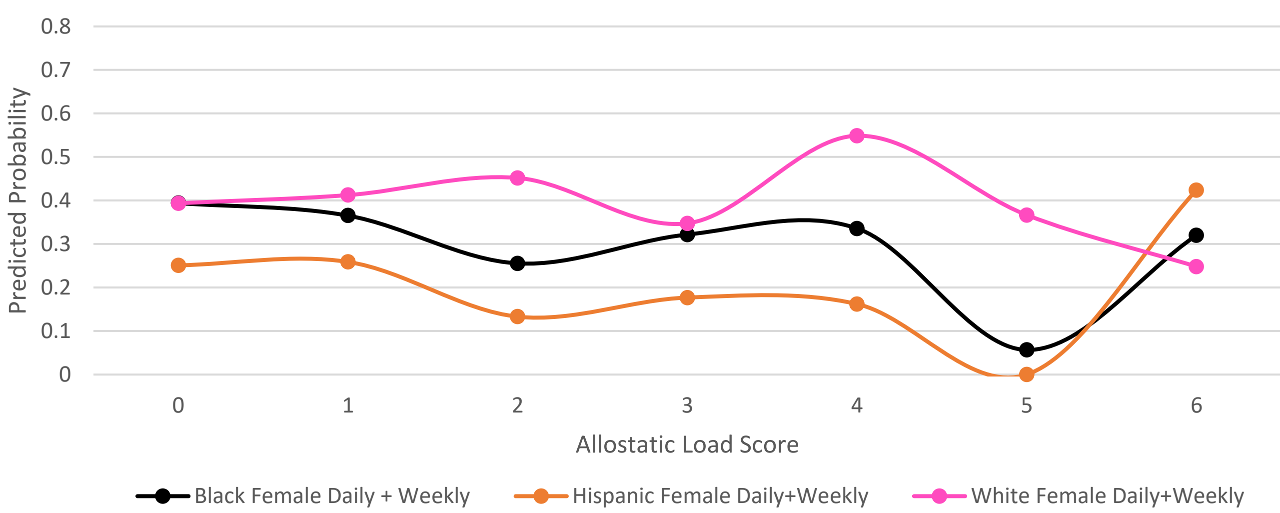


Figure 3B: Probability of Alcohol Use Status by Allostatic Load and Race/Ethnicity Among Women



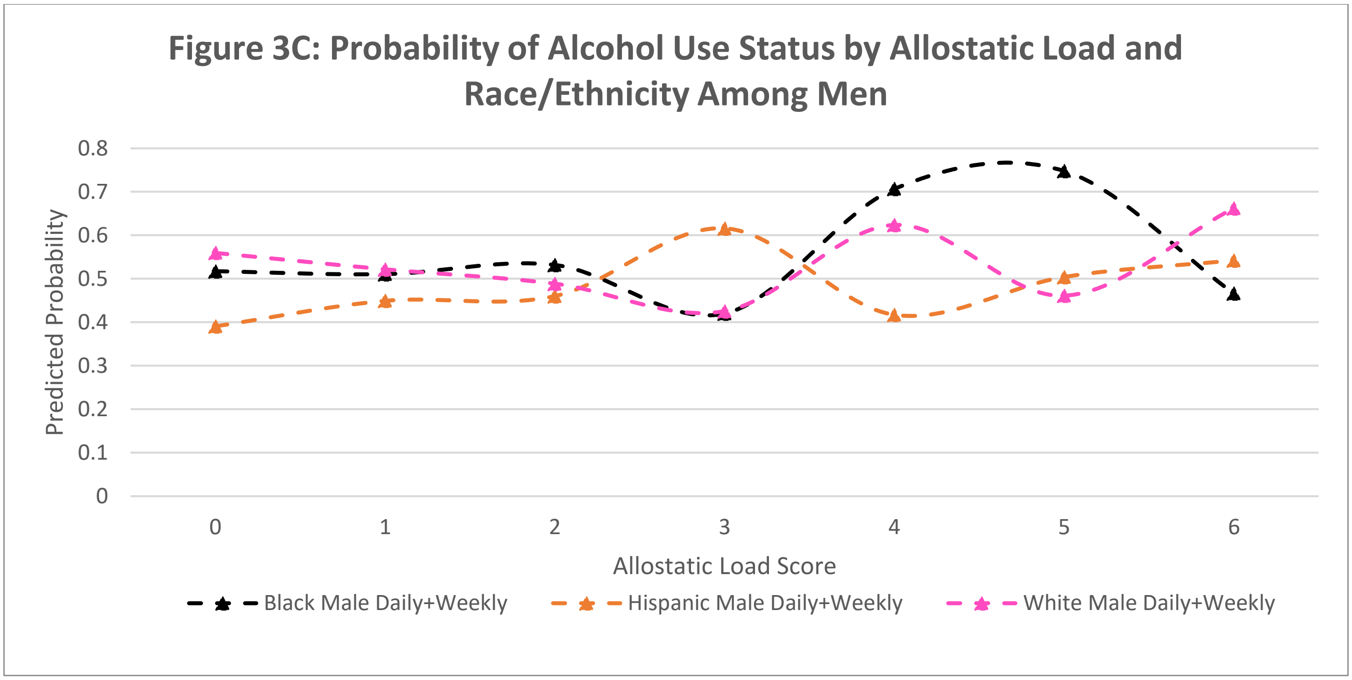


Figure 3C: Probability of Alcohol Use Status by Allostatic Load and Race/Ethnicity Among Men
Predicted Probability
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
Allostatic Load Score
Black Male Daily+Weekly
Hispanic Male Daily+Weekly
White Male Daily+Weekly

Table 7a. Model Estimated Probability of Weekly or Daily Drinking in the Past Year by Allostatic Load Score, Race/Ethnicity, and Sex

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Daily or Weekly Drinker Predicted Probability					
0	0.52	0.39	0.56	0.39	0.39	0.25
1	0.51	0.37	0.52	0.41	0.45	0.26
2	0.53	0.26	0.49	0.45	0.46	0.13
3	0.42	0.32	0.43	0.35	0.62	0.18
4	0.71	0.34	0.62	0.55	0.42	0.16
5	0.75	0.06	0.46	0.37	0.50	0.00
6+	0.47	0.32	0.66	0.25	0.54	0.42
Min Probability	0.00	0.00	0.00	0.00	0.00	0.00
Max Probability	0.75	0.75	0.75	0.75	0.75	0.75

Min, minimum, max, maximum. Tables are heat maps with deeper shades representing a higher predicted probability and less saturated shades representing a lower predicted probability.

Table 7b. Model Estimated Probability of Weekly or Daily Drinking in the Past Year by Allostatic Load Score, Race/Ethnicity, and Sex

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Daily or Weekly Drinker Model Estimated Risk Ratio					
0	REF	REF	REF	REF	REF	REF
1	0.99	0.93	0.93	1.05	1.15	1.03
2	1.03	0.65	0.87	1.15	1.18	0.53
3	0.81	0.82	0.76	0.88	1.58	0.71
4	1.37	0.85	1.11	1.39	1.07	0.65
5	1.45	0.14	0.82	0.93	1.29	0.00
6+	0.90	0.81	1.18	0.63	1.39	1.69
Min Risk Ratio	0.00	0.00	0.00	0.00	0.00	0.00
Max Risk Ratio	1.69	1.69	1.69	1.69	1.69	1.69

Min, minimum, max, maximum. Tables are heat maps with deeper shades representing a higher predicted probability and less saturated shades representing a lower predicted probability.

Chapter 3: Discrimination, Psychological Functioning, and Substance Use Among Young Adults Aged 18-28, 2017

INTRODUCTION

Historically, there has been an age cross-over effect in substance use rates among Blacks and Whites in the U.S. such that Black youth have lower rates of substance use/initiation of substance use[6,7] but in adulthood rates of substance use are more similar among Blacks and Whites. [7-10] This pattern has persisted; for example, in 2017, there was no difference in the prevalence of past month marijuana use between Black and White young adults aged 18-25 and 26-29, but Black young adults had significantly lower use of alcohol and illicit drugs other than marijuana.[186,187] Similarly, among 18-25 year olds, Blacks had significantly lower rates of past month cigarette smoking than Whites (17.0% vs. 26.9%), but among 26-29 year olds there was no difference (26.1% v 30.9%).[187] This is somewhat surprising given the fact that Blacks are more likely to suffer from substance use problems and related mortality and morbidity.[13-16,18-22,186]

The increased substance use consequences observed among Blacks may be partially explained by findings indicating that Blacks are less likely to successfully quit using substances despite being more likely to initiate in young adulthood (as early onset initiation is generally associated with greater cessation difficulties).[22] For instance, previous studies found that late onset (vs. early onset) smoking initiation (≥18 years old) was associated with greater smoking cessation and lower mortality among Whites but lower smoking cessation and no difference in mortality among Blacks.[8,188] Moreover, from 2003 to 2013, Black men and women had the highest rates of tobacco-related cancer incidence in the U.S.[14] A better understanding of the contributors to substance use among Black Americans remains a priority in order to inform strategies to eliminate disparities.

One such contributor is discrimination, which has emerged as a salient risk factor for substance use,[20,24-33] being directly linked to increased risk of licit[20,64,75,141] and illicit substance use[20,70,174] as well as substance use-related problems among Blacks.[18,20,22,24,32,66,72,139,189] In theory, those who undergo experiences of discrimination may use substances as an avoidant coping mechanism to reduce discrimination-related stress.[26,50] Discrimination has also been linked to negative mental health outcomes such as psychological distress[82,83,85], depression[86,190], and anxiety[82,190-193], conditions which have independently been linked to substance use [86]. Additionally, the strong comorbid relationship between mental health and substance use has been well-documented.[101,194-198] In 2017, 46.8% of U.S. young adults aged 18-25 with a substance use disorder had a mental illness, which is twice the prevalence (22.1%) observed among young adults who did not have a substance use disorder in the past year[194]. As such, there is growing literature that suggests that mental health is an important mediator of the discrimination-substance use relationship. For example, in a study of 18-35 year-old Black adults, Clark and colleagues found that depressive symptoms fully mediated the relationship between perceived discrimination and past year substance use.[86] Additionally, the discrimination explained 23.5% of the variance in substance use and 27.7% of the variance in depressive symptoms among African Americans.[86]

Emerging adulthood (ages 18-28) is a life stage often associated with the onset of several mental health conditions[59], increased responsibilities and stress[199,200], and the development of unhealthy behaviors, practices, and coping mechanisms (e.g., licit and illicit substance use)[56,201] that can influence later health. Thus, it is unsurprising that research has found that emerging adults have higher rates of substance use disorders[11,56,57], face unique problems with substance use treatment[58], and are at higher risk for psychological disorders.[59,60] Moreover, Black emerging adults may be at particular risk for discrimination-related issues and substance use.[31,32,41,61,64] In recent years, widely publicized social and political events, such as the 2016 U.S. Presidential election and police shootings of unarmed Black youth and adults, have increased racial tensions and been linked to poor health among Black Americans.[202-204] Similarly, contemporary young adults may be acutely aware of such racial and socio-political issues due to ubiquitous use of the internet, mobile devices, and social media and the visibility of such issues on these platforms[205,206] which may potentially increase their risk of poor mental health and substance use. A 2016 longitudinal study of 16-18 year-olds found that increased societal discrimination concern over the course of one year was associated with increased risk of cigarette smoking, marijuana use, number of substances used and significantly more past month smoking days among Blacks (IRR: 2.97)[207]. Moreover, higher societal discrimination concern at baseline was associated with increased risk of depression and attention-deficit/hyperactivity disorder (ADHD) symptoms one year later.[207] However, it is possible that discrimination-related stress may deter substance use among young adults of color. For example, a recent study of college students found that those who expressed a likelihood to avoid alcohol use on campus for fear of race-based police bias had lower odds (AOR: 0.72) of heavy episodic drinking and higher odds of abstaining from alcohol (AOR: 1.46).[72] Thus, perceived discrimination, particularly racial discrimination, may be an especially relevant stressor for contemporary young adults, but more research is needed to understand how experiences with discrimination are related to substance use in this population.

Examination of associations between discrimination and substance use should also include novel substances such as electronic nicotine delivery systems (ENDS; e.g., e-cigarettes) in addition to previously studied substances such as alcohol, marijuana, and traditional cigarettes. Although the prevalence of cigarette smoking among young adults has continually declined[208,209], including a significant drop from 13.1% to 10.4% from 2016 to 2017[210], ENDS have emerged as highly popular tobacco products among young adults, in part due to the explosion in use of the JUUL.[211,212] A national study found that in 2018, 16%, 12%, and 7% of 18-21 year olds, 22-24 year olds, and 25-34 year olds, respectively, were past-30-day ENDS users. Additionally, 8%, 3%, and 1% of 18-21 year olds, 22-24 year olds, and 25-34 year olds, respectively, reported current JUUL use.[212] While Vallone and colleagues did not find differences in the prevalence of current ENDS use by race among 15-34 year olds, they did find that Blacks were more likely to be current combustible tobacco users and less likely to be current JUUL ENDS users as compared to Whites and that males were more likely to be current ENDS users and combustible tobacco users as compared to females.[212]

Additionally, there is somewhat of a Black-White mental health paradox where Blacks are less likely to be diagnosed with poor mental health outcomes despite having higher rates of poor physical health and more social and economic stressors.[5,87,142,213] Some researchers have suggested that this could be because of measurement bias due to differential misclassification or differential item functioning in assessment tools for certain conditions like depression.[5,214-219] Serious psychological distress (SPD), which is commonly measured using the Kessler Screening Scale for Psychological Distress (K6) scale, may be a better measure of poor mental health among Blacks[82,87,213,220] , potentially due to less measurement bias. Moreover, SPD has been linked to increased mortality rates[221], increased risk of heart disease, diabetes, and chronic obstructive pulmonary disease (COPD)[222], as well as substance use behaviors such as cigarette smoking[221]. A 2003-2004 study of working class Blacks in greater Boston found that overall, 14% of U.S.-born participants had SPD, and having 3 or more experiences of racial discrimination was associated with a higher K6 score and nearly 7 times higher odds of SPD as compared to having 0 discriminatory experiences, even after adjustment for poverty, education, age, gender, response to unfair treatment, and social desirability.[223] Additionally, Spears, Jones, and colleagues found in a 2017 national sample that Black adults (v Whites) had a lower prevalence of self-reported lifetime mental health conditions (16.3% v 20.9%) but did not differ in past month SPD (7.9% v 7.3%).[224] This finding is consistent with National Health Interview Survey data[222] and the 2017 National Survey on Drug Use and Health, which found no difference in the prevalence of past month SPD among Black and White young adults aged 18-25 (12.3% v 13.9%) and 26-29 (8.6% v 10.3%).[187]

Similarly, Keyes' conceptualization of comprehensive mental health posits that mental health and mental illness are two distinct continuums[225], which contrasts with alternative conceptualizations that posit that the presence of mental health is the absence of mental illness[226]. Under Keyes operationalization mental health is comprised of social, emotional, and psychological wellbeing/functioning.[226] Given the Black-White mental health paradox and strong comorbidity between poor mental health outcomes and substance use behaviors[101,227,228], SPD and Keyes' measure of positive wellbeing/mental health could provide unique insights into the discrimination-substance use relationship. However, few studies have examined the relationship between discrimination and nonspecific psychological distress[26,213,229,230] and none have examined the relationship between discrimination and positive wellbeing, as most have focused on diagnosable mental illnesses[34,45].

Most of the previous studies examining the relationships among discrimination, substance use behaviors, and physical and mental health utilized data from the early 2000s or earlier. Given the current socio-political climate, more recent examinations of these relationships are needed, particularly among the young adult priority population. The goal of this study is to provide an updated assessment of the relationships among discrimination, mental health (including SPD and positive wellbeing), and substance use among the priority population of young adults. We aimed to answer the following research questions: 1) Is discrimination directly associated with substance use (cigarette smoking, ENDS use, alcohol use, marijuana use, and other illicit drug use) among Black and White emerging U.S. adults aged 18-28?, 2) Are mental health outcomes such as SPD and positive wellbeing mediators of the discrimination-substance use relationship?, and 3) Are these associations moderated by race/ethnicity and gender? We hypothesized that discrimination would be positively associated with each type of substance use, both directly and indirectly through mental health indicators, and that the associations would be stronger among Blacks and males as compared to Whites and females.

METHODS

Data and Population

Data were obtained from the early release version of the 2017 Transition Into Adulthood Study (TAS) which is a supplemental study of The Panel Study on Income Dynamics (PSID), the longest running longitudinal household study and follow-up to the original PSID Child Development Study (CDS).[231] The PSID is a nationally representative, longitudinal survey of U.S. families that began in 1968 and presently includes up to 5 generations within a given family. The PSID has collected data related to employment, income, wealth, health, housing and food expenditures, and more. Data collection for the PSID is conducted every other year via phone and goes from March-December in odd-numbered years. [231]

Starting in 1997, the PSID supplemented its main survey with the CDS, which collected additional data on a cohort of children aged 0-12 years old and their parents. The purpose of the original CDS supplement was to obtain a nationally representative, longitudinal database of children and their families to study the dynamic process of early human capital formation. Additional waves of CDS were conducted in 2002-2003 when children were 5-17 years old and in 2007-2018 for the children who were still under age 18. The CDS has collected data on family, neighborhood, school environment, social relationships, physical health, and more.

