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Regional Income Inequality and Current Substance Use Among Hispanic 12th Grade Students in the United States

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REGIONAL INCOME INEQUALITY AND CURRENT SUBSTANCE USE AMONG HISPANIC 12TH GRADE STUDENTS IN THE UNITED STATES

by

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INTRODUCTION: Income inequality has been previously shown to be related to adverse population health outcomes. A suggested etiology is that income inequality intensifies status anxiety, leading to unhealthy coping mechanisms such as substance use. Behavioral factors specific to Hispanic cultures may have the potential to build resiliency in adolescents against substance use related to status anxiety, but have not been considered as protective factors in large, nationwide studies on substance use among adolescents.
AIM: Determine the association between regional income inequality in the U.S. and substance use among 12th grade students, and determine whether this association is different for Hispanic students.
METHODS: Public survey data from 2012 – 2018 from the Monitoring the Future Survey, an annual, nationally representative survey on substance use and social and political views of secondary school and college students in the U.S., were used along with data from the U.S. Census Bureau on household income inequality for 4 regions of the U.S, represented by the Gini coefficient. Odds ratios, 95% confidence intervals, and p-values were calculated using binary logistic regression carried out in SAS 9.4 to determine the likelihood of substance use given the respective region's Gini coefficients and controlling for confounders.
RESULTS: The Gini coefficient was negatively associated with substance use for the whole sample (OR <0.001), as well as for Hispanic (OR 0.002) and Black (OR <0.001) participants, and positively associated with substance use for White participants (OR 2.339), but was not significant (CI 0.032 – 170.112). When disaggregated by race only Future Plans and Father's Education were consistently significant predictors for all three racial/ethnic groups and the whole sample. The model's concordance statistic was 0.581,

meaning it was able to correctly predict substance use among participants a little more than half the time.
DISCUSSION: Because the model's predictive power was low, it is not sufficient for determining the true association between substance use and income inequality among the survey population, and differences among racial and ethnic groups could not be determined. Future research should look at specific cultural factors to determine whether they can build resiliency against substance related to status-anxiety at a population level.

APPROVAL PAGE

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Author's Statement Page

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TABLE OF CONTENTS

List of Tables

List of Figures

Chapter I - Introduction

In the United States, the income gap between the top 1% and the bottom 99% is one of the widest of any country in the developed world. Current levels of inequality, which have been increasing since the 1970s, are the highest they have been in five decades, mirroring levels of the 1920s (Sommeiller & Price 2018). In 2018, the top 0.1% of U.S. earners received 196 times as much income as the bottom 90%, with an average income of $32,317,850 (Saez 2018; Sommeiller & Price 2018). Rising income inequality at the national level is leading to rising income inequality at the regional level as well, as wealth guides the rich to more affluent areas and the poor to more affordable areas within the U.S. (Manduca, 2019). Unfortunately, the levels of income inequality are expected to continue rising in the United States due to a variety of issues, including low union membership, low long-term financial gain taxes, and continuing racial and gender discrimination (Institute for Policy Studies, n.d.).

Growing income inequality increases concerns about the effects on the population's well-being. According to one study, state income inequality in the United States correlates with chronic conditions such as obesity, diabetes, and depression, as well as an increased likelihood of heavy drinking and reduced exercise (Matthew, Broderson 2018). Similarly, Wilkinson and Pickett (2009) found significant associations between income inequality and increased use of illegal drugs, when comparing high-income countries, as well as higher rates of addiction and deaths from overdose in the more unequal states in the United States. Wilkinson and Pickett (2009) hypothesize that these trends exist because income inequality corrodes social cohesion and increases feelings of insecurity and stress, which encourage unhealthy behavior, often leading to higher rates of chronic disease. Interestingly, Wilkinson and Pickett claim that the negative effects of income inequality affect people of all income levels, not just those at the very bottom.

Substance use has historically been considered in public health with a focus on improving access to rehabilitative treatment and education campaigns, often with an emphasis on individual behavioral change as a way to combat problematic substance use. Thomas (2007) suggests that a broader lens which includes social, political, and economic context may improve our understanding of the conditions which are conducive to substance use, and thus increase the opportunities for intervention. Merikangas (2002) proposes using the epidemiology triangle to understand substance use epidemiology. This study will consider income inequality and race and ethnicity as factors contributing to substance use (Figure1).

Few studies have looked at the connection between regional income inequality and substance abuse among Hispanic adolescents in the United States. Minority adolescents should be considered distinctly for testing the theory of inequality-driven substance use because of their unique experiences with acculturation. Studies have found that children with substance use disorders are more likely to experience other mental illnesses such as depression and anxiety (Ross & Peselow, 2012; Kelley & Daley, 2013). Acculturative stress experienced by many Hispanic adolescents increases their risk of participating in substance abuse (Unger, 2014). These comorbidities combined with changing social roles and acculturation make for a turbulent experience for minority adolescents at an age when they are more likely to be seeking acceptance from their peers and experimenting with various behaviors to gain such acceptance (U.S. Department of Health and Human Services, n.d.). However, there are numerous practices and behaviors specific to Hispanic cultures which may also serve as protective factors against substance use despite the added stress of acculturation (Unger, 2014).

This study aims to look at substance use among 12th grade students and regional income inequality in the United States. This study also aims to disaggregate the data by race and ethnicity to determine if income inequality affects all students similarly, specifically focusing on Hispanic students and comparing them to their Black and White peers. Answering these questions will provide insight into

the extent to which income inequality affects the health behaviors of minority youth, and how policies to alleviate such inequalities may also alleviate racial and ethnic health disparities.