In 2005, the TAS was launched to gain information about the changes and transitions associated with emerging adulthood. At the start of the TAS the oldest CDS participants were 18-20 years old. Since the TAS was launched, additional waves have been conducted in odd number years through 2015. In 2017 the TAS was relaunched to include all young adults included in the PSID without restricting participants to those who participated in the original or ongoing CDS.[231,232] Thus, to be included in the 2017 TAS sample participants must: 1) be aged 18-28 years, 2) no longer attending high school, and 3) be a member of a family that participated in the 2017 Core CDS or PSID interview either through their own interview as Head/Spouse/Partner or by identification as an “other family unit member” in a household interview. [231,232] The overall sample consisted of 2,522 participants; however, due to our goal of examining Black-White comparisons the analytic sample was restricted to participants who self-identified as Black or White with complete data on discrimination and the mental health mediators, yielding a total of 2,192 participants.

Measures

Discrimination

Discrimination was assessed using the Everyday Discrimination scale[48]. The original Everyday Discrimination scale (EDS) includes 9 items; however, the TAS only included 7 of the 9 items. Respondents were specifically asked about the lifetime occurrence and frequency of: 1) being treated with less courtesy than other people, 2) receiving poorer service than other people at restaurants or stores, 3) being treated by others as if they are not smart, 4) other people acting as they are afraid of them, 5) others acting as if they are dishonest, 6) others acting as if they are better than them, and 7) being treated with less respect than other people. Response options ranged from 1- “never” to 6- “almost every day”.

A one-factor confirmatory factor analysis (CFA) demonstrated adequate fit to the EDS items (χ^2 (14 df): 510.486, $p < .001$; RMSEA: 0.127; CFI: 0.969, TLI: 0.954). Thus, the EDS items were summed across the 7 items and treated as a continuous variable/sum score as consistent with the literature.[20,233-235] The composite score ranged from 7– 42 with higher scores representing more frequent experiences of everyday discrimination. Both the full sample and analytic sample have a Cronbach α of 0.85 for all 7 items.

Substance Use

Cigarette Smoking and Electronic Nicotine Delivery System (ENDS) Use

To assess cigarette smoking participants were asked, “Do you smoke cigarettes?” and response options included ‘yes’ and ‘no’. Those who answered ‘yes’ were classified as current cigarette smokers. Participants also indicated whether they had ever vaped (used a device such as a vape-pen, an e-cigarette, an e-hookah, or e-vaporizer to inhale a mist into the lungs). Ever vapers who reported vaping 1 or more days in the past 30 days were classified as past month ENDS users.

Alcohol Use

Respondents reported whether they had ever drank alcoholic beverages such as beer, wine, or liquor. Past month alcohol use was assessed by asking those who reported ever drinking alcohol, “In the last year, on average, how often did you have any alcohol to drink? Would you say less than once a month, about once a month, several times a month, about once a week, several times a week, or every day?”. Those who responded ‘about once a month’, ‘several times a month’, ‘about once a week’, ‘several times a week’, or ‘every day’ were classified as past month drinkers.

Marijuana and Other Illicit Drugs

Participants were asked to report about medicines and drugs that they had ever tried in their lifetime, even if it was only once and including medicines that were and were not prescribed to them. Drugs assessed included marijuana or hashish, cocaine, heroin, narcotics or pain relievers (not including heroin or over-the-counter pain relievers), amphetamines (not including diet pills), barbiturates, tranquilizers, hallucinogens, and inhalants (not including those used for asthma). Participants also reported the number of occasions that they used the drugs in the past 30 days, and those who indicated that they had used on one or more occasion were classified as past month users. Past month marijuana use was assessed independently while other drugs assessed were combined for a composite past month non-marijuana illicit drug use measure.

<u>Psychological Functioning</u>

Psychological Distress

Past-month psychological distress was assessed using the Kessler-6 (K6) scale[236] which was developed to screen for serious mental illness. Participants were asked a total of 6 items including, “During the past 30 days, about how often did you feel the following symptoms:”

“nervous,” “hopeless,” “restless or fidgety,” “so depressed that nothing could cheer you up,” “that everything was an effort,” and “worthless” . A one-factor CFA demonstrated adequate fit to the K6 items (χ^2 (9 df): 167.663, $p < .001$; RMSEA: 0.089; CFI: 0.988, TLI: 0.980). Thus, the K6 scale items were treated as a continuous variable/sum score. Response options range from 0 (none of the time) to 4 (all of the time), and ratings were summed for a total score ranging from 0 to 24 with higher scores indicating greater psychological distress. Both the full sample and analytic sample yielded a Cronbach’s α of 0.79 for all 6 items.

Positive Mental Health/Wellbeing

Past month positive mental health/wellbeing was assessed using the Mental Health Continuum Short Form (MHC-SF). The MHC-SF is designed to measure emotional or hedonic well-being, as well as social and psychological or eudemonic wellbeing. Participants were asked a total of 14 items including, “In the last month, how often did you feel: “happy”, “interested in life”, “satisfied”, “that you had something important to contribute to society”, “that you belonged to a community like a social group, your school, or your neighborhood”, “that our society is becoming a better place”, “that people are basically good”, “that the way our society works made sense to you”, “good at managing the responsibilities of your daily life”, “that you have warm and trusting relationships with other people”, “that you have experiences that challenged you to grow or become a better person”, “confident to think or express your own ideas and opinions”, “that you liked your personality”, and “that your life had a direction or purpose”? Would you say never, once or twice, about once a week, 2 or 3 times a week, almost every day, or every day?”. A one-factor CFA demonstrated adequate fit to the MHC-SF items (χ^2 (77 df): 3790.137, $p < .001$; RMSEA: 0.148; CFI: 0.833, TLI: 0.803) while the subscales fit the data less well. Thus, the MHC-SF items were treated as a continuous measure. Response options included 0 (never), 1 (once or twice), 2 (about once a week), 3 (2 or 3 times a week), 4 (almost every day), and 5 (everyday) and ratings were summed for a total score ranging from 0 to 70 with higher scores indicating greater levels of overall positive wellbeing. Both the full sample and analytic sample yielded a Cronbach's α of 0.86 for all 14 items.

Participant Characteristics

Age and sex were obtained from the family-level baseline interview in the 2017 PSID while the remainder of participant characteristics were determined using 2017 TAS data. Race/ethnicity was obtained by asking participants to indicate which categories described themselves and participants were offered 8 racial/ethnic categories. Participants in the present study were restricted to those who self-identified as White or Black/African American.

Analyses

As depicted in Figure 1, discrimination served as the primary independent variable, and 5 substance use variables (alcohol, marijuana, other illicit drugs, cigarettes, ENDS) served as the dependent variables. We also examined psychological distress and positive wellbeing as mediators of the discrimination-substance use relationship. Moreover, we aimed to examine the moderating effects of race and sex on the a, b, and c' pathways. Specifically, the a paths represents the association between perceived discrimination and a given mediator (psychological distress or positive wellbeing), the b paths represents the association between a given mediator and a given substance use outcome (past month/current alcohol, marijuana, other illicit drugs, cigarettes, or ENDS use), and the c' paths represent the association between perceived discrimination and a given substance use outcome. Thus, given the complexity, multiple pathways examined, and categorical nature of the moderators, the present study employed multi-group moderated mediation structural equation modeling (SEM). SEM was conducted to assess whether the proposed mediation effects of psychological distress and positive wellbeing varied across levels of the proposed moderators (sex and race) either on discrimination-mediator or mediator-substance use pathways in addition to the discrimination-substance use pathway.[237] SEM has several distributional assumptions and requires considerable preliminary analyses to allow for adequate model specification and estimation.[238,239]

Mediation Analyses

Descriptive statistics and bivariate analyses were initially conducted in SAS 9.4 (Cary, NC) and CFA, mediation, moderation, and multiple-group moderated mediation analyses were conducted in Mplus 8.1 (Muthén & Muthén, 1998-2018). Path analyses were conducted using variance-adjusted weighted least squares (WLSMV) estimator which is appropriate for modeling categorical and continuous data and may be more accurate for categorical/dichotomous outcomes[238]. As such the SEM models were employed using probit regression, which models the inverse of the standard normal cumulative distribution, as opposed to logit regression which uses the inverse of the standard logistic cumulative distribution.

In summary, path analyses were conducted to test the mediating effects of psychological distress and positive wellbeing and the moderating effects of race and sex on the relationship between discrimination and young adult substance use (i.e., current cigarette smoking and past month use of alcohol, marijuana, other illicit drugs, and ENDS). All final models controlled for participant age, the proposed mediators were allowed to covary, and the substance use outcomes were allowed to covary with each other. Additionally, both standardized and unstandardized path coefficients were estimated. For robust standard errors for model parameter estimation, bootstrapping was used to test for statistical significance of mediation and moderated mediation effects by producing 95% confidence intervals from 10,000 resamples of the data. [240] Measures of overall model fit were not presented as the path models were saturated and the model fit perfectly to the data; as depicted in figures 1, all variables share pathways with all other variables in the model.

Firstly, mediation models were run with only 1 mediator and 1 substance use outcome. Next, mediation models were run with both mediators and each substance use outcome and then models were run with both mediators and all substance use outcomes.

Moderated Mediation Analyses

To determine whether the mediation paths were equal among racial groups and sexes, a multiple group approach was utilized rather than including interaction terms. Specifically, multiple group analyses were conducted among Blacks and Whites, males and females, and finally Black males, Black females, White males, and White females. Thus, differential effects were parameterized as group specific effects. To determine whether moderation was present by race, sex, and race by sex, direct and indirect effects of the a, b, and c' pathways were compared across groups. Moreover, moderation by race only was represented by constraining differences between Blacks and Whites to be equal across sexes; moderation by sex only was represented by constraining differences between males and females to be equal across racial groups; and lastly moderation by race and sex was represented by allowing effects to be different across all groups and was defined by the intersection of race and sex. Global differences across all groups were assessed using multiparameter Wald χ^2 tests which were conducted at the alpha = 0.05 level using the Model Test option in Mplus' model constraint command. Additionally, to identify statistically significant differences in specific pathways, terms representing the product of coefficients (ex. a*b) were defined and assessed through 95% bootstrap confidence intervals. If there was no evidence of a difference across groups from the multiparameter Wald test, the pathway was constrained to be equal across groups. All non-significant interaction terms were specified as model constraints

RESULTS

Descriptive Analyses

Univariate statistics and bivariate descriptive analyses by sex and race are reported in Table 1. Bivariate analyses by substance use status in Table 2. Overall, the average everyday discrimination (EDD) score was 16.3 (SD: 7.1), average K6 score was 4.9 (SD: 4.0), MHC-SF score was 50 (SD: 10.9) and age was 22.7 (SD: 3.1) years. The prevalence of past month/current substance use ranged from 6.2% (cigarette smoking) to 28.2% (marijuana). The sample included a slightly higher proportion of female participants and was evenly split by race (Table 1). On average, Black males had higher discrimination scores than Black females and Whites, while Whites had higher positive wellbeing scores (Table 1) than Blacks. Females reported higher psychological distress than males. Whites, especially males, were more likely to be past month drinkers and males were more likely to be past month marijuana users. Black females and Whites were more likely to be past month users of other illicit drugs (not including marijuana). Additionally, Black males had notably higher rates of current cigarette smoking than their female and White counterparts, while White males had notably higher rates of past month ENDS use as compared to their female and Black counterparts (Table 1). Lastly, current cigarette smokers and past month marijuana, other illicit drug, and ENDS users were more likely to have higher EDD and K6 scores and lower positive wellbeing scores (Table 2).

Mediation Analyses

The overall mediation model results are found in Table 3 and a summary of the overall and multiple group moderated mediation structural equation model results are presented in Table 4. In the overall model, there were positive, indirect effects of discrimination on marijuana use (unstandardized a*b = 0.007, 95% CI: 0.004, 0.011), other illicit drug use (unstandardized a*b= 0.010, 95% CI: 0.006, 0.014), cigarette smoking (unstandardized a*b= 0.008, 95% CI: 0.002, 0.014), and ENDS use (unstandardized a*b= 0.008, 95% CI: 0.003, 0.012) through psychological distress. There were also direct effects of discrimination on marijuana use, other illicit drug use, cigarette smoking, and ENDS use, wherein higher discrimination scores predicted current substance use. There was not a direct effect of discrimination on past month alcohol use. However, there was a negative, indirect effects of discrimination on alcohol use ($a*b = -0.003$, 95% CI: -0.006, -0.001) and a positive, indirect effect on past month marijuana use ($a*b = 0.003$, 95% CI: 0.001, 0.006) through positive wellbeing. That is, higher discrimination scores were associated with less positive wellbeing which was associated with higher likelihood of past month alcohol use and lower likelihood of past month marijuana use. In summary, in the overall model psychological distress mediated the effect of discrimination on all substances but alcohol, while positive wellbeing mediated the effect of discrimination only on alcohol and marijuana.

Overall there was evidence of several group differences as indicated by multiparameter Wald tests. For alcohol use, there was evidence of group differences in the effect of discrimination on alcohol use, either directly or indirectly psychological distress, by race and sex (three-way interaction; Wald $\chi^2 = 8.83$ (3 df), $p=0.0316$), by race among males (two-way interaction; Wald $\chi^2 =15.37$ (3 df), $p=.0015$) and females (two-way interaction; Wald $\chi^2 =18.15$ (3 df), $p=.0004$). Additionally, there was evidence of group differences in the effect of discrimination on alcohol use, either directly or indirectly positive wellbeing, by race among males (two-way interaction; Wald $\chi^2 =10.97$ (3 df), $p=.0119$) and females (two-way interaction; Wald $\chi^2 = 9.91$ (3 df), $p=.0193$).

For marijuana use, there was evidence of group differences for discrimination, psychological distress, and marijuana use by race among females (two-way interaction; Wald $\chi^2 = 16.59$ (3 df), $p=0.0009$). For other illicit drug use, there was evidence of group differences for discrimination, psychological distress, and other illicit drug use by race among females (two-way interaction; Wald $\chi^2 = 16.51$ (3 df), $p=0.0009$). For cigarette smoking, there was evidence of group differences for discrimination, psychological distress, and cigarette smoking by race among females (two-way interaction; Wald $\chi^2 = 17.73$ (3 df), $p=0.0005$). Lastly, there was evidence of group differences for discrimination on ENDS use, either directly or indirectly through psychological distress by race among females (two-way interaction; Wald χ^2 = 21.15 (3 df), p=0.0001). There was also evidence of group differences for discrimination on ENDS use, either directly or indirectly through positive wellbeing by race among males (two-way interaction; Wald χ^2 = 8.46 (3 df), p=0.0374),

Moderated Mediation Analyses

Overall there was evidence of several group differences as indicated by single parameter Wald tests. Of the a paths there was evidence of group differences by race among females for the a path between discrimination and psychological distress (Wald χ^2 = 16.21 (1 df), p<.001) and by race among males for the a path between discrimination and positive wellbeing (Wald χ^2 =5.41 (1 df), p=.0200). Of the b paths through psychological distress there was evidence of group differences by race and sex for alcohol use (Wald χ^2 = 4.12 (1 df), p=.0423), by sex among Blacks and Whites for marijuana use (Blacks: Wald χ^2 = 7.14 (1 df), p=.0075; Whites: Wald χ^2 = 4.35 (1 df), p=.0370), and by sex among Blacks for cigarette smoking (Wald χ^2 = 6.66 (1 df), p=.0099). Of the b paths through positive wellbeing there was evidence of group differences by race among females for alcohol use (Wald χ^2 = 9.04 (1 df), p=.0026), by sex among Blacks for alcohol use, marijuana use, and cigarette smoking (alcohol: Wald χ^2 = 4.51 (1 df), p=.0337; marijuana: Wald χ^2 = 5.44 (1 df), p=.0196; cigarettes: Wald χ^2 = 9.42 (1 df), p=.0021), and among Whites for other illicit drug use (Wald χ^2 = 3.91 (1 df), p=.0480). Lastly there was evidence of a sex difference in the c' path between discrimination and marijuana use among Whites (Wald χ^2 = 5.56 (1 df), p=.0184).

The multiple group moderated mediation analysis results by each race and sex subgroup are presented in Tables 5a-5d. Among all groups, discrimination was positively associated with psychological distress and negatively associated with positive wellbeing. Additionally, among all groups, there were both positive, direct and indirect effects between discrimination, psychological distress, and other illicit drug use not including marijuana use (Black males a*b = 0.008, 95% CI: 0.003, 0.013 ; Black females a*b = 0.008 , 95% CI: 0.003, 0.013; White males a*b = 0.012, 95% CI: 0.005, 0.021; White females a*b = 0.008 , 95% CI: 0.003, 0.013) (Tables 6a-d). There was evidence for moderated mediation such that the indirect effect of discrimination on other illicit drug use was strongest for White males.

Moreover, among all groups there were positive, indirect effects of discrimination on marijuana use (Black males a*b = 0.015, 95% CI: 0.008, 0.022; Black females a*b = 0.006, 95% CI: 0.000, 0.011; White males a*b = 0.009, 95% CI: 0.002, 0.016; White females a*b = 0.006, 95% CI: 0.000, 0.011) through psychological distress. There were also indirect effects of discrimination on alcohol use (Black males a*b = -0.005, 95% CI: -0.008, -0.002; Black females a*b = 0.005, 95% CI: 0.000, 0.010; White males a*b = -0.005, 95% CI: -0.008, -0.002; White females a*b = -0.005, 95% CI: -0.008, -0.002) through positive wellbeing. There was an interaction with sex among both Blacks and Whites for the indirect effect on marijuana use wherein the effect was stronger among males as compared to females. Conversely, there were interactions with race and sex for the indirect effect on alcohol use among females and Blacks wherein there was a positive association between discrimination and alcohol use among Black females but negative association among Black males and Whites.

Among Black males only, there was a positive, indirect effect of discrimination on alcohol use (a*b = 0.010, 95% CI: 0.003, 0.017) and cigarette smoking (a*b = 0.015, 95% CI: 0.006, 0.024) through psychological distress as well as a negative, indirect effect of discrimination on cigarette smoking through positive wellbeing (a*b = -0.006, 95% CI: -0.012, 0.000). This indicated a three-way interaction with race and sex wherein the indirect effects were only present among Black males. Meanwhile, among Black males, Black females, and White females (but not White males), there were positive, direct effects between discrimination and marijuana use (Tables 6a, b, d), as well as indirect effects of discrimination on ENDS use through psychological distress (all a*b = 0.011, 95% CI: 0.005, 0.019). This indicated an interaction by sex among Whites wherein there was a direct effect and indirect effect among White females but not White males. Lastly, among Black females, White males, and White females (but not Black males) there were positive, indirect effects of discrimination on marijuana use through positive wellbeing (all a*b = 0.005, 95% CI: 0.002, 0.008) which indicated an interaction by sex among Blacks wherein there was an indirect effect among Black females but none among Black males.

DISCUSSION

The findings of the present study indicate that everyday discrimination is directly associated with higher likelihood of current licit and illicit substance use among emerging U.S. adults. Consistent with hypotheses, these associations were mediated by higher past month psychological distress and lower past month positive wellbeing, which contributes to the literature on mechanisms underlying the associations between discrimination and substance use. Furthermore, our moderation findings suggest that the discrimination-mental-health-substance use relationship varies by race and sex among U.S. emerging adults, indicating that discrimination is a salient predictor of substance use especially for Black male young adults. To our knowledge this study is among the first to examine the role of positive wellbeing and psychological distress as mediators of the relationship as well as potential moderated mediation of the discrimination-substance use relationship. Continuing to address these gaps in the literature can potentially shed light on the role of discrimination in exacerbating rates of substance use among young adults, and Black young adults in particular, given the current socio-political climate.

The present findings are consistent with prior research. For example, Mouzon and colleagues found that among Black Americans, females reported higher psychological distress than males.[82] Other studies have linked everyday discrimination with higher odds of current cigarette smoking among Black men[141] and higher odds of alcohol and substance use disorders among African Americans and Black Caribbeans[20]. Additionally, Rogers and colleagues recently found that higher everyday discrimination was directly associated with higher odds of combustible tobacco use in the overall sample and among Blacks, while discrimination was associated with higher odds of ENDS use in the overall sample and among Whites, which somewhat contrasts the findings of the present study also found indirect associations between discrimination and ENDS use through psychological distress among Blacks.[241] Moreover, persons with serious psychological distress and lifetime mental health conditions have been found to be more likely to be current ENDS users, including daily ENDS users.[224,242,243]

However, we did have evidence of different mediational effects for psychological distress and positive wellbeing: in the overall model, psychological distress mediated the relationship between discrimination and all substance use outcomes except alcohol, while positive wellbeing mediated the relationship between discrimination and alcohol**.** Moreover, both psychological distress and positive wellbeing mediated the relationship between discrimination and marijuana use. Higher levels of positive wellbeing, under Keyes' conceptualization, likely captures positive functioning not only psychologically but emotionally and socially as well. Conversely, psychological distress only indicates the presences of mental illness as opposed to a more composite measure of mental health. Limited previous research indicates that alcohol problems may be more strongly associated with greater psychological distress in comparison to alcohol consumption/ less problematic drinking patterns.[244] Thus, given the present study's focus on past month alcohol use as opposed to heavy drinking, it is possible that the mediational effect of positive wellbeing reflects discrimination contributing to a broader sense of poor wellbeing and recent alcohol consumption wherein a mediational effect with psychological distress may have been more indicative of problematic drinking.

Similarly, it is important to note that alcohol and marijuana were the most prevalently used substances across groups, are associated with positive expectancies[245,246], and are less stigmatized in the broader U.S. community[247], although some studies suggest that alcohol is more stigmatized in the Black community[248] even among those with lifetime alcohol dependence[162]. Thus, it follows that emerging adults experiencing discrimination may experience both psychological distress (and potentially more serious forms of serious mental illness) or less positive wellbeing (on a more holistic level) which in turn may contribute to current marijuana use.

While we found relatively consistent associations across groups for marijuana and illicit drug use, we did find several differences for certain substances by race and sex. For example, psychological distress was indirectly associated with alcohol use and both psychological distress and positive wellbeing were indirectly associated with cigarette smoking among Black males only. These findings are consistent with other studies that indicate that Black males are equally or more likely to be current drinkers or current cigarette smokers than their female and White counterparts and may provide insights into the Black-White substance use age crossover.[18,99,249] In a recent study, Caraballo and colleagues found that from 2001-2013 Black females and males aged 12-25 had lower smoking prevalence than their White but at age 26 or older had similar (females) or higher (males) smoking prevalence than Whites of the same age.[250]

Moreover, while discrimination is generally understood as a stressful experience across racial/ethnic groups and regardless of the type/attribution for the discrimination[37,43,73], more associations were observed among Blacks than Whites. Although the attribution to the discriminatory experience was not included in the path analyses, Black participants were more likely to attribute their discriminatory experiences to race/ethnicity while Whites were more likely to report non-racial attributions. There is some evidence that perceived racism/discrimination in everyday settings is associated with more negative reactions among Blacks than Whites,[251,252] which may explain some of our findings. Additionally, emerging adulthood is a life stage when young adults may have more opportunities to experience discrimination and experience changes in mental health, in addition to undergoing major life changes and gaining additional responsibilities. Thus, it is possible that as young adults, especially Blacks and Black males, undergo emerging adulthood, they are more likely to encounter certain psychosocial stressors that contribute to their substance use and establish a pattern of coping-related substance use. Future preventative interventions and substance use treatment programs, especially those targeted toward Blacks, may benefit by addressing discrimination and non-specific mental health outcomes.

Nevertheless, several associations were indeed found between discrimination and substance use among White emerging adults. In 2017, 55% of White Americans endorsed the belief that discrimination against Whites exists in America today, and those who endorsed this belief were also more likely to report institutional and interpersonal experiences of discrimination. However, only 4-19% of Whites reported personal experiences of racial discrimination.[253] Although discrimination may be less frequent and potentially less strong of a trigger for substance use among White emerging adults, it is an important predictor. Future research should consider additional racial comparisons of the discrimination-mental health and discrimination-mental-health substance use relationships to better understand the underlying mechanisms of discrimination across groups.

Limitations

The present study utilized only one wave of the TAS data and thus is unable to assess causality or the directionality of associations. However, it is important to note that there is a temporal ordering to the measures used in the present study. Specifically, the frequency of every day discrimination was assessed with more frequent occurrences corresponding with higher discrimination scores, which would likely precede and was modeled with psychological functioning and substance use behaviors in the past month. Nevertheless, future studies would benefit from longitudinal data as well as biochemical verification of substance use and clinically relevant mental health mediators. Moreover, the present study relied on self-report/perceived discrimination as opposed to actual or experimentally-controlled discrimination. Although perceived discrimination may be a more relevant measure in relation to health, it is important to acknowledged that those who perceive discriminatory experiences may in turn have poor mental health and be more sensitive to perceptions of discrimination which in turn may influence the severity of the effect of discrimination on their mental health.

Additionally, analyses were only adjusted for age. Future studies should also consider adjustment for other demographic characteristics such as the ethnicity of Black participants (e.g., Afro-Latino, African, Afro-Caribbean) socioeconomic position, and psychosocial stressors or protective factors such as social support, the importance of racial/ethnic identity, or the attribution to discriminatory experiences (e.g., attributed to race vs. other factors). Regardless, the present study is a novel examination of the discrimination-substance use relationship in that it not only focuses on the priority population of U.S. emerging adults but examines the mediation effects of positive wellbeing in addition to ENDS use and illicit drug outcomes which very few studies have examined.

CONCLUSION

Among U.S. emerging adults aged 18-28, in 2017, higher everyday discrimination was associated with current use of alcohol, marijuana, other illicit drugs, cigarettes, and ENDS. Moreover, these relationships were mediated by indicators of psychological functioning, such that more frequent discrimination was associated with greater psychological distress and less positive wellbeing, which predicted higher likelihood of substance use. There was also evidence of different mediational effects wherein psychological distress was associated with indirect effects on all substances but alcohol while positive wellbeing was only associated with indirect effects on alcohol and marijuana use which may reflect differences in stigma and severity of use behaviors. Additionally, moderated mediation analyses revealed that discrimination was particularly associated with substance use among Black males. Future discrimination research should not only consider the effects of race and sex but the role of mental health outcomes as mediators to understand for which groups discrimination is a strong social determinant of substance use and the underlying mechanisms of the discrimination-substance use relationship.

Table 1: Discrimination, Mental Health Mediators, Substance Use Outcomes, and Age by Race and Sex Among U.S. Young Adults Age 18-28, 2017

	Overall	Black Male	Black Female	White Male	White Female
	n=2214	n=516	n=600	n=536	n=560
PREDICTOR AND MEDIATORS	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)
Every Day Discrimination	16.3 (7.1)	17.2 (8.2) [a]	15.6 (6.9) [b]	16.6 (6.8) [a]	15.8 (6.2) [b]
Psychological Distress	4.9 (4.0)	4.5 (4.0) [a]	5.1 (3.9) [b]	4.8 (4.1) [ab]	5.2 (4.0) [b]
Positive Wellbeing	50.0 (10.9)	49.8 (11.2) [ab]	49.2 (10.9) [b]	50.5 (11.1) [ab]	50.7 (10.5) [a]
SUBSTANCE USE MEASURES					
Past Month Alcohol Use***	23.6 (522)	22.1 (114)	18.0 (108)	30.2 (162)	24.5 (137)
Past Month Marijuana Use***	28.2 (625)	36.6 (189)	22.5 (135)	33.4 (179)	21.8 (122)
Past Month Other Illicit Drug Use***	14.4 (319)	9.7 (50)	14.2 (85)	17.7 (95)	15.9 (89)
Cigarette Smoking Status***	6.2 (138)	11.6 (60)	3.2 (19)	6.2 (33)	4.3 (24)
Past Month ENDS Use***	7.5 (167)	6.8 (35)	3.8 (23)	13.4 (72)	6.6 (37)
DEMOGRAPHIC CHARACTERISTICS					
Age	22.7 (3.1)	22.6 (3.2)	22.7 (3.0)	22.6 (3.1)	22.8 (3.1)
Sex					
Male	47.6 (1054)	-	-	-	-
Female	52.4 (1160)	-	-	-	-
Race/Ethnicity					
White, NH	49.5 (1096)	-	-	-	-
Black, NH	50.5 (1118)	-	-	-	-

M, mean, SD, standard deviation, NH, non-Hispanic. *** indicates p<.001. Differences in superscripts indicate statistically significant differences in means across groups (i.e. [a] groups with [a] and [b] have statistically significant different means).

Table 2: Discrimination, Mental Health Mediators, and Demographic Characteristics by Current Substance Use Status Among U.S. Young Adults Age 18-28, 2017

	Alcohol		Marijuana		Other Illicit		Cigarettes		ENDS	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	n=521	n=1691	n=625	n=1588	n=319	n=1895	n=136	n=2076	n=167	n=2045
Predictor and Mediator	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)
Every Day Discrimination	16.7 (7.1)	16.1 (7.1)	*** 18.3 (7.3)	15.5 (6.9)	*** 18.3 (7.2)	15.9 (7.0)	*** 18.7 (8.9)	16.1 (6.9)	*** 18.7 (8.2)	16.1 (7.0)
Psychological Distress	5.0 (4.1)	4.9 (4.0)	*** 6.1 (4.3)	4.5 (3.8)	*** 6.5 (4.4)	4.6 (3.9)	*** 6.5 (5.1)	4.8 (3.9)	*** 6.4 (4.8)	4.8 (3.9)
Positive Wellbeing	50.8 (10.6)	49.8 (11.0)	*** 47.6 (11.2)	51.0 (10.6)	*** 47.2 (12.1)	50.5 (10.6)	* 48.1 (11.1)	50.1 (10.9)	* 48.3 (12.1)	50.2 (10.8)
DEMOGRAPHIC CHARACTERISTICS										
Age	*** 22.0 (2.6)	22.9 (3.2)	22.6 (3.0)	22.7 (3.2)	* 23.0 (3.0)	22.6 (3.1)	21.9 (3.0)	22.7 (3.1)	*** 21.6 (3.1)	22.8 (3.1)
Sex	**		***				***		***	
Male	53.0 (276)	45.9 (776)	58.9 (368)	43.1 (684)	45.5 (145)	47.9 (907)	68.4 (93)	46.2 (959)	64.1 (107)	46.2 (945)
Female	47.0 (245)	54.1 (915)	41.1 (257)	56.9 (903)	54.5 (174)	52.1 (986)	31.6 (43)	53.8 (1117)	35.9 (60)	53.8 (1100)
Race/Ethnicity	***				**				***	
Black, NH	42.6 (222)	52.9 (894)	51.8 (324)	49.9 (792)	42.3 (135)	51.8 (981)	58.1 (79)	50.0 (1037)	34.7 (58)	51.7 (1058)
White, NH	57.4 (299)	47.1 (797)	48.2 (301)	50.1 (795)	57.7 (184)	48.2 (912)	41.9 (57)	50.1 (1039)	65.3 (109)	48.3 (987)

M, mean, SD, standard deviation, NH, non-Hispanic. *** indicates p<.001.

Table 3: Decomposition of Direct and Indirect Effects from the Overall Model: Unstandardized and Standardized Probit Regression Coefficients, N= 2192

Variable	Overall					
	Unstandardized Coefficient	SE	p	95% LL	CI UL	Standardized Coefficient
Discrimination → Distress	**0.22**	**0.01**	**<.001**	**0.20**	**0.25**	**0.39**
Discrimination → Wellbeing	**-0.40**	**0.03**	**<.001**	**-0.47**	**-0.34**	**-0.26**
Distress → Alcohol	0.01	0.01	0.39	-0.01	0.03	0.03
Wellbeing → Alcohol	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.08**
Discrimination → Distress → Alcohol	.002			-0.002	0.006	
Discrimination → Wellbeing → Alcohol	**-0.003**			**-0.006**	**-0.001**	
Discrimination → Alcohol	0.01	0.00	0.14	-0.00	0.02	0.05
Distress → Marijuana	**0.03**	**0.01**	**<.001**	**0.02**	**0.05**	**0.13**
Wellbeing → Marijuana	**-0.01**	**0.00**	**0.01**	**-0.01**	**0.00**	**-0.09**
Discrimination → Distress → Marijuana	**.007**			**0.004**	**0.011**	
Discrimination → Wellbeing→ Marijuana	**0.003**			**0.001**	**0.006**	
Discrimination → Marijuana	**0.02**	**0.00**	**<.001**	**0.01**	**0.03**	**0.16**
Distress → Illicit Drugs	**0.04**	**0.01**	**<.001**	**0.03**	**0.06**	**0.17**
Wellbeing → Illicit Drugs	0.00	0.00	0.30	-0.01	0.00	-0.04
Discrimination → Distress → Illicit Drugs	**0.010**			**0.006**	**0.014**	
Discrimination → Wellbeing → Illicit Drugs	0.001			-0.001	0.004	
Discrimination → Illicit Drugs	**0.02**	**0.01**	**<.001**	**0.01**	**0.03**	**0.11**
Distress → Smoking	**0.04**	**0.01**	**<.001**	**0.01**	**0.06**	**0.14**
Wellbeing → Smoking	0.00	0.01	0.67	-0.01	0.01	0.02
Discrimination → Distress → Smoking	**0.008**			**0.002**	**0.014**	
Discrimination → Wellbeing → Smoking	-0.001			-0.005	0.003	
Discrimination → Smoking	**0.01**	**0.01**	**0.03**	**0.00**	**0.03**	**0.10**
Distress → ENDS	**0.03**	**0.01**	**<.001**	**0.01**	**0.06**	**0.13**
Wellbeing → ENDS	0.00	0.00	0.79	-0.01	0.01	0.01
Discrimination → Distress → ENDS	**0.008**			**0.003**	**0.012**	
Discrimination → Wellbeing → ENDS	0.000			-0.004	0.003	
Discrimination → ENDS	**0.02**	**0.01**	**0.01**	**0.00**	**0.03**	**0.11**

Table 4: Summary Table of SEM Results for Overall and Multiple Group Moderated Mediation Model

	Overall	Black Males	Black Females	White Males	White Females
Discrimination → Distress	+	+	+	+	+
Distress → Alcohol		+			
Discrimination → Alcohol					
Discrimination → Distress → Alcohol		+			
Distress → Marijuana	+	+	+	+	+
Discrimination → Marijuana	+	+	+		+
Discrimination → Distress → Marijuana	+	+	+	+	+
Distress → Illicit Drugs	+	+	+	+	+
Discrimination → Illicit Drugs	+	+	+	+	+
Discrimination → Distress → Illicit Drugs	+	+	+	+	+
Distress → Smoking	+	+			
Discrimination → Smoking	+				
Discrimination → Distress → Smoking	+	+			
Distress → ENDS	+	+	+		+
Discrimination → ENDS	+				
Discrimination → Distress → ENDS	+	+	+		+
Discrimination → Wellbeing	-	-	-	-	-
Wellbeing → Alcohol	+	+	-	+	+
Discrimination → Wellbeing → Alcohol	-	-	+	-	-
Wellbeing → Marijuana	-		-	-	-
Discrimination → Wellbeing → Marijuana	+		+	+	+
Wellbeing → Illicit Drugs					
Discrimination → Wellbeing → Illicit Drugs					
Wellbeing → Smoking		+			
Discrimination → Wellbeing → Smoking		-			
Wellbeing → ENDS					
Discrimination → Wellbeing → ENDS					

Checkmark indicates significant pathway at the $\alpha < 0.05$ level. Discrimination was assessed by the Everyday Discrimination scale, Distress or psychological distress was assessed by the K-6 scale, and Wellbeing or positive wellbeing was assessed by the MHC-SF scale.