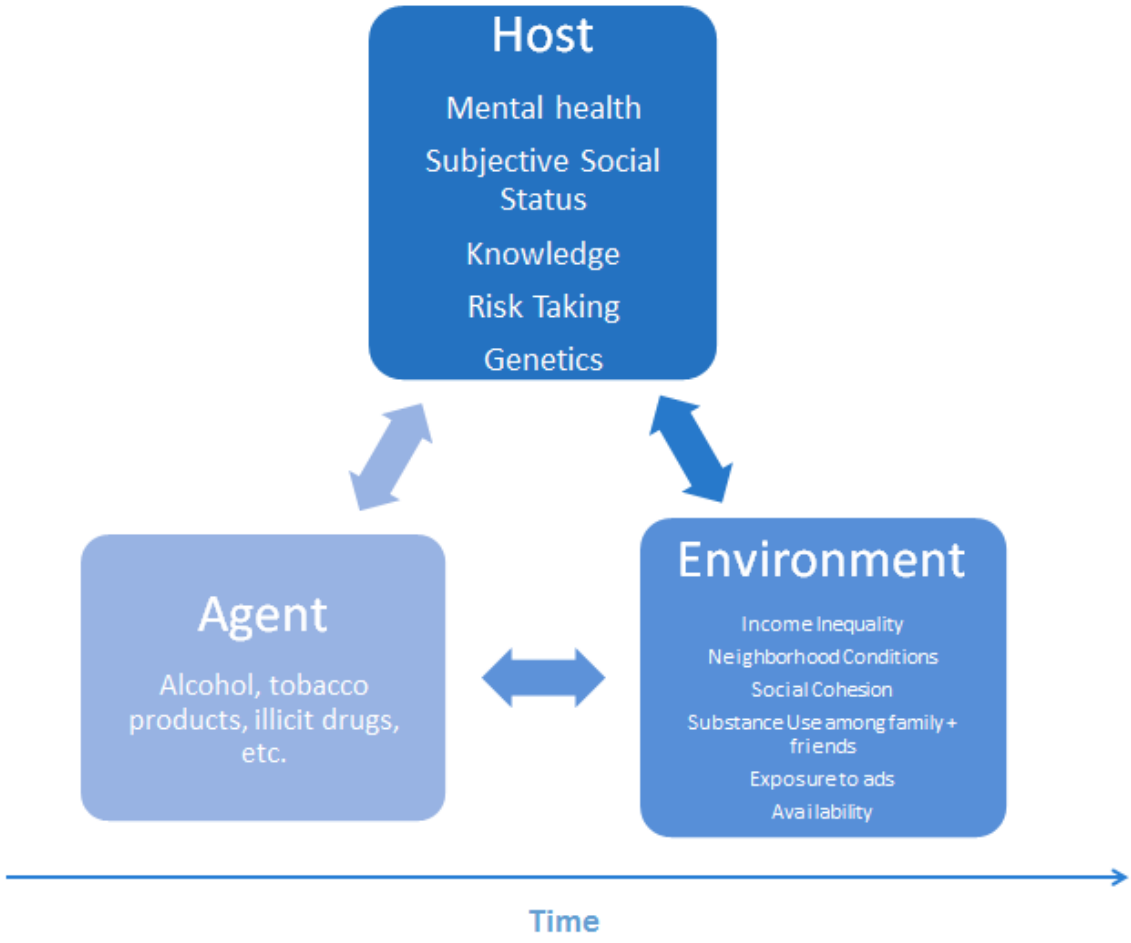

Figure 1. Epidemiological triangle: how different factors influence substance use

Chapter II - Literature Review

2.1 Income, Inequality, and Health Outcomes

Understanding environmental context is crucial to understanding the occurrence and distribution of health events, especially because environmental context and individual factors often overlap. Such is the case with income. Individual income was shown to be associated with increased substance use in one study, although when adjusted, social reinforcement was a stronger predictor than personal income (Kar, Haynie, Luk, Simmons-Morton 2018). Social reinforcement becomes stronger depending on the socioeconomic factors present in the environment, such as the income of social contacts. Community-wide income reflected in the socioeconomic status of a neighborhood has also been shown to be associated with substance use (Karriker-Jaffe, 2013). In a study based in New York City, urban neighborhoods with higher median income and more income maldistribution had higher rates of alcohol and marijuana consumption among adults (Galea, Aher, Tracy, Valhov, 2007).

Similarly, positive associations with income inequality have been found for diabetes, heavy drinking, smoking, sexually transmitted infections, and overall longevity (Matthew & Broderson 2018; Li, Guindon; Neumayer & Plumper 2016; Quon, McGrath, 2014; Harling, Subramanian, Barnighausen, Kawachi, 2013). However, results from such studies are often inconsistent. When comparing studies, it is difficult to draw a conclusion for which outcomes are truly associated with income inequality rather than a confounding factor. In a nationwide study of BRFSS data, Matthew and Broderson (2018) found a positive association between state income inequality and heavy drinking, but no significant associations between smoking and income inequality, and surprisingly, a negative correlation with mental health. In fact, they found that mental health improved the most in the lowest income groups as state income inequality increased. Among adolescents in multiple low and middle income countries, Li and Guindon (2014) found that a 1 unit increase in the Gini coefficient was associated with a 5% increase in current

smoking in both males and females, but when using income dispersion instead of the Gini coefficient to measure inequality, the positive association was only significant in males. However, in another study from Brazil looking at health risk behaviors as a result of violent victimization of 9th grade students in urban areas, metropolitan-area income inequality was found to only be associated with drunkenness in females and no other outcome (Ramos, Daley, Seidle-de-Moura, Nadanovsky, 2017). In a statewide study of adolescent smoking risk among California adolescents, county-level income inequality was associated with established smoking, but not experimental smoking, and the relationship was significant among male, white, and urban area adolescents, but not significant among African American or Hispanic adolescents, although this was attributed to low numbers of participants (Mistry, McCarthy, de Vogli, Crespi, Wu, Patel, 2011). In contrast to these findings, Connelly, Goel, and Ram (2010) found no association between state-level income inequality in the United States and cigarette consumption. And finally, Stevens (2016) ran a qualitative comparative analysis to assess the relationship between country-level income inequality and cannabis use. He concluded that high levels of cannabis use were associated with high levels of income inequality, but only in combination with high urbanization within the country. These studies indicate that the association between income inequality and health outcomes depends on various factors, including geographic area, time span, and analysis of possible confounders or mediators such as social environment and mental health.