Table 5a-d: Decomposition of Direct and Indirect Effects from the Multiple Group Moderated Mediated Model: Unstandardized and Standardized Probit Regression Coefficients, Blacks: Male n= 508, Female n= 594; Whites

	Black Males					
Variable	Unstandardized Coefficient	SE	p	95% LL	CI UL	Standardized Coefficient
Discrimination → Distress	**0.22**	**0.01**	**0.00**	**0.20**	**0.25**	**0.45**
Discrimination → Wellbeing	**-0.42**	**0.03**	**0.00**	**-0.49**	**-0.35**	**-0.31**
Distress → Alcohol	**0.05**	**0.02**	**0.00**	**0.01**	**0.08**	**0.19**
Wellbeing → Alcohol	**0.01**	**0.00**	**0.00**	**0.00**	**0.02**	**0.13**
Discrimination → Alcohol	0.01	0.01	0.16	0.00	0.02	0.07
Distress → Marijuana	**0.07**	**0.02**	**0.00**	**0.04**	**0.10**	**0.26**
Wellbeing → Marijuana	0.00	0.01	0.65	-0.01	0.01	0.03
Discrimination → Marijuana	**0.02**	**0.01**	**0.00**	**0.01**	**0.03**	**0.19**
Distress → Illicit Drugs	**0.04**	**0.01**	**0.00**	**0.01**	**0.06**	**0.15**
Wellbeing → Illicit Drugs	-0.01	0.00	0.05	-0.02	0.00	-0.09
Discrimination → Illicit Drugs	**0.02**	**0.01**	**0.01**	**0.00**	**0.03**	**0.13**
Distress → Cigarettes	**0.07**	**0.02**	**0.00**	**0.03**	**0.10**	**0.27**
Wellbeing → Cigarettes	**0.02**	**0.01**	**0.04**	**0.00**	**0.03**	**0.17**
Discrimination → Cigarettes	0.01	0.01	0.19	-0.01	0.03	0.09
Distress → ENDS	**0.05**	**0.02**	**0.00**	**0.02**	**0.08**	**0.20**
Wellbeing → ENDS	0.01	0.01	0.48	-0.01	0.02	0.05
Discrimination → ENDS	0.02	0.01	0.06	-0.00	0.03	0.12

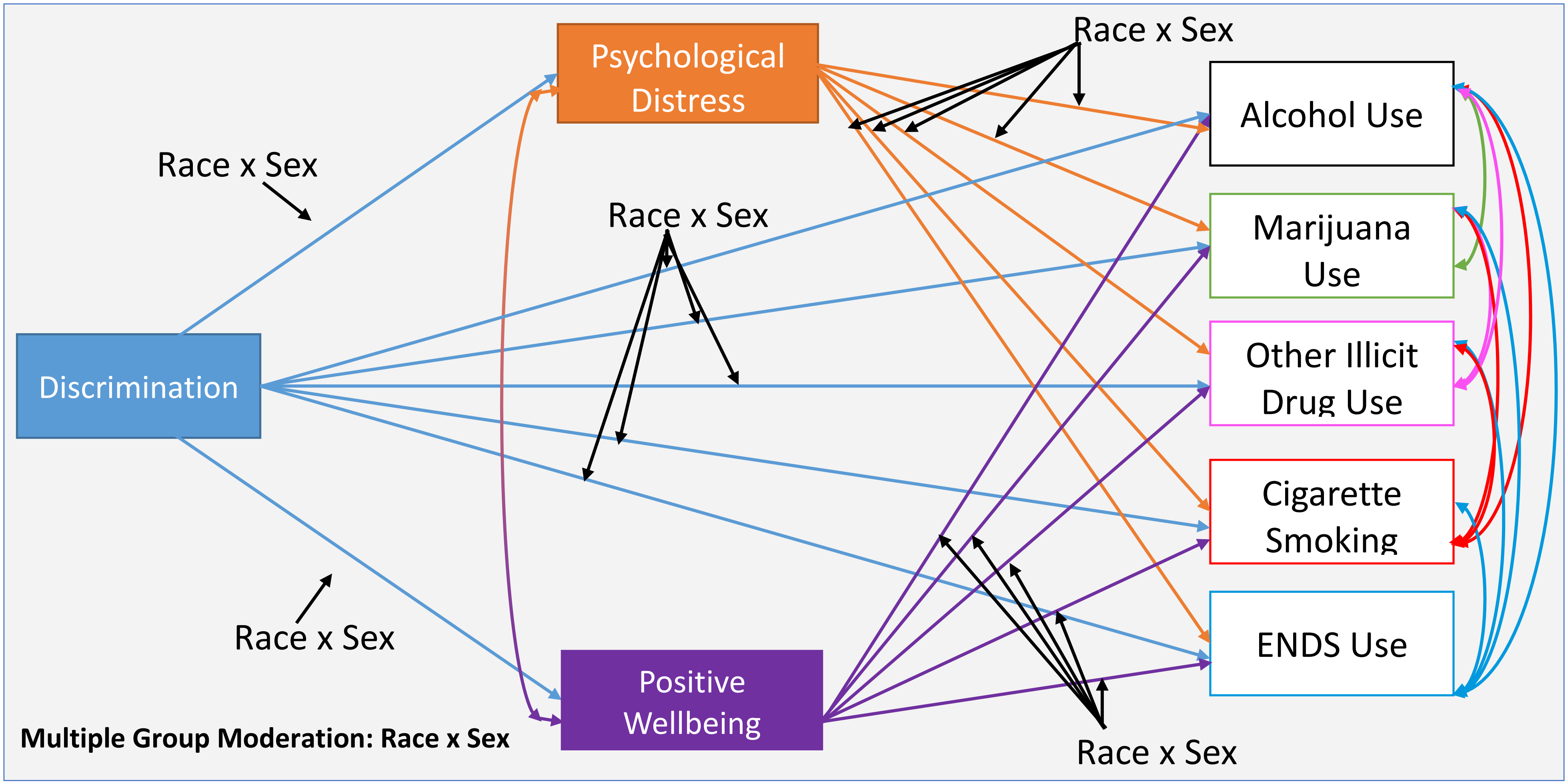
Variable	Black Females					
	Unstandardized Coefficient	SE	p	95% LL	CI UL	Standardized Coefficient
Discrimination → Distress	**0.22**	**0.01**	**<.001**	**0.20**	**0.25**	**0.39**
Discrimination → Wellbeing	**-0.42**	**0.03**	**<.001**	**-0.49**	**-0.35**	**-0.27**
Distress → Alcohol	-0.01	0.02	0.39	-0.05	0.02	-0.06
Wellbeing → Alcohol	**-0.01**	**0.01**	**0.05**	**-0.02**	**0.00**	**-0.13**
Discrimination → Alcohol	0.01	0.01	0.16	0.00	0.02	0.06
Distress → Marijuana	**0.03**	**0.01**	**0.04**	**0.00**	**0.05**	**0.10**
Wellbeing → Marijuana	**-0.01**	**0.00**	**<.001**	**-0.02**	**-0.01**	**-0.13**
Discrimination → Marijuana	**0.02**	**0.01**	**<.001**	**0.01**	**0.03**	**0.16**
Distress → Illicit Drugs	**0.04**	**0.01**	**<.001**	**0.01**	**0.06**	**0.14**
Wellbeing → Illicit Drugs	-0.01	0.00	0.05	-0.02	0.00	-0.09
Discrimination → Illicit Drugs	**0.02**	**0.01**	**0.01**	**0.00**	**0.03**	**0.11**
Distress → Smoking	0.02	0.02	0.20	-0.01	0.05	0.08
Wellbeing → Smoking	-0.01	0.01	0.10	-0.02	0.00	-0.11
Discrimination → Smoking	0.01	0.01	0.19	-0.01	0.03	0.07
Distress → ENDS	**0.05**	**0.02**	**<.001**	**0.02**	**0.08**	**0.20**
Wellbeing → ENDS	0.01	0.01	0.48	-0.01	0.02	0.05
Discrimination → ENDS	0.02	0.01	0.06	-0.00	0.03	0.11

	White Males					
Variable	Unstandardized Coefficient	SE	p	95% LL	CI UL	Standardized Coefficient
Discrimination → Distress	**0.22**	**0.01**	**<.001**	**0.20**	**0.25**	**0.38**
Discrimination → Wellbeing	**-0.42**	**0.03**	**<.001**	**-0.49**	**-0.35**	**-0.26**
Distress → Alcohol	-0.02	0.02	0.33	-0.05	0.02	-0.07
Wellbeing → Alcohol	**0.01**	**0.00**	**<.001**	**0.00**	**0.02**	**0.12**
Discrimination → Alcohol	-0.01	0.01	0.60	-0.02	0.01	-0.03
Distress → Marijuana	**0.04**	**0.02**	**0.01**	**0.01**	**0.07**	**0.16**
Wellbeing → Marijuana	**-0.01**	**0.00**	**<.001**	**-0.02**	**-0.01**	**-0.13**
Discrimination → Marijuana	0.00	0.01	0.62	-0.01	0.02	0.03
Distress → Illicit Drugs	**0.06**	**0.02**	**<.001**	**0.02**	**0.09**	**0.22**
Wellbeing → Illicit Drugs	0.01	0.01	0.30	-0.01	0.02	0.08
Discrimination → Illicit Drugs	**0.02**	**0.01**	**0.03**	**0.00**	**0.04**	**0.14**
Distress → Smoking	0.02	0.02	0.20	-0.01	0.05	0.08
Wellbeing → Smoking	-0.01	0.01	0.10	-0.02	0.00	-0.11
Discrimination → Smoking	0.01	0.01	0.73	-0.02	0.03	0.03
Distress → ENDS	0.02	0.02	0.32	-0.02	0.06	0.08
Wellbeing → ENDS	0.00	0.01	0.57	-0.02	0.01	-0.04
Discrimination → ENDS	0.01	0.01	0.20	-0.01	0.04	0.09

Variable	White Females Psychological Distress as Mediator Unstandardized Coefficient	SE	p	95% CI LL	UL	Standardized Coefficient
Discrimination → Distress	**0.22**	**0.01**	**<.001**	**0.20**	**0.25**	**0.36**
Discrimination → Wellbeing	**-0.42**	**0.03**	**<.001**	**-0.49**	**-0.35**	**-0.25**
Distress → Alcohol	0.02	0.02	0.38	-0.02	0.05	0.06
Wellbeing → Alcohol	**0.01**	**0.00**	**<.001**	**0.00**	**0.02**	**0.11**
Discrimination → Alcohol	0.01	0.01	0.55	-0.01	0.03	0.04
Distress → Marijuana	**0.03**	**0.01**	**0.04**	**0.00**	**0.05**	**0.09**
Wellbeing → Marijuana	**-0.01**	**0.00**	**<.001**	**-0.02**	**-0.01**	**-0.12**
Discrimination → Marijuana	**0.02**	**0.01**	**<.001**	**0.01**	**0.03**	**0.14**
Distress → Illicit Drugs	**0.04**	**0.01**	**<.001**	**0.01**	**0.06**	**0.14**
Wellbeing → Illicit Drugs	-0.01	0.00	0.05	-0.02	0.00	-0.09
Discrimination → Illicit Drugs	**0.02**	**0.01**	**0.01**	**0.00**	**0.03**	**0.10**
Distress → Smoking	0.02	0.02	0.20	-0.01	0.05	0.08
Wellbeing → Smoking	-0.01	0.01	0.10	-0.02	0.00	-0.10
Discrimination → Smoking	0.01	0.01	0.19	-0.01	0.03	0.06
Distress → ENDS	**0.05**	**0.02**	**<.001**	**0.02**	**0.08**	**0.19**
Wellbeing → ENDS	0.01	0.01	0.48	-0.01	0.02	0.05
Discrimination → ENDS	0.02	0.01	0.06	-0.00	0.03	0.09

Discrimination was assessed by the Everyday Discrimination scale, Distress or psychological distress was assessed by the K-6 scale, and Wellbeing or positive wellbeing was assessed by the MHC-SF scale.

Figure 1: Path Diagram of Hypothesized Moderated Mediated Discrimination-Psychological Functioning-Substance Use Relationship



Chapter 4: The Importance of Discrimination Attribution and Sex as Moderators of Discrimination, Mental Health, and Substance Use Among U.S. Black Young Adults

INTRODUCTION

Discrimination has been defined as differential or unfair treatment based on actual or perceived membership in a group. Discrimination often involves socially derived beliefs that groups hold about each other and reflects patterns of dominance and oppression through expressions of a struggle for power and privilege.[29,254-256] Moreover, discrimination can be based on membership of one or more groups such as race/ethnicity, national origin, gender, age, sexual orientation and gender identity.[257] It occurs on multiple levels including institutional (unfair institutional practices or polices) and interpersonal (perceived discriminatory experiences/interactions during social encounters).[26,257] Research suggests that discrimination is a salient social determinant of health, with links to poor physical[34,35,38,40,54,156,258-263] and mental health[41,42,45,54,55,89,190,192,193,223,229,234,259,264-266], as well as health risk behaviors such as substance use[18-20,24,28,30,32,66,72,86,88,139,174,189]. A growing body of literature has aimed to elucidate the mechanisms underlying associations between discrimination and health outcomes.[267]

Discrimination is generally conceptualized as a stressful experience regardless of what group it is directed to (e.g., racial/ethnic groups, socio-economically disadvantaged, etc.) or the attribution to the discriminatory experience (e.g., sexism/gender-related discrimination, ageism/age-related discrimination, racial discrimination, etc.).[37,43,73] However, some limited research suggests that Black Americans are more negatively impacted on a biological level from discrimination-related stress than their White and non-Black racial/ethnic minority counterparts[258], and some research indicates that discrimination contributes to premature biological aging as measured by telomere length among Black Americans[109,268]. Additionally, a larger body of research indicates that Blacks report higher rates of discrimination overall as well as discrimination attributed specifically to race, and that they experience greater discrimination-related health consequences than Whites [54,55,193,229,269]. Discrimination may be an important social determinant of the persistent disparities in the U.S. between Blacks and Whites in rates of chronic diseases, cancer, substance use-related problems, poor birth outcomes, and mortality, which cannot be explained by differences in socio-economic status alone.[270-275]. Young adulthood is a transitionary life period where risky health behaviors such as substance use can be established and contribute to poor health outcomes later in life. Thus, gaining a better understanding of the factors that contribute to the negative impact of discrimination on the lives of young adults could help to inform interventions to prevent risky health behaviors (including substance use) as well as more distal health consequences.