Citing various similar studies on income inequality and health outcomes, Wilkinson and Pickett (2017) explain the link between wealth maldistribution and health outcomes with strong social gradients, such as substance use and obesity. They argue that as societies become more hierarchal, social status becomes an important defining characteristic. As inequality in a society increases, status becomes more important, and status anxiety becomes more prevalent. This sensitivity to social status then leads to unhealthy coping mechanisms such as materialistic pursuits, comfort eating, and substance use, which lead to an increase in chronic diseases.

2.2 Mental Health

Status anxiety can be examined by examining subjective social status. Subjective social status or subjective socioeconomic status (SSS or subjective SES) is how an individual sees their own status in the social hierarchy compared to their perceptions of other people in their society (Rivenbark & Copeland, 2019). It is useful in measuring the psychosocial stress that may be related to income inequality, and has been shown to be associated with various health outcomes. Adolescents' SSS is usually associated closely with other measures of socioeconomic status such as parental income and neighborhood income, indicating a high awareness of how they compare to their peers (Rivenbark & Copeland, 2019). Supporting this idea are the findings of Coley, Sims, Dearing, and Spielvogle (2018), in which the economic contexts of schools have a particularly strong influence on youth well-being, and that students in poorer schools report higher levels of depressive symptoms, anxiety symptoms, violence, and engagement in intoxication, but students in affluent schools reported higher levels of engagement in any intoxication as well as property crime. Coley et al. (2018) conclude that growing income inequality may reduce economic diversity in schools, leading to an increase in the risks associated with school level poverty or affluence. This may be explained by a study of Canadian adolescents which compared their substance use to their immigrant generation, and found that, in line with the theories of harmful acculturation mentioned below, 2nd and 3rd generation immigrants were far more likely to engage in substance abuse than 1st generation immigrants, but that substance abuse among 1st generation immigrants was highly associated with their subjective socioeconomic status (Hamilton, van der Maas, Boak, Mann, 2014).

The link between mental health and substance use is well studied. Children with psychopathologic symptoms, including depression, anxiety, and conduct problems in school were at higher risk of substance use than their peers who did not exhibit these symptoms (Fidalgo, 2016;

Maslowski, 2013). In a longitudinal study of substance use in emerging adulthood, troubled child-parent relationships were linked with psychological distress and substance use in young adults (Plummer Lee, Beckert, Marsee, 2018).The depression and anxiety associated with lower subjective social status are also associated with substance use, as the two are often comorbid conditions (Basanez, Unger, Soto, Crano, Baezconde-Garbanati, 2013). However, the etiologies of these conditions are unique to social and cultural contexts, which differ for Hispanic and non-Hispanic adolescents (Grigsby, Forster, Soto, Baezconde-Garbanati, Unger, 2014). A study examining low-income Latinos in primary care determined that trends in SSS and poor mental health outcomes were also strongly associated with negative affect – the tendency to often experience negative emotions such as fear, anxiety, anger, and depression (Zvolensky, Bakhshaie, Paulus, Garza, Valdivieso, Sampogna, Bogiaizian, Robles, Schmidt, 2016), in which case income alone may explain the disparities in mental health.

2.3 Substance Use Among Hispanic Adolescents

There are numerous risks and protective factors associated with substance use among Hispanic adolescents. In a summary of findings from Project RED, Unger (2014) found that many factors specific to having a Hispanic background served as determinants for substance use. One finding was that cultural values of respect for elders and interdependency among family members served as protective factors against substance abuse, whereas expectations of risk taking for males increased their risk for substance use. Other findings included the increased risks associated with acculturation, which was also present in numerous other studies. Related to acculturation was “parentification”, which occurs when parents who are immigrants rely on the acculturation and adaptation of their children to navigate the adoptive country’s culture; Unger (2014) found that this may be a risk factor for substance use if large discrepancies exist between parent and child levels of acculturation. However, differences in these relationships were found among different national origins of Hispanic families when comparing those of

Cuban descent in Miami to those of Latin American descent in Los Angeles, calling into question the generalizations made about the entire Hispanic population before this disaggregated analysis was conducted (Schwartz, Unger, Des Rosiers, Huang, Baezconde-Garbanati, Lorenzo-Blanco, Villamar, Soto, Pattarroyo, Szapocznik, 2012). Perceived discrimination was also a risk factor strongly associated with substance use, implying that Hispanic adolescents' perceptions of their niche in their communities impact their health behavior (Basanez et al., 2013). Additionally, adolescents with stronger Hispanic orientation had lower odds of substance abuse. Those who are confident in their Hispanic orientation may have fewer worries about discrimination. Unger (2014) concludes that the risks associated with acculturation can be mitigated through enculturation, in which Hispanic adolescents strengthen their cultural ties. However, a level of acculturation is necessary to adequately navigate different cultural norms, and adolescents who managed to simultaneously participate in American culture and maintain Hispanic orientation were the least likely to participate in substance abuse (Unger, 2014; Grigsby, Forster, Soto, Baezconde-Garbanati, Unger, 2014) . This is supported by a study which found Hispanic youth with higher self-image, lower levels of stress, stronger coping skills are less likely to use drugs while those who spoke Spanish at home, had peers who used drugs, and had intentions to use drugs in the future were more likely to participate in substance use (Schinke, Schwinn, Hopkins, Wahlstrom, 2016). Although the protective factors highlighted by Schinke et al. (2016) exist across racial and ethnic groups, unique cultural backgrounds create different paths to these attributes, and understanding the paths that Hispanic adolescents take can improve the efficacy of preventative measures.

2.4 Gaps in the Literature

The inconsistent results from these studies may be due to various factors, including different measures of income inequality and small sample sizes. Given the complex etiology of adolescent substance use and income inequality, confounders can easily distort these relationships as well. The

major measure of income inequality is the Gini coefficient, but it is calculated at different geographic levels in different studies, depending on the research question. Additionally, the majority of studies utilize cross-sectional data from one survey cycle, with some limited to one locality, which limits the number of observations. There are not currently any large scale studies which have examined the impacts of income inequality on substance use in adolescents disaggregated by race and ethnicity.