We previously found that discrimination was related to higher likelihood of substance use, both directly and indirectly via psychological distress and positive wellbeing, among Black and White young adults. Moreover, a greater number of associations were found among Black participants, especially Black males. One factor that may have contributed to these differences is the attribution to discrimination. There is mixed evidence of the potential moderating influence of discrimination attribution on the health of Black Americans.[276] For example, in a study using data from 2001-2003, race as the main attribution for discrimination did not modify the relationship between discrimination and major depressive disorder among Caribbean Blacks women and African America men and women.[233] Conversely, other studies that used the same dataset found that among African Americans, everyday racial discrimination but not everyday non-racial discrimination was associated with higher odds of serious psychological distress[277] and poorer self-rated physical health and oral health as well as greater health problems.[262] Additionally, a meta-analysis suggested that discrimination attributed to race or gender was less strongly associated with wellbeing than discrimination attributed to sexual orientation, mental illness, physical illness/ disabilities, weight, or being HIV-positive.[278] Moreover, this meta-analysis suggested that "concealable" attributions (e.g., mental illness, sexual orientation) and “controllable” (e.g., weight) were more strongly correlated with wellbeing and psychological distress than non-concealable and uncontrollable attributions (e.g., race, gender) and advantaged groups.[278] They also found similar effects among those from disadvantaged groups (e.g., Black, gay) as compared to those from advantaged groups.[278] Furthermore, some researchers have suggested that attributing discriminatory experiences to race may have a more negative impact on mental health than non-racial attributions as race-related attributions imply a threat to a major facet of one’s social identity that is fixed and conspicuous.[277,279]

Moreover, it may be important to also examine the effects of discrimination and discrimination attribution by other factors such as sex. Under intersectionality theory,[4] persons belonging to multiple groups can experience non-additive multiple and/or unique forms of discrimination due to their group membership. For example, White women may experience sexism; women of color may experience both racism and sexism; and sexual minority women of color can experience heterosexism, racism, and sexism. However, it is important to note that such discrimination is non-additive, such that people of color can experience gendered racism, or the intersection between sexism and racism,[37,280,281] wherein women of color, particularly Black women may be stereotyped/perceived as being promiscuous, angry, domineering, “mammies”, or “welfare queens,” and Black men may be perceived as criminals/dangerous, hypersexual, hypermasculine, or “thugs”.[282-285]Additionally, previous findings are mixed on whether the negative health impact of discrimination related stress differs by sex, especially among African Americans.[25,286,287] Cooper and colleagues suggested that Black males may be more negatively impacted by racial discrimination/discrimination-related stress due to greater exposure to discrimination and more negative stereotypes as compared to Black females.[287] However, Borrell and colleagues suggested that Blacks females’ physical and mental health may be more negatively impacted by racial discrimination than their male counterparts.[288]

Few studies have examined the importance of discrimination attribution, with fewer examining the comparative effects of various attributions. Moreover, much of the literature on discrimination and attributions among Black Americans utilized data from the National Survey of American Life, a 2001-2003 U.S. nationally representative study of Caribbean Blacks, African Americans, and Whites. Thus, additional research is needed that utilizes updated sources of data and that examine the influence of discrimination attribution. Addressing this gap in the literature is important because it can potentially shed light on the role of discrimination in exacerbating rates of substance use among Blacks, especially given the current socio-political climate where racial tensions have continued to grow throughout the Obama administration[289-291], during and after the 2016 presidential election[292,293] amidst widespread reports of racial discrimination[294] and publicized, recorded, and purportedly biased instances of police shootings of unarmed Black adults and youth[295-299]. Findings could inform more rigorous studies and eventually interventions designed at reducing discrimination-related stress and substance use among racial-ethnic minorities, particularly Blacks.

Accordingly, this study examined whether associations between discrimination and substance use differed by attribution for discriminatory experiences, in addition to exploring potential differences by sex, among the priority population of Black U.S. young adults.

We hypothesized that both sex and attribution would moderate the discrimination-mental health-substance use relationship such that those who attribute discrimination to race, especially males, would be more likely to be current substance users as compared to those who do not report race as the primary attribution.

METHODS

Data and Population

Data were obtained from the early release version of the 2017 Transition Into Adulthood Study (TAS), a supplemental study of The Panel Study on Income Dynamics (PSID).[231] The PSID is nationally representative and the longest running longitudinal household study in the U.S. [231] The TAS was launched in 2005 to collect information related to emerging adulthood and is conducted in odd number years. Beginning in 2017 the TAS was relaunched and now includes al young adults in the PSID as opposed to those who only participated in a different supplemental study as children.[231,232] Additional details can be found in paper 2.

The overall 2017 sample included 2,522 young adults aged 18-28; however, given the goal of the present study to examine moderation effects of the discrimination-mental-health-substance use relationship among Black emerging adults only participants who self-identified as Black were included. Thus, our analytic sample included Black participants with complete data on discrimination, psychological distress, and positive wellbeing which included 1,118 participants.

Measures

Independent Variable: Discrimination

Discrimination was assessed using the Everyday Discrimination (EDD) scale[48]. The original EDD scale includes 9 items; however, the TAS only included 7 of the 9 items. Respondents were specifically asked about the lifetime occurrence and frequency of: 1) being treated with less courtesy than other people, 2) receiving poorer service than other people at restaurants or stores, 3) being treated by others as if they are not smart, 4) other people acting as if they are afraid of them, 5) others acting as if they are dishonest, 6) others acting as if they are better than them, and 7) being treated with less respect than other people. Response options ranged from 1- “never” to 6- “almost everyday”. The EDD items were summed across the 7 items and treated as a continuous variable/sum score. The composite score ranged from 7– 42 with higher scores representing more frequent experiences of everyday discrimination. Both the full sample and analytic sample have a Cronbach α of 0.85 for all 7 items.

Dependent Variables: Substance Use

Tobacco Use

Current cigarette smokers were participants who answered yes to the following item, “Do you smoke cigarettes?”. Participants also indicated whether they had ever vaped (used a device such as a vape-pen, an e-cigarette, an e-hookah, or e-vaporizer to inhale a mist into the lungs). Ever vapers who reported vaping 1 or more days in the past 30 days were classified as past month ENDS users. Current tobacco use was classified as current smoking or current ENDS use. Current use of cigarettes and ENDS were not examined separately due to insufficient use prevalence across all groups.

Alcohol Use

Respondents reported whether they had ever drank alcoholic beverages such as beer, wine, or liquor. Past month alcohol use was assessed by asking those who reported ever drinking alcohol, “In the last year, on average, how often did you have any alcohol to drink? Would you say less than once a month, about once a month, several times a month, about once a week, several times a week, or every day?”. Those who responded about ‘once a month’, ‘several times a month’, ‘about once a week’, ‘several times a week’, and ‘every day’ were classified as past month drinkers.

Marijuana

Participants were asked to report about medicines and drugs, including marijuana, that they had ever tried in their lifetime, even if it was only once and including medicines that were and were not prescribed to them. Participants also reported the number of occasions that they used marijuana in the past 30 days, and those who indicated that they had used on one or more occasion were classified as past month users. Use of other illicit drugs were not assessed due to insufficient use prevalence across groups.

<u>Mediators: Psychological Functioning</u>

Psychological Distress

Past-month psychological distress was assessed using the Kessler-6 (K6) scale[236] which was developed to screen for serious mental illness. Participants were asked a total of 6 items including, “During the past 30 days, about how often did you feel the following symptoms:” “nervous,” “hopeless,” “restless or fidgety,” “so depressed that nothing could cheer you up,” “that everything was an effort,” and “worthless”. K6 scale items were treated as a continuous variable/sum score and response options range from 0 (none of the time) to 4 (all of the time), and ratings were summed for a total score ranging from 0 to 24. Higher overall scores indicated greater psychological distress. Both the full sample and analytic sample have a Cronbach α of 0.75 for all 6 items.

Positive Mental Health/Wellbeing

Past month positive mental health/wellbeing was assessed using the Mental Health Continuum Short Form (MHC-SF). The MHC-SF is designed to measure emotional or hedonic well-being, as well as social and psychological or eudemonic wellbeing. Participants were asked a total of 14 items including, “In the last month, how often did you feel: “happy”, “interested in life”, “satisfied”, “that you had something important to contribute to society”, “that you belonged to a community like a social group, your school, or your neighborhood”, “that our society is becoming a better place”, “that people are basically good”, “that the way our society works made sense to you”, “good at managing the responsibilities of your daily life”, “that you have warm and trusting relationships with other people”, “that you have experiences that challenged you to grow or become a better person”, “confident to think or express your own ideas and opinions”, “that you liked your personality”, and “that your life had a direction or purpose”? Would you say never, once or twice, about once a week, 2 or 3 times a week, almost every day, or every day?”. MHC-SF items were treated as continuous and response options included 0 (never), 1 (once or twice), 2 (about once a week), 3 (2 or 3 times a week), 4 (almost every day), and 5 (everyday) and ratings were summed for a total score ranging from 0 to 70 with higher scores indicating greater levels of overall positive wellbeing. Both the full sample and analytic sample have a Cronbach α of 0.84 for all 6 items.

<u>Moderators: Sex and Attribution to Discriminatory Experiences</u>

Participant age and sex were obtained from the 2017 family-level baseline PSID interview. The attribution to discriminatory experiences was not assessed among participants who indicated for all EDD items that they either "never" experienced and/or experienced the EDD items "less than once a year". Attribution to discriminatory experiences was assessed through several items. Following the assessment of EDD items, interviewers stated the following after instructing participants to look at an interview booklet and state the letter that corresponded to their response: "We've talked about a number of things that may have happened to you in your day-to-day life. Thinking of those experiences which have happened to you, overall what do you think were the reasons for this experience/these experiences?". Participants were allowed to select multiple attributions and responses included: a) ancestry, national origins, or ethnicity; b) gender; c) race; d) age; e) height or weight; f) some other aspect of physical appearance; g) religion; h) sexual orientation; i) occupation; and j) other. Participants who reported more than one attribution were then asked the following, "Which of those do you think was the main reason for this experience/these experiences?". All responses were classified into 4 categories: Race/ethnicity as sole or main attribution/ primary attribution (which included participants who only reported one attribution [race or ethnicity] or whose main attribution was race or ethnicity); Race/ethnicity as an additional attribution (which included participants who reported multiple attributions including race/ethnicity but did not report race/ethnicity as their main attribution); Non-racial attribution (which included participants who did not include race/ethnicity as an attribution); and Attribution not assessed (because of low frequency of discriminatory experiences).

Analyses

As shown in Figure 1, discrimination was the independent variable, there were 3 substance use outcomes (alcohol, marijuana, tobacco), and psychological distress and positive wellbeing were examined as mediators of the discrimination-substance use relationship. Moreover, sex and the attribution to discriminatory experiences were examined as moderators of the a, b, and c' pathways. Specifically, the a paths represent the relationship between discrimination and a given mediator (psychological distress or positive wellbeing), the b paths represent the relationship between a given mediator and a given substance use outcome (past month/current alcohol, marijuana, or tobacco use), while the c' paths represent the relationship between discrimination and a given substance use outcome. Consequently, we employed multi-group moderated mediation structural equation modeling (SEM) as depicted in Figure 1 considering the categorical nature of the moderators and the complexity of the multiple pathways examined.[237] Specifically, we sought to assess whether the proposed mediation effects of psychological distress and positive wellbeing varied across different attributions and sex on the a, b, and c pathways.

Mediation Analyses

SAS 9.4 (Cary, NC) was used to conduct descriptive statistics and bivariate analyses while Mplus 8.1 (Muthén & Muthén, 1998-2018) was used to conduct CFA, mediation, moderation, and multiple-group moderated mediation analyses. Path analyses were conducted using variance-adjusted weighted least squares (WLSMV) estimator which is useful for modeling categorical and continuous data and may model categorical/dichotomous outcomes more accurately.[238] Thus, probit regression was utilized in all SEM models where the inverse of the standard normal cumulative distribution is modeled. Path analyses were used to test psychological distress and positive wellbeing as mediators and sex and attribution as moderators to the discrimination-substance use (current tobacco use, past month use of alcohol and marijuana) relationship. Mediators were allowed to covary and outcomes were allowed to covary with each other. Final models controlled for age and standardized as well as unstandardized coefficients were estimated and reported. Additionally, 95% bootstrap confidence intervals were computed from 10,000 resamples of the data to obtain robust standard errors to determine statistical significance of mediation and moderated mediation effects.[240] Moreover, since all path models were saturated (all variables were connected to all other variables in a given pathway), the models fit perfectly to the data and overall measures of model fit were not presented (Figures 1). Further details of the model building process are provided in paper 2 but a brief summary is provided here. Mediation models were conducted with each mediator and outcome variables followed by models with all mediators and outcomes.

Moderated Mediation Analyses

Next, a multiple group approach was utilized to assess whether mediation paths were equal among sexes and attribution groups and differential effects were parameterized as group specific effects (instead of using interaction terms). Thus, analyses were conducted among males who reported race as the main or sole attribution (race as primary attribution), females who reported race as the main or sole attribution (race as primary attribution), males who reported race as an attribution but not as the main or sole attribution (race as an additional attribution), females who reported race as an attribution but not as the main or sole attribution (race as an additional attribution), males who only reported non-racial attributions, females who only reported non-racial attributions, males whose attribution was not assessed, and females whose attribution was not assessed.

In order to identify moderation effects, the a, b, and c' pathways were compared across all 8 groups. Moderation by sex was represented through constraining differences between males and females to be equal across attribution groups, while moderation by attribution group was represented through constraining differences between those who reported race as a primary attribution, race as an additional attribution, only non-racial attribution, or whose attribution was not assessed to be equal across sexes. Finally, moderation by both sex and attribution group was represented by allowing effects to be different across each group specified by the intersection of sex and attribution. Moderation of the mediation pathways were tested globally through a multiparameter Wald test at the $\alpha=0.05$ level using the Model Test option in Mplus' model constraint command and specific significant pathways were identified through

95% bootstrap confidence intervals of terms representing the product of coefficients. Where there was no evidence to indicate a difference across groups (as indicated by the multiparameter Wald test), the pathway was constrained to be equal across groups.

RESULTS

Descriptive Analyses

Table 1 reports univariate statistics and bivariate analyses by sex and attribution while Tables 2 reports bivariate descriptive analyses by substance use. The average EDD score was 16.3, average psychological wellbeing score was 4.8, positive wellbeing score was 49.5 and age was 22.6 years. The prevalence of past month/current substance use ranged from 11.1% (tobacco- cigarettes and/or ENDS) to 29% (marijuana), and a higher proportion of participants were female. Regarding attribution to discriminatory experiences, 36.5% of participants reported race as the sole or main reason, 16.9% reported race as an attribution but not as the main reason, 22.7% only reported non-racial attributions, and 23.9% of participant’s attribution was not assessed due to a low frequency of discriminatory experiences (Table 1). In general, those who reported a race-related attribution had a higher discrimination score than other groups. Among those whose attribution was not assessed had lower psychological distress scores and higher positive wellbeing scores than those whose attribution was assessed (Table 1). Similarly, those who reported race-related attributions had a higher prevalence of past month alcohol use and males had a higher prevalence of marijuana and tobacco use than those who reported non-racial attributions, whose attribution was not reported, and females. Past month marijuana users, drinkers, and current tobacco users were more likely to have higher EDD than non-current substance users. Lastly, past month marijuana users and current tobacco users were more likely to have higher psychological distress scores but lower positive wellbeing scores (Table 2) than non-current users.

Mediation Analyses

The full overall mediation model results are presented in Table 3 and a summary of the overall and multiple group moderated mediation structural equation model results are presented in Table 4. In the overall model, discrimination was positively associated with psychological distress and negatively associated with positive wellbeing. However, there were no indirect effects through wellbeing and indirect effects through psychological distress only for marijuana and tobacco use. Overall, higher discrimination was directly related to higher likelihood of marijuana use and tobacco use, and both of these associations were mediated by higher levels of psychological distress (marijuana use: a*b = 0.007, 95% CI: 0.003, 0.011; tobacco use: a*b= 0.009, 95% CI: 0.004, 0.014). However, discrimination was not related to alcohol use. Although discrimination was related to lower positive wellbeing scores, positive wellbeing was not significantly associated with substance use.

Overall there was evidence of several group differences as indicated by multiparameter Wald tests. For alcohol use, there was evidence of group differences in the effect of discrimination on alcohol use, either directly or indirectly through psychological distress, by race and sex (three-way interaction; Wald χ^2 = 10.99 (3 df), p=0.0118), by attribution among females (two-way interaction; Wald χ^2 =9.68 (3 df), p=.0215), by sex among those with race as a secondary attribution (two-way interaction; Wald χ^2 =9.76 (3 df), p=.0207), Additionally, there was evidence of group differences in the effect of discrimination on alcohol use, either directly or indirectly positive wellbeing, by attribution among females (two-way interaction; Wald χ^2 = 8.99 (3 df), p=.0295).

For tobacco use, there was evidence of a group difference in the effect of discrimination either directly or indirectly through psychological distress, by sex among those with race as a secondary attribution (two-way interaction; Wald χ^2 = 8.43 (3 df), p=.0379). Similarly, there was evidence of a group difference in the effect of discrimination on tobacco use, either directly or indirectly through positive wellbeing, by sex among those whose attribution was not assessed (two-way interaction; Wald χ^2 = 14.11 (3 df), p=.0028). Lastly, for marijuana use there was evidence of a group difference in the effect of discrimination either directly or indirectly through positive wellbeing, by sex among those whose attribution was not assessed (two-way interaction; Wald χ^2 = 9.31 (3 df), p=.0255).