Chapter III - Methods

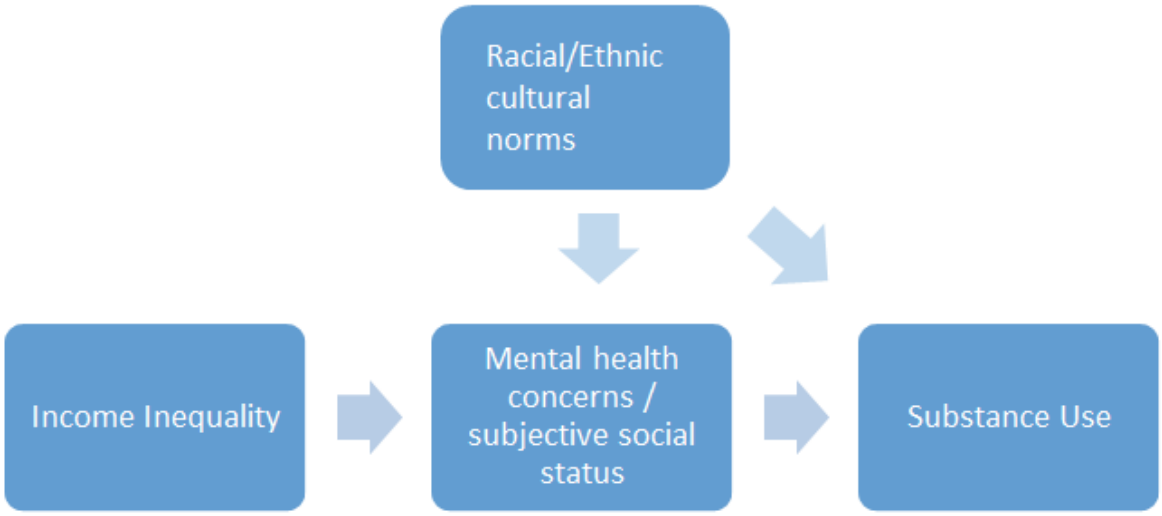

Figure 2. Directed acyclic graph (DAG) for substance use caused by income inequality.

3.1 Survey Data

The Monitoring the Future (MTF) survey has been conducted annually in the United States since 1975. The survey asks 8th, 10th, and 12th grade students, as well as college students and young adults, questions about substance use and other behaviors, as well as their social and political attitudes (University of Michigan, 2020). The survey employs multi-stage random sampling in which one or two schools are randomly selected from a specified geographic area, and classes within each school are randomly selected to participate. Each school may have up to 350 students included in the survey, and about 50,000 students are surveyed annually in public and private schools across the U.S (University of Michigan, 2020). Schools principals are contacted first to obtain permission to survey their students. Once this permission is granted, teachers are contacted and asked to introduce the survey to the students 10 days before the survey administration. Parents are informed through informative flyers

which also allow them to opt their child out of the study, and students are reassured that their participation is voluntary. The surveys are administered during regular class time, and students are reassured at every step of the confidentiality of their answers.

The present study utilized data from 12th grade students in all 50 states from 2012 to 2018. The following variables were used: U.S. region, regional Gini coefficient, legal age, sex, race/ethnicity, parents' education level, residence in a large or small metropolitan statistical area, students' future academic or career plans, and any substance use in the past 30 days. This study observed substance use rather than substance abuse - we looked at any use of 10 substances in the past 30 days, regardless of dose or legality. The time frame of 30 days serves to reduce the number of participants engaging in experimental or short term use, and increase the likelihood of capturing problematic, habitual use. Dichotomous recodes of 10 substance use variables were recoded again to have one binary variable for substance use, representing any use of the 10 substances in the past 30 days. Future academic and career plans were recoded into dichotomous variables. The race variable was recoded into dummy variables. Each survey cycle consists of 6 forms which ask different questions – 1 core form for all students, and 5 other forms which are distributed equally among students, so that each student completes a total of 2 forms. Each form is available as a single dataset. Of the available datasets from the survey, only the core datasets from each cycle were utilized for this study to ensure a sample size large enough to be nationally representative of all 3 racial and ethnic groups– doing so limited the variables that could be used in the model.

Regional household income inequality data was obtained from the United States Census Bureau's American Community Survey (ACS). The ACS is a continuous survey focusing on census tracts and block groups, in which monthly samples are used to create annual estimates. The survey includes detailed questions on education, housing, income, and other variables, and generally has a high

response rate because its completion is required by federal law. Region level household income inequality will be represented using the Gini coefficient, the most widely used measure of income inequality in the social sciences. The Gini coefficient ranges from 0 to 1, with 0 indicating perfect equality, and 1 indicating perfect inequality (United States Census Bureau, 2016).

3.2 Statistical Analysis

Statistical analyses were carried out using SAS 9.4. Frequencies for the chosen variables were calculated along with frequencies among students who answered the questions on substance use. Multi-variable logistic regression was carried out to determine the strength of the association between income inequality and substance use among 12th grade students in combination with the other variables listed above. The full model included the variables listed above and all their interactions, the reduced model was determined using backward selection. From the variables left after backwards selection, those that were not strongly related to the hypothesis according to the literature were removed from the model. After running the logistic regression, additional variables were dropped based on their contribution to the model. The final reduced model was used to determine the strength of the association between region level income inequality and substance abuse among Hispanic versus non-Hispanic adolescents. The results were used to determine the likelihood of substance use based on the regional Gini coefficient after controlling for the chosen covariates. It was hypothesized that substance use and income inequality are associated with the Gini coefficient, and that the association is weaker among Hispanic adolescents due to the cultural factors discussed in the literature review. A full description of each of the variables is found in the data dictionary in **Appendix A.**

Full Model:

SubstanceUse = gini + Sex + gini*Sex + MothersEducation + gini*MothersEducation + Sex*MothersEducation + FathersEducation + gini*FathersEducation + Sex*FathersEducation + MothersEducation*FathersEducation + FutPlan + gini*FutPlan + Sex*FutPlan + MothersEducation*FutPlan + FathersEducation*FutPlan + LargeMSA + gini*LargeMSA + Sex*LargeMSA + MothersEducation*LargeMSA + FathersEducation*LargeMSA + FutPlan*LargeMSA + SmallMSA + gini*SmallMSA + Sex*SmallMSA + MothersEducation*SmallMSA + FathersEducation*SmallMSA + FutPlan*SmallMSA + LargeMSA*SmallMSA + age + gini*age + Sex*age + MothersEducation*age + FathersEducation*age + FutPlan*age + LargeMSA*age + SmallMSA*age + Black + gini*Black + Sex*Black + MothersEducation*Black + FathersEducation*Black + FutPlan*Black + LargeMSA*Black + SmallMSA*Black + age*Black + White + gini*White + Sex*White + MothersEducation*White + FathersEducation*White + FutPlan*White + LargeMSA*White + SmallMSA*White + age*White + Black*White

Reduced Model:

SubstanceUse = gini + Sex + MothersEducation + FathersEducation + FutPlan + LargeMSA + Age + Black + White + Sex*FutPlan + Sex*age+ FutPlan*age + gini*White + LargeMSA*White + gini*FutPlan + gini*LargeMSA + FutPlan*LargeMSA

Chapter IV - Results

4.1 Descriptive Statistics

The total sample of participants from surveys from 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018 is 94,892. Of these participants, 92,959 participants provided answers for questions on substance use. Almost half are male and 57% are over the age of 18. Out of the 4 regions, most participants reside in the South (Table 1). 64.6% are white, 14.2% are Black, and 21.12% are Hispanic, frequencies which are proportionate to those of the general population (**Appendix C**).

Table 1
Sample Characteristics

		N	*Percent*	*Frequency Missing*
Sex				
	Male	42430	49.05	
	Female	44082	50.95	8380
Race				
	Black	10785	14.24	
	White	48965	64.64	
	Hispanic	15996	21.12	19146
Age				
	Under 18	38810	43.06	
	18 Or Older	51316	56.94	4766
Region				
	Northeast	18444	19.44	
	North Central	21561	22.72	
	South	33796	35.62	
	West	21091	22.23	0
Large MSA				
	Not	60790	64.06	
	Large MSA	34102	35.94	0
Small MSA				
	Not	17918	18.88	
	SMSA	76974	81.12	0
Future Plans				
	No	14027	16.31	
	Yes	71974	83.69	0
Father's Education				
	Grade School	4345	5.34	
	Some Hs	9809	12.06	
	Hs Grad	22495	27.67	
	Some College	14207	17.47	
	College Grad	19114	23.51	
	Grad School	11336	13.94	13586
Mother's Education				
	Grade School	3999	4.71	
	Some Hs	7137	8.4	
	Hs Grad	18575	21.86	
	Some College	17155	20.19	
	College Grad	25452	29.95	
	Grad School	12650	14.89	9924
Substance Use				
	No	51200	55.08	
	Yes	41759	44.92	1933

More than half (55.08%) of the participants did not currently use (in the past 30-days) any of the 10 categories of substances examined in this study: Cigarettes, alcohol, marijuana and hashish, LSD, other hallucinogens, amphetamines, sedatives and barbiturates, tranquilizers, inhalants, and narcotics. Of the almost 45% of participants who have used these substances in the past 30 days, most are White, over the age of 18 and reside in the South, mostly in small metropolitan statistical areas (SMSA). A majority of these participants have plans for college, vocational school, or the military (Table 2). By parents' education, the highest recent substance use was observed among participants whose fathers were high school graduates and whose mothers were college graduates, which correlates with the overall frequencies of parents' education seen in Table 1.

Among those who did engage in current substance use, 81% resided in small metropolitan statistical areas, 33% reside in the Southern region, 25% had fathers who were high school graduates, 28% had mothers who were college graduates, 58% were white, and 75% had plans to pursue academic or professional goals after high school.

Table 2

Prevalence of Substance Use by Sample Characteristics

		Substance Use N (%)			
		No	*Yes*	*Total*	*Missing*
Large MSA	*Yes*	17856 (19.21)	15306 (16.47)	33162 (35.67)	
	No	33344 (35.87)	26453 (28.46)	59797 (64.33)	
	Total	51200 (55.08)	41759 (44.92)	92959 (100)	1933
Small MSA	*Yes*	41328 (44.46)	33914 (36.48)	75242 (80.94)	
	No	9872 (10.62)	7845 (8.44)	17717 (19.06)	
	Total	51200 (55.08)	41759 (44.92)	92959 (100)	1933
Age	*Under 18*	21836 (24.26)	16921 (18.8)	38757 (43.07)	
	18 Or Older	27788 (30.88)	23445 (26.05)	51233 (56.93)	
	Total	49624 (55.14)	40366 (44.86)	89990 (100)	4902
Sex	*Male*	22489 (26.03)	19874 (23)	42363 (49.03)	
	Female	25141 (29.1)	18893 (21.87)	44034 (50.97)	
	Total	47630 (55.13)	38767 (44.87)	86397 (100)	8495
Region	*Northeast*	8939 (9.62)	9166 (9.86)	18105 (19.48)	
	North Central	11752 (12.64)	9328 (10.03)	21080 (22.68)	
	South	19004 (20.44)	13963 (15.02)	32967 (35.46)	
	West	11505 (12.38)	9302 (10.01)	20807 (22.38)	
	Total	51200 (55.08)	41759 (44.92)	92959 (100)	1933
Father's Education	*Grade School*	2582 (3.18)	1757 (2.16)	4339 (5.34)	
	Some High School	5165 (6.36)	4630 (5.7)	9795 (12.06)	
	High School Grad	12208 (15.03)	10266 (12.64)	22474 (27.67)	
	Some College	7544 (9.29)	6645 (8.18)	14189 (17.47)	
	College Grad	10639 (13.1)	8458 (10.41)	19097 (23.51)	
	Graduate School	6146 (7.57)	5180 (6.38)	11326 (13.94)	
	Total	44284 (54.52)	36936 (45.48)	81220 (100)	13672
Mother's Education	*Grade School*	2451 (2.89)	1542 (1.82)	3993 (4.7)	
	Some High School	3926 (4.63)	3201 (3.77)	7127 (8.4)	
	High School Grad	10105 (11.91)	8441 (9.95)	18546 (21.85)	
	Some College	9243 (10.89)	7895 (9.3)	17138 (20.19)	
	College Grad	13934 (16.42)	11494 (13.54)	25428 (29.96)	
	Graduate School	6704 (7.9)	5938 (7)	12642 (14.9)	
	Total	46363 (54.63)	38511 (45.37)	84874 (100)	10018
Race/Ethnicity	*Black*	6923 (9.15)	3822 (5.05)	10745 (14.2)	
	White	24773 (32.75)	24160 (31.94)	48933 (64.68)	
	Hispanic	9361 (12.37)	6611 (8.74)	15972 (21.11)	
	Total	41057 (54.27)	34593 (45.73)	75650 (100)	19242
Future Plans	*Yes*	40494 (47.14)	31406 (36.56)	71900 (83.7)	
	No	6914 (8.05)	7089 (8.25)	14003 (16.3)	
	Total	47408 (55.19)	38495 (44.81)	85903 (100)	8989