<u>Moderated Mediation Analyses</u>

Overall there was evidence of several group differences as indicated by single parameter Wald tests. Specifically, Of the a paths there was evidence of a group difference by sex among those who reported race as a secondary attribution (Wald χ^2 = 6.09 (1 df), p=.0136), Of the b paths, through psychological distress there was evidence of group differences by sex among those who reported race as the sole or main attribution and whose attribution was not assessed for alcohol use (race sole or main attribution: Wald χ^2 = 5.03 (1 df), p=.0249; attribution not assessed: Wald χ^2 = 4.56 (1 df), p=.0327) and tobacco use (race as sole or main attribution: Wald χ^2 = 5.42 (1 df), p=.0199; attribution not assessed: Wald χ^2 =4.14 (1 df), p=.0420). Of the b paths through positive wellbeing there was evidence of group differences by attribution among females for tobacco use (Wald χ^2 = 3.90 (1 df), p=.0483) as well as by sex among those whose attribution was not assessed for alcohol (Wald χ^2 = 4.27 (1 df), p=.0389), marijuana (Wald χ^2 = 8.26 (1 df), p=.0041), and tobacco use (Wald χ^2 = 12.98 (1 df), p=.0003). Lastly, of the c' paths, there was evidence of group differences of the effect of discrimination on alcohol use by race and sex (Wald χ^2 = 7.84 (1 df), p=.0051) and by attribution among females (Wald χ^2 = 8.14 (1 df), p=.0043).

The multiple group moderated mediation analysis results by sex and attribution are presented in Tables 5a-5h. Among all groups other than those whose attribution was not assessed, discrimination was associated with higher psychological distress. Discrimination was associated with lower positive wellbeing only among those who reported race as the main or sole attribution and those who only reported non-racial attributions. Among males who reported race as the sole or main attribution, there were indirect effects of discrimination on alcohol use (a*b= 0.013, 95% CI: 0.005, 0.024), marijuana use (a*b= 0.012, 95% CI: 0.005, 0.023), and tobacco use (a*b= 0.018, 95% CI: 0.009, 0.029) through psychological distress. Among females who reported race as the sole or main attribution, psychological distress mediated the association between discrimination and marijuana use (a*b= 0.012, 95% CI: 0.005, 0.023) but not other substances. Thus, there were differences by sex among those with race as the sole or main attribution wherein there were indirect effects for alcohol and tobacco among males but none among females. Additionally, there were no significant indirect effects among males reporting racial attributions as secondary or whose attribution was not assessed.

Among males and females who only reported non-racial attributions, discrimination was directly related to higher likelihood of tobacco use (Tables 6e-f), but discrimination was not related to other substances and there were no significant indirect effects. Lastly, among males and females for whom attribution was not assessed, there was a direct effect between discrimination and alcohol use (Tables 6g-h) which indicated the presence of sex and attribution effects wherein direct effects were only found among those whose attribution was not assessed but the effect was stronger among females than males. As with those who reported only non-racial attributions, discrimination was not associated with other substance use among this subgroup.

DISCUSSION

The current findings suggest that among African American emerging adults, attributions for discriminatory experiences may play an important role in predicting psychological functioning and substance use. Attributions and sex both moderated the associations among discrimination, psychological distress and current substance use. Our hypothesis was supported in that most mediational effects were found among males who reported race as the sole or main attribution for their experiences of discrimination. Psychological distress fully mediated the relationship between discrimination and current use of alcohol, marijuana and tobacco among this subgroup. We previously found that discrimination was most strongly related to psychological distress and substance use among Black males, and the current findings suggest that discriminatory experiences that are specifically perceived as racial may be particularly detrimental in this population.

Our findings support the notion that racial discrimination may be a particularly salient risk factor for substance use among Black young adults in the U.S. and Black males in particular. Moreover, the full mediation of substance use through psychological distress among Black males and Black females (for marijuana use) who reported race as the sole or main attribution to their experiences of discrimination suggest that substance use among this population is related to coping with the negative effect of discrimination related psychological distress. A 2017 nationally representative study found that 62% of African Americans aged 18-29 reported being unfairly stopped or treated by the police because they are Black and 25% reported that they have considered moving because they have experienced discrimination where they live.[300] Similarly, a 2017 nationally representative study of 18-34 year olds found that 52% of African Americans cited racism as the most important problem in the U.S., whereas racism tied with terrorism/homeland security as the third most important problem among only 26% of White Americans (health care was the most important problem and environment/climate change the second among Whites).

Additionally, 44% and 42% of African Americans reported experiencing racial discrimination while looking for a job and while on the job, respectively, compared to only 13% and 14% of Whites.[301] Moreover, they found that 75% of African Americans believed that race relations in the U.S. were getting worse since the last year, 55% of African Americans reported that they felt that what happens to their racial group in the U.S. will have a lot to do with what happens in their own lives, and 79% expressed agreement with the statement that “Generations of slavery and discrimination have created conditions that make it difficult for Blacks to work their way out of the lower class”.[302] Thus, given the current socio-political climate racial discrimination may be emerging as an even stronger trigger for substance use among Black young adults in the U.S.

Young African Americans’ own personal experiences of racial discrimination coupled with the perceived pervasiveness of discrimination and unfair treatment throughout the African American community (whether exhibited through their own social networks or publicized examples) may contribute to discrimination being a particularly toxic stressor. Kessler and colleagues[229] and Stevens-Watkins[83] and colleagues previously found that the association between perceived discrimination and psychological distress was comparable to associations between mental health and major life events such as the death of a loved one, job loss, and victimization. Moreover, Guthrie and colleagues found that racial discrimination was highly correlated with cigarette smoking, but once the effects of stress were removed the relationship was attenuated, highlighting the role of stress as an underlying mechanism.[303]

It is also important to highlight that direct effects were found among groups who reported non-racial attributions or whose attribution was not assessed due to low frequency of reported discriminatory experiences. Specifically, discrimination was directly associated with tobacco use among those who reported non-racial attributions and directly associated with alcohol use among those whose attribution was not assessed. Firstly, the notion that discrimination is associated with combustible substance use among Blacks is supported, regardless of attribution. Secondly, participants who reported an attribution had higher discrimination scores on average than those whose attribution was not assessed which could suggest that combustible substances are used in response to more chronic experiences of discrimination. Previous research suggests that alcohol is more stigmatized in the Black community than in dominant U.S. society[139,162,248] which may in turn contribute to higher prevalence of combustible substances such as marijuana, cigarettes, and cigars among Blacks. Moreover, the association between discrimination and alcohol use among those whose attribution was not assessed may reflect more problematic drinking behaviors in addition to demonstrating suppressant effect of discrimination on substance use that has been observed in several studies. For example, a study of college students found that those who expressed a likelihood to avoid alcohol use on campus for fear of race-based police bias had lower odds (AOR: 0.72) of heavy episodic drinking and higher odds of abstaining from alcohol (AOR: 1.46).[72] Thus, it is possible that due to their lack of frequent experiences of discrimination, those whose attribution was not assessed may be less likely to fear negative consequences or stigma associated with alcohol use and in turn may be more likely to drink.

As the relationships among stress[126], psychological distress[79,88,224,304-307], and substance use have been well-documented, it is intuitive that discrimination-related stress would be associated with substance use in the priority population of Black young adults. Moreover, there is some evidence that substance users who experience psychological distress may be less successful with cessation attempts for tobacco, marijuana, and alcohol compared to those without severe psychological distress[306,308-310]. Thus, it is possible that discrimination has particularly damaging implications on the health of young Black Americans. Emerging adulthood is a life stage associated with increased potential for exposure to racial discrimination[2,311] in addition to stress associated with the transition from childhood to adulthood. Furthermore, emerging adulthood has been linked to higher rates of poor mental health outcomes and the onset of substance use [312]. Consequently, it is possible that experiences of discrimination during this transitionary life period may contribute to persistent substance use and poor mental health throughout the life course, which in turn contribute to disparities in mortality and morbidity. Additional research is needed to further understand the relationship and extent to which discrimination at multiple levels (e.g., inter-personal, institutional), contributes to mental health and substance use as well as potential protective factors of these associations. Furthermore, substance use interventions and prevention efforts targeted to young Black Americans should also consider addressing racial discrimination specifically. Nevertheless, the present study adds to the small but growing literature on the role of racial discrimination and substance use specifically among African American emerging adults and is consistent with previous studies.[24,66,88]

Limitations

The present study utilized only one wave of the TAS data and thus is unable to assess causality or the directionality of associations. However, there was an inherent temporal ordering of the modeled variables in that the frequency of perceived discrimination was modeled with past month psychological functioning and past month substance use. It is more logical that discrimination would precede the mental health mediators and substance use outcomes as opposed to mental health and substance use preceding experiences of discrimination. Additionally, differences in the discrimination-psychological functioning-substance use relationship was examined across a total of 8 groups by participant's attribution to discrimination and sex. Consequently, the sample sizes in each group were small and analyses may have been limited by inadequate power. Moreover, we relied on self-reported perceived discrimination as opposed to actual/controlled experiences of discrimination. Thus, it is possible that those who perceive discriminatory experiences may be more likely to be experience related mental health consequences and/or perceiver more frequent occurrences of discrimination. Future studies would benefit from longitudinal data and larger samples as well as biochemical verification of substance use and clinically relevant mental health mediators. Additionally, analyses were only adjusted for age, and we were unable to assess the impact of social factors such as the importance participants' racial/ethnic identity or their response to unfair treatment, which could impact the discrimination-mental health-substance use relationship. For example, Krieger and colleagues found that U.S. born Blacks who accepted unfair treatment as a fact of life, regardless of whether they talked about it or were quiet about it, had significantly higher psychological distress scores and odds of serious psychological distress as compared to those who took action and talked with others about it.[223] Future studies should examine the degree to which responses to unfair treatment may interact with attributions and other factors to predict the effects of discrimination on health outcomes. Lastly, we were unable to assess the ethnicity of Black participants (e.g., Afro-Latino, African, Afro-Caribbean) and previous research suggests that there are intragroup differences in the negative effects of discrimination.[20,86,89,192,234,260] Nevertheless, the present study provides a current examination of the racial discrimination-substance use relationship and focuses on the priority population of young adults who may be particularly vulnerable to the damaging effects of racial discrimination.

CONCLUSION

The present study suggests that discriminatory experiences that are specifically attributed to race contribute to licit and illicit substance use among Black emerging adults. Findings add to the growing literature indicating that racial discrimination is a salient social determinant of health and health behaviors among young Black Americans. Specifically, the current study utilized recent 2017 data to examine discrimination and substance use and can serve as foundational research for future studies that can further examine how these associations may vary over time as the current socio-political climate continues to evolve. While additional research is needed to further understand the underlying mechanisms and potential protective factors, future studies and substance use prevention efforts may benefit from addressing the role of racial discrimination on young minority substance use.

Table 1: Discrimination, Mental Health Mediators, Substance Use Outcomes, and Age by Attribution to Discriminatory Experiences and Sex Among African American Young Adults Age 18-28, 2017

	Overall	Male Main/Sole	Female Main/Sole	Male Additional	Female Additional	Male Non-Racial	Female Non-Racial	Male Not Assessed	Female Not Assessed
SUBSTANCE USE MEASURES		n=199	n=204	n=79	n=108	n=110	n=140	n=120	n=143
		M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)
Every Day Discrimination Score	16.3 (7.6)	20.8 (7.5) ^{a}	19.0 (6.6) ^{b}	21.0 (7.0) ^{a}	18.8 (5.6) ^{b}	18.0 (6.5) ^{b}	15.8 (5.5) ^{c}	7.8 (1.7) ^{d}	8.0 (1.7) ^{d}
Psychological Distress Score	4.8 (4.0)	5.0 (4.1) ^{a}	5.6 (3.9) ^{a}	5.4 (4.4) ^{a}	6.1 (3.8) ^{b}	5.4 (4.4) ^{a}	5.3 (3.8) ^{a}	2.4 (2.3) ^{c}	3.6 (3.5) ^{d}
Positive Wellbeing Score	49.5 (11.0)	49.9 (10.3) ^{ab}	48.3 (11.1) ^{a}	47.2 (11.5) ^{a}	48.1 (10.8) ^{a}	48.0 (11.9) ^{a}	48.8 (10.8) ^{a}	53.3 (10.8) ^{c}	52.0 (10.1) ^{bc}
Past Month Alcohol Use*	19.9 (223)	23.6 (47)	22.1 (45)	22.8 (18)	24.1 (26)	16.4 (18)	13.6 (19)	24.2 (29)	12.6 (18)
Past 30 Day Marijuana Use***	29.0 (324)	41.7 (83)	25.0 (51)	41.8 (33)	25.0 (27)	40.0 (44)	24.3 (34)	23.3 (28)	14.7 (21)
Past Month Tobacco Use***	11.1 (124)	18.6 (37)	4.9 (10)	13.9 (11)	8.3 (9)	15.5 (17)	7.1 (10)	15.8 (19)	6.3 (9)
DEMOGRAPHIC CHARACTERISTICS									
Age	22.6 (3.1)	22.4 (3.1) ^{a}	23.1 (3.0) ^{b}	22.7 (3.3) ^{ab}	22.3 (2.9) ^{a}	22.5 (3.2) ^{ab}	22.6 (3.1) ^{ab}	22.7 (3.2) ^{ab}	22.7 (3.1) ^{ab}
Sex									
Male	46.3 (518)	-	-	-	-	-	-	-	-
Female	53.7 (600)	-	-	-	-	-	-	-	-
Attribution to Discrimination									
Race as Sole or Main Reason	36.5 (403)	-	-	-	-	-	-	-	-
Race as Other Reason	16.9 (187)	-	-	-	-	-	-	-	-
Non-Racial Attribution	22.7 (251)	-	-	-	-	-	-	-	-
Attribution Not Assessed	23.9 (264)	-	-	-	-	-	-	-	-

M, mean, SD, standard deviation, NH, non-Hispanic. *** indicates p<.001. Differences in superscripts indicate statistically significant differences in means across groups (i.e. ^{a} groups with ^{a} and ^{b} have statistically significant different means.

Table 2: Discrimination, Mental Health Mediators, and Participant Characteristics by Current Substance Use Status Among African American Young Adults Age 18-28, 2017

	Alcohol		Marijuana		Tobacco	
	Yes	No	Yes	No	Yes	No
PREDICTOR AND MEDIATORS	n=222 M (SD) or % (n)	n=894 M (SD) or % (n)	n=324 M (SD) or % (n)	n=792 M (SD) or % (n)	n=123 M (SD) or % (n)	n=993 M (SD) or % (n)
Every Day Discrimination Score	**		***		***	
	17.5 (7.8)	16.0 (7.5)	18.7 (8.1)	15.4 (7.2)	18.7 (9.2)	16.0 (7.3)
Psychological Distress Score			***		***	
	5.3 (4.2)	4.7 (3.9)	5.9 (4.3)	4.4 (3.7)	6.3 (4.9)	4.7 (3.8)
Positive Wellbeing Score			***			
	48.4 (11.2)	49.7 (10.9)	47.5 (11.6)	50.3 (10.7)	48.6 (13.1)	49.6 (10.7)
PARTICIPANT CHARACTERISTICS						
Age						
	22.5 (2.5)	22.7 (3.2)	22.6 (2.9)	22.7 (3.2)	22.3 (3.0)	22.7 (3.1)
Sex			***		***	
Male						
	51.4 (114)	45.0 (402)	58.3 (189)	41.3 (327)	69.1 (85)	43.4 (431)
Female						
	48.6 (108)	55.0 (492)	41.7 (135)	58.7 (465)	30.9 (38)	56.6 (562)
Attribution to Discrimination						
	*		***			
Race as Sole or Main Reason						
	41.8 (92)	28.2 (311)	41.7 (134)	34.4 (269)	38.5 (47)	36.3 (356)
Race as Additional Reason						
	20.0 (44)	16.2 (143)	18.7 (60)	16.2 (127)	16.4 (20)	17.0 (167)
Non-Racial Attribution						
	16.8 (37)	24.1 (213)	24.3 (78)	22.0 (172)	22.1 (27)	22.7 (223)
Attribution Not Assessed						
	21.4 (47)	24.5 (216)	15.3 (49)	27.4 (214)	23.0 (28)	24.0 (235)

M, mean, SD, standard deviation, *** indicates p<.001.