Income inequality in the 4 census regions of the United States from 2012 to 2018 is displayed in Table 3. If the alternative hypothesis is true, the levels of substance use will correlate with these values. Income inequality does not surpass a Gini coefficient of 0.5 and did not drop below 0.45 within the years examined in this study (2012-2018). On average, the most inequality (the highest Gini coefficient) was observed in the Northeast, followed by the South, the West, and finally the North Central region. We expected to see higher substance use in the Northeast, however as seen in Table 2, the highest rates were observed in the South.

Table 3

Gini Estimates by Region

Region	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*Average*
Northeast	0.4849	0.492	0.4923	0.4928	0.4921	0.4955	0.4858	0.490771
North Central	0.4575	0.4635	0.461	0.4634	0.4652	0.4633	0.4793	0.464743
South	0.4795	0.4827	0.4822	0.4841	0.4839	0.4835	0.466	0.480271
West	0.4703	0.4773	0.4765	0.4768	0.4784	0.4761	0.4958	0.478743

4.2 Logistic Regression

A multivariable logistic regression analysis was conducted to determine the relationship between the Gini coefficient of these regions and substance use among 12th graders. The Gini coefficient was a significant predictor, but had the largest standard error (SE=2.18) of any predictor in the model. All other predictors were also significant with p-values less than 0.01. The variables for the Gini coefficient, father's education, future plans, residence in a large MSA, age, being Black, being White, and the interactions between sex and future plans all had negative beta estimates, so that as they increase, the likelihood of current substance use decreases (Table 4).

Table 4

Analysis of Maximum Likelihood Estimates

Parameter	*DF*	*Estimate*	*Standard Error*	*Wald Chi-Square*	*Pr > ChiSq*
Intercept	1	5.0984	1.0435	23.8714	<.0001
Gini	1	-10.7434	2.1756	24.3845	<.0001
Sex	1	0.1448	0.0425	11.6158	0.0007
Mother's Education	1	0.0329	0.00662	24.7436	<.0001
Father's Education	1	-0.0404	0.00636	40.4205	<.0001
Future Plans	1	-2.8758	0.946	9.2419	0.0024
Small MSA	1	-2.5843	0.711	13.2131	0.0003
Age	1	-0.1277	0.0426	8.9824	0.0027
Black	1	-0.2173	0.0272	63.9934	<.0001
White	1	-6.1784	0.7435	69.0536	<.0001
Sex x Future Plans	1	-0.1316	0.0415	10.0551	0.0015
Sex x Age	1	0.1349	0.0299	20.2901	<.0001
Future Plans x age	1	0.176	0.0425	17.1864	<.0001
Gini x White	1	13.3789	1.5511	74.3981	<.0001
Small MSA x White	1	0.3255	0.0314	107.1897	<.0001
Gini x Future Plans	1	5.148	1.9734	6.8055	0.0091
Gini x Small MSA	1	5.0087	1.4836	11.3981	0.0007
Future Plans x Small MSA	1	0.2396	0.0468	26.1902	<.0001

Estimated odds ratios were also significant at a 0.01 p-value (Table 5) Odds ratios were compared across the Race/Ethnicity categories (Table 5). When compared to the overall model, the Gini coefficient was a less significant predictor for Hispanic participants with confidence intervals including 1.00 and a high p-value. Similar patterns were observed for Black and White participants in terms of lacking significance, but the estimated odds ratio for White participants was much higher than for any other group at 2.34 (CI 0.032, 170.112). The variable denoting Future Plans was a significant predictor with an estimated odds ratio of 0.662 (CI .610, .719).

Table 5

Odds Ratio Estimates for Substance Use by Race/Ethnicity

		OR	*95% Confidence Limits*		*p-Value*
All	*Gini*	<0.001	<0.001	0.002	<.0001
	Sex	1.156	1.063	1.256	0.0007
	Mother's Education	1.033	1.02	1.047	<.0001
	Father's Education	0.96	0.948	0.972	<.0001
	Future Plans	0.662	0.61	0.719	<.0001
	Small MSA	0.829	0.757	0.908	<.0001
	Age	0.88	0.81	0.957	0.0027
	Black	0.805	0.763	0.849	<.0001
	White	1.251	1.201	1.303	<.0001
Hispanic	*Gini*	0.002	<0.001	6.296	0.1331
	Sex	1.062	0.917	1.231	0.4213
	Mother's Education	1.053	1.032	1.076	<.0001
	Father's Education	0.979	0.959	0.999	0.0432
	Future Plans	0.573	0.495	0.662	<.0001
	Small MSA	0.857	0.748	0.983	0.0273
	Age	0.792	0.684	0.917	0.0018
	Black	1	.	.	.
	White	1	.	.	.
Black	*Gini*	<0.001	<0.001	1.897	0.0614
	Sex	1.3	0.997	1.694	0.0525
	Mother's Education	0.989	0.951	1.029	0.5967
	Father's Education	0.947	0.91	0.985	0.0071
	Future Plans	0.72	0.549	0.944	0.0174
	Small MSA	1.009	0.774	1.314	0.9476
	Age	1.03	0.789	1.345	0.8271
	Black	1	.	.	.
	White	1	.	.	.
White	*Gini*	2.339	0.032	170.112	0.6976
	Sex	1.205	1.08	1.344	0.0008
	Mother's Education	1.022	1.003	1.041	0.024
	Father's Education	0.946	0.93	0.963	<.0001
	Future Plans	0.718	0.644	0.8	<.0001
	Small MSA	1.05	0.925	1.192	0.4532
	Age	0.903	0.809	1.008	0.0699
	Black	1	.	.	.
	White	1	.	.	.

4.3 Goodness of Fit Tests

The concordance (c) statistic, which ranges from 0.05 to 1.0, is the probability that an observed case will have a higher probability of being classified as a case than an observed control (Austin and Streyerberg, 2012). For this model, the c statistic is 0.581, meaning that a participant who has engaged in substance use in the past 30 days has a probability of 0.581 for being classified as such than a participant who did not engage in substance use. The corresponding ROC curve is included in **Appendix B**. The Hosmer and Lemeshow Goodness of Fit test resulted in a chi-square value of 28.7 with a p-value of 0.0008, revealing a significant difference between the model's predictions and the actual observed outcomes. A summary of the goodness of fit tests is provided in Table 6. These tests for fitness demonstrate poor fit of the model to the data and poor predictive power despite the statistical significance of all predictors in the model, perhaps pointing to additional confounders that were not included in the model or were not measured. We were therefore unable to reject the null hypothesis that there is no association between the regional Gini coefficient and substance use among 12th grade students in the U.S., or that this association is not different for Hispanic students. Further research is needed to determine whether the Gini coefficient has different associations with substance use by race and ethnicity.

Table 6

Goodness of Fit Tests

Model	*# of Parameters*	*C-statistic*	*Hosmer-Lemeshow: Chi-Square (p-value)*
Simple	1	0.508	131.6791 (<.0001)
Full	55	0.584	16.6393 (0.0341)
Reduced	17	0.581	26.7356 (0.0008)

Chapter V – Discussion

5.1 Summary and Implications

The study was conducted to determine the effects of regional income inequality on current substance use among 12th grade students in the United States, and to determine the presence of racial disparities in that association. The hypothesis was that the association between income inequality and substance use would not be as strong for Hispanic students when compared to all students, due to protective factors that come with cultural differences such as stronger emphasis on family and community.

A nationwide, cross sectional survey on substance use obtained from the University of Michigan, and Gini coefficients obtained from the U.S. Census Bureau, were used to test this hypothesis using multivariable logistic regression. The regression analysis showed a negative association between the Gini coefficient and current substance use after controlling for age, sex, race, parents' education, residence in a small metropolitan statistical area, and various interactions between these variables. After fitting the model for race, the association between the Gini coefficient and substance use changed, suggesting that race/ethnicity may be a moderating factor. However, due to the poor fit of the model to the data as understood through the goodness of fit tests, this model is not sufficient for accurate prediction of substance use based on regional income inequality. Because the factors included were all statistically significant, the model may be improved with the inclusion of additional and more specific factors.

5.2 Strengths and Limitations

The strengths of this study include its large sample size, randomized, nationwide, cluster sampling, and accuracy of geographic classifications (MSAs). The Gini coefficients can be assumed to be accurate as they were directly obtained from the Census Bureau.

The weaknesses in this study include selection bias, lack of specification of type and method of substance use, and the simplification of certain variables such as race and ethnicity, and future plans. Selection bias occurs when the sample selected for the study systematically excludes an important part of the population. In the case of this study, the survey is only including students at schools and excludes the nearly 695,000 teens aged 16-19 that were not in school nor high school graduates in 2018 alone (The Annie E. Casey Foundation, 2020). This is an especially significant portion of the population to exclude from such models because adolescents not in school are more likely to struggle with substance use and poverty (Maynard, Vaughn, Salas-Wright, 2015). Limiting the substance use variable to use in the past 30 days was intended to exclude experimental use and capture those who regularly engage in substance use. This study took 10 dichotomous variables for substance use in the past 30 days and combined them into one variable for any substance use in the past 30 days. This approach can put someone who took a few sips of alcohol in the past 30 days in the same group of cases as someone who struggles with alcohol addiction. A stratified analysis would likely reveal which cases of substance use are more or less strongly associated with regional income inequality. Another issue concerning disaggregation is the lack of racial and ethnic groups to classify participants. Public use records only display data by Black, White, Hispanic, and Other. Because the hypothesis assumed that cultural values and practices would act as protective factors for Hispanic participants, the diversity of Hispanic populations in the US was overlooked and the participants were homogenized for the purpose of the study, erasing key cultural differences. Similarly, the variable for future plans simplified a complicated variable about the likelihood of four possibilities after high school into a binary response. The variable likely does not capture the true number of participants who have future plans which serve as protective factors against substance use.

Additionally, using large geographic areas for analysis increases the likelihood of error and the exclusion of confounding factors from the model. Using a smaller geographic area, such as a census tract

or neighborhood, would allow more precise analysis of the effects of income inequality on health outcomes.

Chapter VI – Conclusion

We were unable to reject the null hypothesis or draw any conclusions on the association between substance use and income inequality. While the literature supports a positive association in various contexts, there is not enough evidence to suggest either a positive or a negative association in the present study.

The low predictive and explanatory power of the model further underscores the complex etiology of substance use. While multiple factors were considered significant, more research is needed on the true environmental and contextual predictors of substance use, and how cultural factors can either serve as protection or exacerbate risk. Further research should consider more precise factors of culture and mental health as factors in building resilience to the effects of income inequality such as increased substance use. The model may be improved by addressing the weaknesses mentioned in the Discussion - using more specific variables and smaller geographic areas for analysis.