Table 3: Decomposition of Direct and Indirect Effects from the Overall Model: Unstandardized and Standardized Probit Regression Coefficients, N= 1089

Variable	Overall					
	Unstandardized Coefficient	SE	p	95%	CI	Standardized Coefficient
Discrimination → Distress	**0.19**	**0.02**	**<.001**	**0.15**	**0.22**	**0.36**
Discrimination → Wellbeing	**-0.03**	**0.00**	**<.001**	**-0.04**	**-0.02**	**-0.23**
Distress → Alcohol	0.01	0.01	0.35	-0.01	0.04	0.05
Wellbeing → Alcohol	-0.02	0.04	0.70	-0.10	0.07	-0.02
Discrimination → Distress → Alcohol	0.002	0.002	0.36	-0.003	0.007	
Discrimination → Wellbeing → Alcohol	0.001	0.001	0.70	-0.002	0.003	
Discrimination → Alcohol	0.01	0.01	0.05	0.00	0.02	0.09
Distress → Marijuana	**0.04**	**0.01**	**<.001**	**0.02**	**0.06**	**0.14**
Wellbeing → Marijuana	-0.06	0.04	0.15	-0.14	0.02	-0.06
Discrimination → Distress → Marijuana	**0.007**	**0.002**	**0.001**	**0.003**	**0.011**	
Discrimination → Wellbeing → Marijuana	0.002	0.001	0.16	-.001	0.005	
Discrimination → Marijuana	**0.03**	**0.01**	**<.001**	**0.02**	**0.04**	**0.19**
Distress → Tobacco	**0.05**	**0.01**	**<.001**	**0.02**	**0.07**	**0.18**
Wellbeing → Tobacco	0.08	0.06	0.19	-0.03	0.19	0.08
Discrimination → Distress → Tobacco	**0.009**	**0.003**	**0.001**	**0.004**	**0.014**	
Discrimination → Wellbeing→ Tobacco	-0.002	0.002	0.20	-0.006	0.001	
Discrimination → Tobacco	**0.02**	**0.01**	**0.03**	**0.00**	**0.03**	**0.11**

Table 4: Summary Table of SEM Results for Overall and Multiple Group Moderated Mediation Model

	Overall	Males-Racial Attribution Primary	Females-Racial Attribution Primary	Males-Racial Attribution Additional	Females-Racial Attribution Additional	Males-Non-racial Attribution	Females-Non-racial Attribution	Males-Attribution Not Assessed	Females-Attribution Not Assessed
Discrimination → Distress	+	+	+	+	+	+	+		
Distress → Alcohol		+						+	
Discrimination → Alcohol								+	+
Discrimination → Distress → Alcohol		+							
Distress → Marijuana	+	+	+						
Discrimination → Marijuana	+								
Discrimination → Distress → Marijuana	+	+	+						
Distress → Tobacco	+	+						+	
Discrimination → Tobacco	+					+	+		
Discrimination → Distress → Tobacco	+	+							
Discrimination → Wellbeing	-	-	-			-	-		
Wellbeing → Alcohol									
Discrimination → Wellbeing → Alcohol									
Wellbeing → Marijuana									-
Discrimination → Wellbeing → Marijuana									
Wellbeing → Tobacco								+	
Discrimination → Wellbeing → Tobacco									

Checkmark indicates significant pathway at the α < 0.05 level. Discrimination was assessed by the Everyday Discrimination scale, Distress or psychological distress was assessed by the K-6 scale, and Wellbeing or positive wellbeing was assessed by the MHC-SF scale.

Table 5a-h: Decomposition of Direct and Indirect Effects from the Multiple Group Moderated Mediated Model: Unstandardized and Standardized Probit Regression Coefficients, Racial Attribution Primary Attribution: Male n= 194, Female n=200; Racial Attribution Additional Attribution Male n=78, Female n=107; Non-racial Attribution Male n=109 , Female n=139 ; Attribution Not Assessed Male n=119 , Female n=143

Males-Racial Attribution Primary						
Variable	Unstandardized Coefficient	SE	p	95%	CI	Standardized Coefficient
Discrimination → Distress	**0.18**	**0.03**	**<.001**	**0.12**	**0.24**	**0.33**
Discrimination → Wellbeing	**-0.03**	**0.01**	**0.01**	**-0.05**	**-0.01**	**-0.19**
Distress → Alcohol	**0.08**	**0.02**	**<.001**	**0.03**	**0.12**	**0.30**
Wellbeing → Alcohol	-0.03	0.08	0.69	-0.18	0.12	-0.03
Discrimination → Alcohol	0.01	0.02	0.36	-0.02	0.04	0.10
Distress → Marijuana	**0.07**	**0.02**	**<.001**	**0.03**	**0.11**	**0.27**
Wellbeing → Marijuana	0.06	0.08	0.42	-0.08	0.23	0.06
Discrimination → Marijuana	0.02	0.01	0.15	-0.01	0.04	0.11
Distress → Tobacco	**0.10**	**0.02**	**<.001**	**0.06**	**0.15**	**0.39**
Wellbeing -→ Tobacco	0.14	0.11	0.19	-0.05	0.37	0.14
Discrimination → Tobacco	0.01	0.01	0.43	-0.02	0.04	0.07

Females-Racial Attribution Primary						
Variable	Unstandardized Coefficient	SE	p	95%	CI	Standardized Coefficient
Discrimination → Distress	**0.18**	**0.03**	**<.001**	**0.12**	**0.24**	**0.31**
Discrimination → Wellbeing	**-0.04**	**0.01**	**<.001**	**-0.06**	**-0.02**	**-0.24**
Distress → Alcohol	0.01	0.04	0.73	-0.06	0.08	0.05
Wellbeing → Alcohol	-0.03	0.08	0.69	-0.18	0.12	-0.03
Discrimination → Alcohol	0.00	0.02	0.98	-0.03	0.03	0.00
Distress → Marijuana	**0.07**	**0.02**	**<.001**	**0.03**	**0.11**	**0.26**
Wellbeing → Marijuana	0.06	0.08	0.42	-0.08	0.23	0.07
Discrimination → Marijuana	0.02	0.01	0.15	-0.01	0.04	0.10
Distress → Tobacco	0.05	0.06	0.43	-0.08	0.17	0.19
Wellbeing → Tobacco	0.14	0.11	0.19	-0.05	0.37	0.15
Discrimination → Tobacco	0.01	0.01	0.43	-0.02	0.04	0.07

Males-Racial Attribution Additional						
Variable	Unstandardized Coefficient	SE	p	95%	CI	Standardized Coefficient
Discrimination → Distress	**0.35**	**0.06**	**<.001**	**0.25**	**0.46**	**0.56**
Discrimination → Wellbeing	-0.02	0.02	0.29	-0.06	0.02	-0.14
Distress → Alcohol	-0.01	0.04	0.84	-0.09	0.05	-0.03
Wellbeing → Alcohol	-0.19	0.13	0.14	-0.48	0.01	-0.19
Discrimination → Alcohol	-0.06	0.03	0.08	-0.13	0.00	-0.36
Distress → Marijuana	0.04	0.03	0.18	-0.02	0.10	0.17
Wellbeing → Marijuana	-0.14	0.11	0.19	-0.37	0.06	-0.15
Discrimination → Marijuana	0.04	0.02	0.06	0.00	0.08	0.23
Distress → Tobacco	0.04	0.05	0.46	-0.06	0.12	0.15
Wellbeing → Tobacco	-0.15	0.16	0.37	-0.53	0.11	-0.16
Discrimination → Tobacco	0.02	0.03	0.46	-0.04	0.07	0.13

Females-Racial Attribution Additional						
Variable	Unstandardized Coefficient	SE	p	95%	CI	Standardized Coefficient
Discrimination → Distress	**0.15**	**0.08**	**0.05**	**0.02**	**0.31**	**0.23**
Discrimination → Wellbeing	-0.03	0.02	0.08	-0.08	0.00	-0.18
Distress → Alcohol	-0.01	0.04	0.84	-0.09	0.05	-0.03
Wellbeing → Alcohol	-0.19	0.13	0.14	-0.48	0.01	-0.20
Discrimination → Alcohol	0.00	0.02	0.96	-0.05	0.05	0.01
Distress → Marijuana	0.04	0.03	0.18	-0.02	0.10	0.15
Wellbeing → Marijuana	-0.14	0.11	0.19	-0.37	0.06	-0.15
Discrimination → Marijuana	0.04	0.02	0.06	0.00	0.08	0.19
Distress → Tobacco	0.04	0.05	0.46	-0.06	0.12	0.13
Wellbeing → Tobacco	-0.15	0.16	0.37	-0.53	0.11	-0.15
Discrimination → Tobacco	0.02	0.03	0.46	-0.04	0.07	0.10

Males-Non-Racial Attribution						
Variable	Unstandardized Coefficient	SE	p	95%	CI	Standardized Coefficient
Discrimination → Distress	**0.16**	**0.05**	**<.001**	**0.07**	**0.25**	**0.25**
Discrimination → Wellbeing	**-0.05**	**0.02**	**0.01**	**-0.09**	**-0.02**	**-0.30**
Distress → Alcohol	0.00	0.04	0.93	-0.07	0.06	0.01
Wellbeing → Alcohol	0.02	0.11	0.82	-0.18	0.24	0.03
Discrimination → Alcohol	0.02	0.02	0.38	-0.02	0.06	0.12
Distress → Marijuana	0.01	0.02	0.63	-0.04	0.05	0.05
Wellbeing → Marijuana	-0.15	0.08	0.07	-0.32	0.00	-0.17
Discrimination → Marijuana	0.03	0.02	0.08	0.00	0.06	0.18
Distress → Tobacco	0.04	0.03	0.18	-0.02	0.10	0.18
Wellbeing → Tobacco	0.09	0.13	0.52	-0.15	0.38	0.10
Discrimination → Tobacco	**0.04**	**0.02**	**0.02**	**0.01**	**0.08**	**0.27**

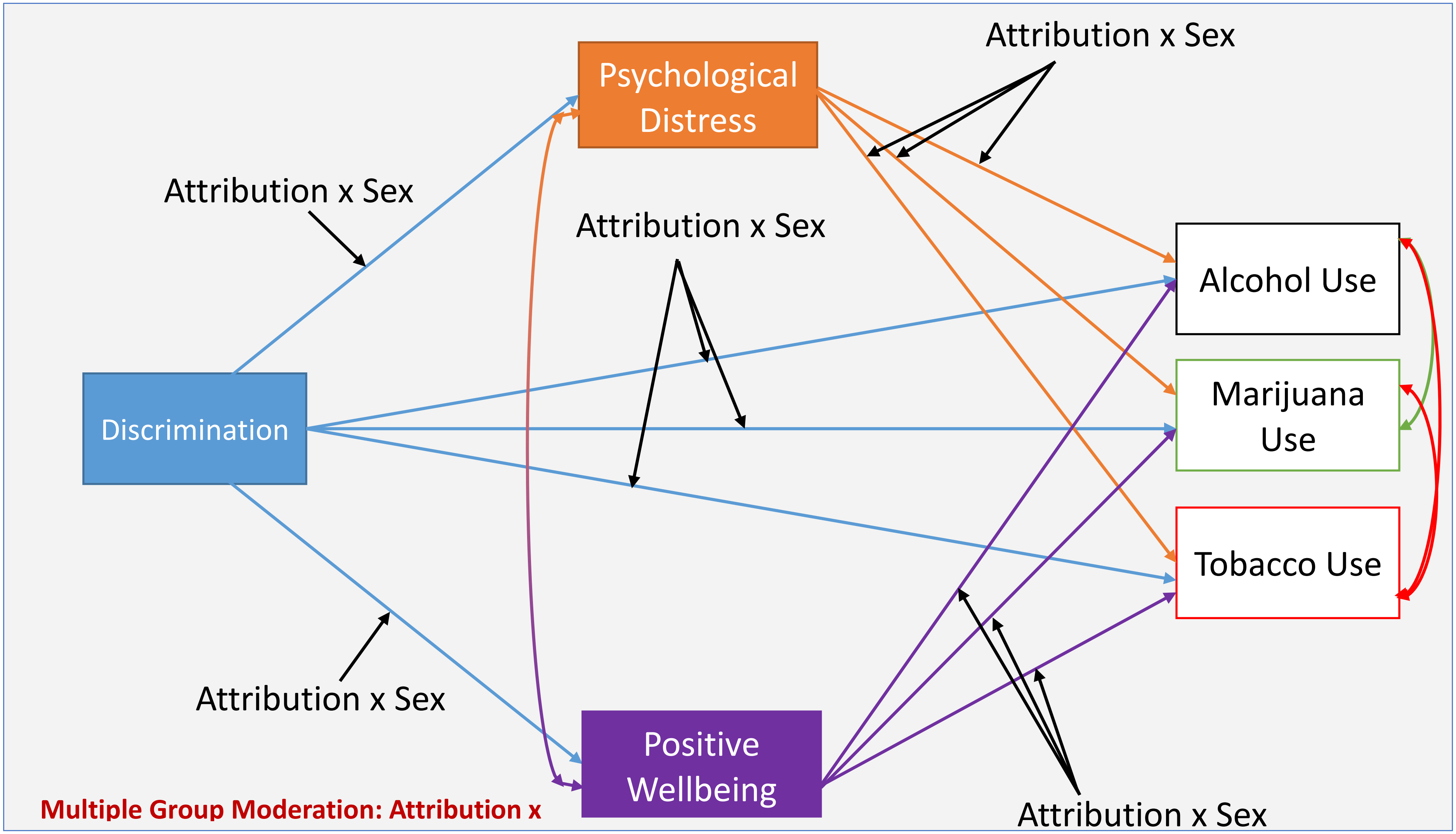
Females-Non-racial Attribution						
Variable	Unstandardized Coefficient	SE	p	95%	CI	Standardized Coefficient
Discrimination → Distress	**0.16**	**0.05**	**<.001**	**0.07**	**0.25**	**0.23**
Discrimination → Wellbeing	**-0.04**	**0.02**	**0.02**	**-0.08**	**-0.01**	**-0.20**
Distress → Alcohol	0.00	0.04	0.93	-0.07	0.06	0.01
Wellbeing → Alcohol	0.02	0.11	0.82	-0.18	0.24	0.03
Discrimination → Alcohol	0.00	0.03	0.86	-0.05	0.04	-0.02
Distress → Marijuana	0.01	0.02	0.63	-0.04	0.05	0.04
Wellbeing → Marijuana	-0.15	0.08	0.07	-0.32	0.00	-0.16
Discrimination → Marijuana	0.03	0.02	0.08	0.00	0.06	0.15
Distress → Tobacco	0.04	0.03	0.18	-0.02	0.10	0.16
Wellbeing → Tobacco	0.09	0.13	0.52	-0.15	0.38	0.09
Discrimination → Tobacco	**0.04**	**0.02**	**0.02**	**0.01**	**0.08**	**0.23**

Males-Attribution Not Assessed						
Variable	Unstandardized Coefficient	SE	p	95%	CI	Standardized Coefficient
Discrimination → Distress	-0.01	0.07	0.90	-0.14	0.13	-0.01
Discrimination → Wellbeing	-0.02	0.07	0.75	-0.16	0.09	-0.03
Distress → Alcohol	**0.09**	**0.04**	**0.04**	**0.01**	**0.17**	**0.19**
Wellbeing → Alcohol	0.18	0.12	0.13	-0.04	0.43	0.19
Discrimination → Alcohol	**0.20**	**0.09**	**0.03**	**0.07**	**0.41**	**0.32**
Distress → Marijuana	0.04	0.03	0.20	-0.02	0.10	0.09
Wellbeing → Marijuana	0.06	0.11	0.61	-0.15	0.27	0.06
Discrimination → Marijuana	0.01	0.03	0.74	-0.05	0.05	0.01
Distress → Tobacco	**0.11**	**0.05**	**0.04**	**0.02**	**0.21**	**0.25**
Wellbeing → Tobacco	**0.38**	**0.16**	**0.02**	**0.13**	**0.73**	**0.41**
Discrimination → Tobacco	0.03	0.03	0.29	-0.03	0.10	0.06

Females-Attribution Not Assessed						
Variable	Unstandardized Coefficient	SE	p	95%	CI	Standardized Coefficient
Discrimination → Distress	-0.01	0.07	0.90	-0.14	0.13	0.00
Discrimination → Wellbeing	0.04	0.05	0.41	-0.05	0.14	0.07
Distress → Alcohol	0.00	0.05	0.94	-0.11	0.07	-0.01
Wellbeing → Alcohol	-0.08	0.14	0.57	-0.33	0.20	-0.07
Discrimination → Alcohol	**0.22**	**0.08**	**0.01**	**0.09**	**0.41**	**0.36**
Distress → Marijuana	0.04	0.03	0.20	-0.02	0.10	0.13
Wellbeing → Marijuana	**-0.27**	**0.13**	**0.04**	**-0.53**	**-0.02**	**-0.27**
Discrimination → Marijuana	0.01	0.03	0.74	-0.05	0.05	0.01
Distress → Tobacco	0.02	0.06	0.76	-0.09	0.10	0.06
Wellbeing → Tobacco	-0.24	0.23	0.29	-0.56	0.07	-0.25
Discrimination → Tobacco	0.03	0.03	0.29	-0.03	0.10	0.06

. Discrimination was assessed by the Everyday Discrimination scale, Distress or psychological distress was assessed by the K-6 scale, and Wellbeing or positive wellbeing was assessed by the MHC-SF scale.

Figure 1: Path Diagram of Hypothesized Moderated Mediated Discrimination-Psychological Functioning-Substance Use Relationship



Chapter 5. Dissertation Summary and Future Directions in Research

In summary, Chapter 2 explored the relationship between allostatic load and substance use by race/ethnicity and gender and found that the non-linear relationship between allostatic load and substance use varied by race/ethnicity and gender. Meanwhile, Chapter 3 explored the relationship between discrimination, psychological functioning, and substance use among Black and White emerging adults and found that that the direct and indirect associations between discrimination and substance use through psychological distress and positive wellbeing, varied by race and sex. Lastly, Chapter 4 explored the moderation effects of attribution to discrimination and sex on the discrimination-psychological functioning-substance use relationship among Black emerging adults and found that racial discrimination specifically was associated with indirect associations among Blacks, especially males, and that non-racial/no attribution was associated with direct effects on tobacco and alcohol use, respectively.

Overall, the three studies contribute to filling several gaps in the literature. Specifically, Chapter 2 addressed the dearth of information related to the allostatic load-substance use relationship and utilized an empirically driven specification of allostatic load. Additionally, Chapters 3 and 4, utilized recent, 2017 data to explore the allostatic load-mental health-relationship, the priority population of emerging adults, under researched measures of psychological functioning, and novel substance use outcomes such as ENDS and illicit drugs other than marijuana.

The information gained from these studies provided several new insights and implications. Firstly, the studies establish a clear relationship between allostatic load/discrimination and substance use across the adult life course in the past two decades. Secondly, Chapters 3 and 4 highlight the importance of mental health/psychological functioning to the discrimination-substance use relationship and support the theory that discrimination related substance use is coping motivated. Moreover, Chapters 3 and 4 highlight the salience of racial discrimination as a risk factor for substance use among contemporary emerging adults, especially Black males. Future directions for allostatic load/discrimination research include longitudinal examinations, explorations of potential protective factors, utilization of chemically verified and clinically relevant mental health and substance use measures, as well as accounts for other social and psychosocial factors such as intragroup ethnicity and substance use motivations. Moreover, substance use prevention efforts and interventions may especially benefit from updated and more rigorous examinations of these associations.

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APPENDIX A

Table A1: Log Likelihood of Simple Models by Allostatic Load Variable and Substance Use Outcome

	Intercept Only Model	Continuous Allostatic Load Score	Dichotomous AL 3	All Dummy Variables	Al6789	AL789	AL89
Outcome	LL	LL	LL	LL, LR χ^2, df, p	LL, LR χ^2, df, p	LL, LR χ^2, df, p	LL, LR χ^2, df, p
Past Month Marijuana Use	-44542588.5	-44366290	-44442069.5	-44085019, LR χ^2: 562542, 1, <.001	-44297323.5, LR χ^2: 137933, 6, <.001	-44187056.5, LR χ^2: 358467, 7, <.001	-44085019, LR χ^2: 562542, 8, <.001
Cigarette Smoking Status	-118122141	-117657880.5	-117607099	-117119381, LR χ^2: 1076999, 1, <.001	-117394914, LR χ^2: 525933, 12, <.001	-117300629, LR χ^2: 714503, 14, <.001	-117170512, LR χ^2: 974737, 16, <.001
Alcohol Use Status	-162930765	-161714794.5	-162292452	-	-160539856, LR χ^2: 2349877, 24, <.001	-160408199, LR χ^2: 2613191, 28, <.001	-160270905.5, LR χ^2: 2887778, 32, <.001

LL, log likelihood, LR, likelihood ratio, df, degrees of freedom. Reported likelihood ratio tests were conducted with the continuous allostatic load score model representing the simple model. Quasi-complete separation of data points was detected with the all dummy variable model for alcohol use status. Thus, we were unable to run the model and therefore, unable to report the log likelihood as denoted by the dash. The continuous allostatic load score model utilized a continuous allostatic load measure that ranged from a score of 0 to 9; the all dummy variable model utilized a total of 10 dummy variables, with each representing a level/score of the allostatic load sum (dummy variable representing allostatic load of 0 versus all else was not included in the model as a reference group); the al6789 model utilized a total of model 7 dummy variables, with each representing a score of the allostatic load sum but with scores 6-9 collapsed into 1 variable; the al789 model utilized a total of model 8 dummy variables, with each representing a score of the allostatic load sum but with scores 7-9 collapsed into 1 variable (dummy variable representing allostatic load of 0 versus all else was not included in the model as a reference group); the al89 model utilized a total of model 9 dummy variables, with each representing a score of the allostatic load sum but with scores 8-9 collapsed into 1 variable.

Table A2: Regression Model Main Effects and Joint Test Interaction Estimates by Substance Use Outcome

Parameter	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Alcohol Use	F, (df, df), p	Wald $\chi^{2,}$ df, p	Wald $\chi^{2,}$ df, p	Wald $\chi^{2,}$ df, p	Wald $\chi^{2,}$ df, p	Wald $\chi^{2,}$ df, p	Wald $\chi^{2,}$ df, p
Allostatic Load (AL)	**6.91, (24, 9), 0.0025**	**478.44, 24, p<.0001**	**454.78, 24, <.0001**	**92.96, 24, <.0001**	**42029, 24, <.0001**	**412.92, 24, <.0001**	**29943.47, 24, <.0001**
Race/Ethnicity	-	**24.23, 8, 0.0021**	13.34, 8, 0.10	**24.84, 8, 0.0017**	10.34, 8, 0.24	11.69, 8, 0.17	**1157.98, 8, <.0001**
Gender	-	**46.82, 4, <.0001**	**46.67, 4, <.0001**	**11.43, 4, 0.0221**	**21.24, 4, 0.0003**	7.25, 4, 0.12	6.90, 4, 0.14
AL*Race/Ethnicity	-	**-**	**861518.37, 32, <.0001**	-	**-**	**57820.99, 32, <.0001**	**2066487.13, 35, <.0001**
AL*Gender	-	**-**	**-**	**92.41, 24, <.0001**	**-**	**109.85, 24, <.0001**	**6680.13, 24, <.0001**
Race/Ethnicity*Gender	-	**-**	**-**	-	32.78, 8, <.0001	**30.18, 8, 0.0002**	**122.30, 8, <.0001**
AL*Race/Ethnicity*Gender	-	**-**	**-**	-	**-**	**-**	**58423533.2, 35, <.0001**
Cigarette Smoking	F, df, df, p	F, df, df, p	Wald $\chi^{2,}$ df, p	Wald $\chi^{2,}$ df, p	Wald χ^2, df, p	Wald χ^2, df, p	Wald χ^2, df, p
Allostatic Load	**2.65 (12, 21), 0.0245**	0.86 (12, 21), 0.59	14.36, 12, 0.28	14.04, 12, 0.30	16.60, 12, 0.17	**34.93, 12, 0.0005**	20.72, 12, .05
Race/Ethnicity	-	**19.74, (4, 29), <.0001**	**10.70, 4, 0.0301**	**89.07, 4, <.0001**	**71.02, 4, <.0001**	**10.33, 4, 0.0353**	5.34, 4, 0.25
Gender	-	0.26 (2, 31), 0.77	0.58, 2, 0.75	2.58, 2, 0.28	0.22, 2, 0.90	1.28, 2, 0.53	0.86, 2, 0.65

AL*Race/Ethnicity	-	-	**59.61, 24, <.0001**	-	-	**44.34, 24, 0.0069**	34.50, 24, .08
AL*Gender	-	-	-	9.23, 12, 0.68	-	8.17, 12, 0.77	7.38, 12, 0.83
Race/Ethnicity*Gender	-	-	-	-	**13.62, 4, 0.0086**	**13.37, 4, 0.0096**	4.94, 4, 0.29
AL*Race/Ethnicity*Gender	-	-	-	-	-	-	**1125.58, 24, <.0001**
Marijuana Use	F, df, df, p	F, df, df, p	F, df, df, p	F, df, df, p	Wald χ^2, df, p	Wald χ^2, df, p	Wald χ^2, df, p
Allostatic Load	1.66 (6, 27), 0.17	0.44, (6, 27), 0.84	0.21(6, 27), 0.97	0.99, (6, 27), 0.45	3.22, 6, 0.78	4.38, 6, 0.63	3.21, 6, 0.78
Race/Ethnicity	-	**26.56, (2, 31), <.0001**	**9.85, (2, 31), 0.0005**	**25.42, (2, 31), <.0001**	**23.82, 2, <.0001**	**14.35, 2, 0.0008**	**9.83, 2, 0.0073**
Gender	-	**16.40, (1, 32), 0.0003**	**16.10, (1,32), 0.0003**	**5.56, (1, 32), .0247**	**12.82, 1, 0.0003**	**5.60, 1, 0.0180**	3.76, 1, 0.05
AL*Race/Ethnicity	-	-	0.72, (12, 21), 0.72	-	-	15.63, 12, 0.21	12.78, 12, 0.39
AL*Gender	-	-	**-**	2.39, (6, 27), 0.06	-	**16.72, 6, 0.0104**	9.52, 6, 0.15
Race/Ethnicity*Gender	-	-	**-**	-	3.07, 2, 0.22	3.40, 2, 0.18	1.96, 2, 0.38
AL*Race/Ethnicity*Gender	-	-	**-**	-	-	-	**266.04, 12, <.0001**

AL, allostatic load, df, degrees of freedom. Regression estimates were from a joint test which is a test that all the parameters associated with that effect are zero. Boldface indicates statistical significance at the p< 0.05 level. Dash indicates parameter not included in the model. Adjusted models also controlled for age, education, and poverty level.

Table A1a. Model Estimated Probability of Being a Former or Never Cigarette Smoking by Allostatic Load Score, Race/Ethnicity, and Gender

	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Former Smoker Predicted Probability					
0	0.23	0.17	0.25	0.18	0.26	0.20
1	0.10	0.00	0.29	0.24	0.20	0.12
2	0.14	0.03	0.18	0.24	0.28	0.10
3	0.10	0.14	0.29	0.32	0.20	0.13
4	0.15	0.27	0.27	0.26	0.27	0.21
5	0.10	0.14	0.23	0.27	0.28	0.28
6+	0.14	0.04	0.25	0.26	0.22	0.23
Min Probability	0	0	0	0	0	0
Max Probability	0.32	0.32	0.32	0.32	0.32	0.32

	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Never Smoker Predicted Probability					
0	0.45	0.49	0.49	0.53	0.61	0.66
1	0.69	0.88	0.46	0.48	0.71	0.83
2	0.62	0.64	0.51	0.48	0.61	0.78
3	0.58	0.63	0.51	0.42	0.70	0.69
4	0.59	0.50	0.52	0.41	0.62	0.67
5	0.73	0.80	0.53	0.57	0.62	0.62
6+	0.53	0.87	0.38	0.54	0.60	0.63
Min Probability	0.38	0.38	0.38	0.38	0.38	0.38
Max Probability	0.88	0.88	0.88	0.88	0.88	0.88

Table A1b. Model Estimated Risk Ratio of Being a Former or Never Cigarette Smoking by Allostatic Load Score, Race/Ethnicity, and Gender

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Former Smoker Model Estimated Risk Ratio					
0.00	REF	REF	REF	REF	REF	REF
1.00	0.44	0.00	1.18	1.31	0.76	0.59
2.00	0.59	0.16	0.72	1.29	1.07	0.49
3.00	0.44	0.79	1.19	1.76	0.75	0.68
4.00	0.66	1.57	1.08	1.42	1.02	1.06
5.00	0.43	0.81	0.94	1.49	1.08	1.43
6+	0.63	0.24	1.00	1.42	0.84	1.18
Min Risk Ratio	0.00	0.00	0.00	0.00	0.00	0.00
Max Risk Ratio	1.76	1.76	1.76	1.76	1.76	1.76

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Never Smoker Model Estimated Risk Ratio					
0.00	REF	REF	REF	REF	REF	REF
1.00	1.54	1.80	0.93	0.91	1.17	1.25
2.00	1.37	1.31	1.04	0.89	1.01	1.18
3.00	1.28	1.29	1.04	0.79	1.15	1.05
4.00	1.31	1.02	1.06	0.77	1.03	1.01
5.00	1.62	1.64	1.09	1.07	1.03	0.93
6+	1.18	1.79	0.78	1.01	0.98	0.95
Min Risk Ratio	0.77	0.77	0.77	0.77	0.77	0.77
Max Risk Ratio	1.80	1.80	1.80	1.80	1.80	1.80

Table A2a. Model Estimated Probability of Never Drinking or Drinking Less Than Monthly or Monthly in the Past Year by Allostatic Load Score, Race/Ethnicity, and Gender

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Never Drinker Model Estimated Probability					
0.00	0.02	0.05	0.07	0.16	0.12	0.23
1.00	0.04	0.11	0.16	0.08	0.09	0.17
2.00	0.11	0.13	0.18	0.15	0.15	0.16
3.00	0.24	0.17	0.10	0.07	0.13	0.28
4.00	0.07	0.10	0.15	0.05	0.06	0.05
5.00	0.09	0.39	0.17	0.15	0.11	0.37
6+	0.11	0.18	0.14	0.18	0.12	0.12
Min Probability	0.02	0.02	0.02	0.02	0.02	0.02
Max Probability	0.39	0.39	0.39	0.39	0.39	0.39

	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Less Than Monthly Model Estimated Probability					
0.00	0.14	0.21	0.16	0.23	0.16	0.22
1.00	0.27	0.32	0.10	0.27	0.15	0.27
2.00	0.07	0.29	0.09	0.20	0.08	0.41
3.00	0.19	0.11	0.26	0.29	0.03	0.41
4.00	0.07	0.28	0.07	0.24	0.20	0.47
5.00	0.04	0.27	0.12	0.31	0.20	0.31
6+	0.28	0.41	0.05	0.50	0.17	0.40
Min Probability	0.03	0.03	0.03	0.03	0.03	0.03
Max Probability	0.50	0.50	0.50	0.50	0.50	0.50

	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Monthly Drinker Model Estimated Probability					
0.00	0.32	0.34	0.21	0.21	0.33	0.30
1.00	0.18	0.20	0.22	0.24	0.30	0.30
2.00	0.29	0.32	0.24	0.20	0.31	0.30
3.00	0.16	0.39	0.22	0.29	0.23	0.13
4.00	0.15	0.29	0.16	0.16	0.33	0.32
5.00	0.12	0.29	0.25	0.17	0.18	0.32
6+	0.14	0.09	0.14	0.07	0.17	0.06
Min Probability	0.06	0.06	0.06	0.06	0.06	0.06
Max Probability	0.39	0.39	0.39	0.39	0.39	0.39

Table A2b. Model Estimated Risk Ratio of Never Drinking or Drinking Less Than Monthly or Monthly in the Past Year by Allostatic Load Score, Race/Ethnicity, and Gender

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Never Drinker Model Estimated Risk Ratio					
0.00	REF	REF	REF	REF	REF	REF
1.00	1.67	2.16	2.22	0.48	0.81	0.74
2.00	4.93	2.57	2.55	0.97	1.29	0.69
3.00	10.73	3.30	1.37	0.43	1.08	1.20
4.00	3.25	1.83	2.08	0.32	0.49	0.22
5.00	4.00	7.44	2.33	0.92	0.95	1.56
6+	5.23	3.48	1.96	1.14	1.07	0.50
Min Risk Ratio	0.22	0.22	0.22	0.22	0.22	0.22
Max Risk Ratio	10.73	10.73	10.73	10.73	10.73	10.73

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Less Than Monthly Drinker Model Estimated Risk Ratio					
0.00	REF	REF	REF	REF	REF	REF
1.00	2.01	1.52	0.61	1.16	0.93	1.24
2.00	0.49	1.39	0.60	0.84	0.51	1.86
3.00	1.37	0.54	1.64	1.27	0.19	1.87
4.00	0.53	1.30	0.44	1.05	1.21	2.14
5.00	0.30	1.27	0.80	1.36	1.24	1.44
6+	2.02	1.93	0.34	2.15	1.01	1.83
Min Risk Ratio	0.30	0.30	0.30	0.30	0.30	0.30
Max Risk Ratio	2.15	2.15	2.15	2.15	2.15	2.15

Allostatic Load Score	Black Males	Black Females	White Males	White Females	Hispanic Males	Hispanic Females
	Monthly Drinker Model Estimated Risk Ratio					
0.00	REF	REF	REF	REF	REF	REF
1.00	0.55	0.59	1.06	1.13	0.92	1.00
2.00	0.90	0.92	1.11	0.92	0.93	1.01
3.00	0.49	1.14	1.04	1.35	0.69	0.45
4.00	0.46	0.86	0.75	0.73	0.99	1.08
5.00	0.38	0.84	1.17	0.80	0.55	1.08
6+	0.44	0.27	0.68	0.33	0.51	0.21
Min Risk Ratio	0.21	0.21	0.21	0.21	0.21	0.21
Max Risk Ratio	1.35	1.35	1.35	1.35	1.35	1.35