Despite the poor fit of the model, the disaggregated odds ratios revealed significant differences among odds of substance use by race and ethnicity. Continuing to research the impacts of race and ethnicity on health may reveal opportunities for programs and policies specific to racial and ethnic groups who may have been historically overlooked. Understanding the harms and benefits associated with acculturation will help health professionals to better serve minority communities and alleviate racial and ethnic health disparities.

Disclaimer – The author declares no conflict of interest.

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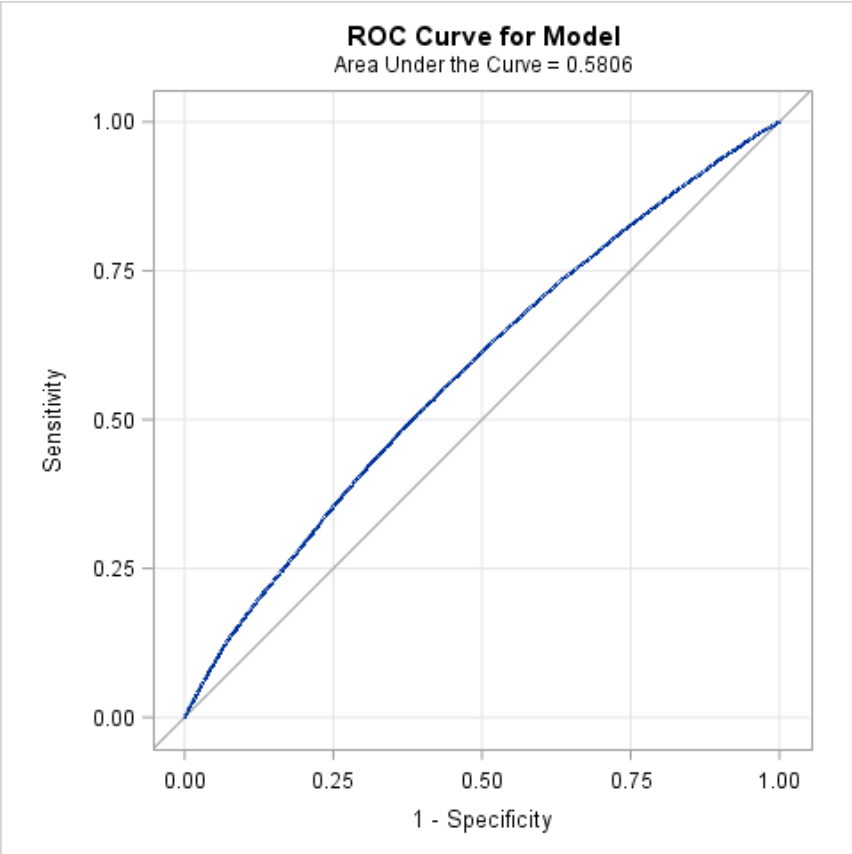
Appendix A

Data Dictionary

Variable	***Descrpition***
SubstanceUse	Dichotomous variable for any substance use in the past 30 days of the following: Cigarettes, alcohol, marijuana or hashish, LSD, psychedelics, amphetamines, sedatives, tranquilizers, inhalants, and narcotics.
Gini	Household income inequality per region per year
Usgini	Household income inequality in the US per year
Black	Participants identifying as Black
White	Participants identifying as White
Hispanic	Participants identifying as Hispanic
Northeast	Northeast region of the United States, including the following states: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania
NorthCentral	North Central region of the United States including the following states: Ohio, Michigan, Indiana, Illinois, Wisconsin, Missouri, Iowa, Minnesota, Kansas, Nebraska, South Dakota, North Dakota
South	Southern region of the United States including the following states: Delware, Maryland, Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas
West	Western region of the United States including the following states: Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, Utah, Colorado, Arizona, New Mexico.
Sex	Participant's sex
FathersEducation	Education level of the participant's father
MothersEducation	Education level of the participant's mother
FutPlan	Dichotomous variable for paticipant's plans to attend vocational school, a 2-year college, a 4-year college, or to join the military
LargeMSA	Participant's residence in a large metropolitan statistical area
SmallMSA	Participant's residence in a small metropolitan statistical area
age	Dichotmous variable for participant's age as above or below 18 years.

Appendix B

Goodness of Fit Tests for Final Reduced Model



Partition for the Hosmer and Lemeshow Test					
Group	***Total***	***SubstanceUse = 1***		***SubstanceUse = 0***	
		Observed	***Expected***	***Observed***	***Expected***
1	7652	2695	2683.73	4957	4968.27
2	7645	2896	2952.43	4749	4692.57
3	7651	3051	3073.99	4600	4577.01
4	7647	3206	3197.45	4441	4449.55
5	7649	3358	3348.8	4291	4300.2
6	7650	3503	3473.46	4147	4176.54
7	7638	3670	3609.89	3968	4028.11
8	7648	3904	3815.13	3744	3832.87
9	7653	3958	4136.13	3695	3516.87
10	7642	4570	4520.04	3072	3121.96

Appendix C

Table of racial and ethnic frequencies by generation in the United States

TABLE 1

US race-ethnic profiles of major generations, 2018

	White*	Black*	Asian	AIAN**	2+ Races*	Hispanic	TOTAL
Gen Z	50.9	13.8	5.3	0.8	4.1	25.0	100.0
Millennials	55.1	13.8	7.2	0.8	2.2	20.9	100.0
Gen X	59.7	12.6	6.9	0.7	1.4	18.8	100.0
Baby Boomers	71.6	11.0	5.0	0.7	1.0	10.8	100.0
Earlier Gens	78.0	8.4	4.4	0.5	0.7	8.0	100.0

Note: Ages for generations in 2018 are Gen Z (ages 0-21), Millennials (22-37), Gen X (38-53), Baby Boomers (54-72), and earlier generations (73 and above).
* Non-Hispanic members of racial group
** American Indians and Alaska Natves (Non-Hispanic)

Source: William H Frey analysis of US Census population estimates released June 20, 2019

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