

A comprehensive multivariate model of biopsychosocial factors associated with opioid misuse and use disorder in a 2017-2018 United States national survey

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Abstract

Background: Few studies have comprehensively and contextually examined the relationship of variables associated with opioid use. Our purpose was to fill a critical gap in comprehensive risk models of opioid misuse and use disorder in the United States by identifying the most salient predictors.

Methods: A multivariate logistic regression was used on the 2017 and 2018 National Survey on Drug Use and Health, which included all 50 states and the District of Columbia of the United States. The sample included all noninstitutionalized civilian adults aged 18 and older (N=85,580; weighted N=248,008,986). The outcome of opioid misuse and/or use disorder was based on reported prescription pain reliever and/or heroin use dependence, abuse, or misuse. Biopsychosocial predictors of opioid misuse and use disorder in addition to sociodemographic characteristics and other substance dependence or abuse were examined in our comprehensive model. Biopsychosocial characteristics included socioecological and health indicators. Criminality was the socioecological indicator. Health indicators included self-reported health, private health insurance, psychological distress, and suicidality. Sociodemographic variables included age, sex/gender, race/ethnicity, sexual identity, education, residence, income, and employment status. Substance dependence or abuse included both licit and illicit substances (i.e., nicotine, alcohol, marijuana, cocaine, inhalants, methamphetamine, tranquilizers, stimulants, sedatives).

Results. The comprehensive model found that criminality (adjusted odds ratio [AOR]=2.58, 95% confidence interval [CI]=1.98-3.37, $p<0.001$), self-reported health (i.e., excellent compared to fair/poor [AOR=3.71, 95%CI=2.19-6.29, $p<0.001$], good [AOR=3.43, 95%CI=2.20-5.34, $p<0.001$], and very good [AOR=2.75, 95%CI=1.90-3.98, $p<0.001$]), no private health insurance (AOR=2.12, 95%CI=1.55-2.89, $p<0.001$), serious psychological distress (AOR=2.12, 95%CI=1.55-2.89, $p<0.001$), suicidality (AOR=1.58, 95%CI=1.17-2.14, $p=0.004$), and other substance dependence or abuse were significant predictors of opioid misuse and/or use disorder. Substances associated were nicotine (AOR=3.01, 95%CI=2.30-3.93, $p<0.001$), alcohol (AOR=1.40, 95%CI=1.02-1.92, $p=0.038$), marijuana (AOR=2.24, 95%CI=1.40-3.58, $p=0.001$), cocaine (AOR=3.92, 95%CI=2.14-7.17, $p<0.001$), methamphetamine (AOR=3.32, 95%CI=1.96-5.64, $p<0.001$), tranquilizers (AOR=16.72, 95%CI=9.75-28.65, $p<0.001$), and stimulants (AOR=2.45, 95%CI=1.03-5.87, $p=0.044$).

Conclusions. Biopsychosocial characteristics such as socioecological and health indicators, as well as other substance dependence or abuse were stronger predictors of opioid misuse and use disorder than sociodemographic characteristics.

Background

Estimates indicate that up to 29% of persons misuse prescription pain relievers for chronic pain,[1] and between 8 to 12% develop a use disorder.[2, 3] The United States (US) Department of Health and Human Services declared the opioid crisis a public health emergency in 2017, although the first wave of the epidemic can be traced to the 1990s.[3] In 2016 alone, the record numbers of opioid misuse and overdose death provided a stark realization of how the epidemic has become a public health crisis.[2] For instance, opioid related deaths increased 345% between 2001 to 2016.[4] Subsequently, between July 2016 and September 2017 deaths due to illicit opioids overdose deaths increased by 30% leading to emergency declaration in 45 states.[4]

Projections revealed that if current prevention and intervention strategies do not change by 2025, the rate of misuse and overdose death will rise by 61%.[5] In response to the epidemic, multiple federal, state, and local agencies have implemented various strategies to address the opioid crisis. Current interventions such as increasing availability of naloxone are projected to result in approximately a 4% reduction in opioid-related deaths.[6] Similar interventions like reduced prescribing for pain patients and excess opioid management can increase life years and quality-adjusted life years, but overdose deaths would increase among those with opioid dependence due to a move from prescription opioids to heroin.[6] Overall, these strategies are found to have minimal impact preventing only 3.0% to 5.3% of overdose deaths.[5]

Studies by Chen and colleagues[5] and Pitt and colleagues[6] have further revealed that current universal interventions are not enough to address the multidimensional and dynamic aspects of the opioid epidemic. Improving universal opioid prevention strategies to more tailored approaches has been suggested.[7] Non-Hispanic whites, for instance, have become the primary focus for multiple prevention programs and strategies as they have been found to misuse opioid at greater rates.[8-10] However, multiple racial/ethnic groups have been found to be affected by opioid misuse and are at differential risk.[8-10] Other racial/ethnic groups found to experience high disparities in misuse and related outcomes include American Indian/Alaska Natives[8], Asians[11], and Hispanics.[12] As such, these epidemiological studies have revealed a possible racial/ethnic disparity.

Opioid misuse and/or use disorder are also linked to multiple risk factors not limited to race and ethnicity. Scholl et al.[9] revealed a complex relationship between sociodemographic factors and opioid misuse where age was a significant indicator, particularly among younger age groups. The current opioid misuse and/or use disorder literature has also found that the relationships of race/ethnicity and age are not strong predictors for misuse when considered in the context of other biopsychosocial factors. Other sociodemographic factors like sex/gender must

be considered. For instance, Nicholson and Vincent [13] observed that the prevalence of prescription opioid misuse varied among Black women and men. Specifically, Black women with lower socioeconomic status had an increased the probability of misuse, while older age, higher educational attainment, and rural residence were associated with a lower probability.[13] Although men have been found to be more likely to misuse opioids at the population level, women in certain cases have been found to be at higher odds of misuse.[14-16] For example, Serdarevic, Striley, and Cottler [15] found women to have higher rates of lifetime prescription opioid use when compared to men.

Other biopsychosocial factors like criminality and sexual identity, although understudied, have been associated with misuse and/or use disorder. Individuals with criminality or involvement with the legal system had a prevalence of 22.4% for prescription opioid use, 33.2% for prescription opioid misuse, 51.7% for prescription opioid use disorder, and 76.8% for heroin use.[17] Similarly, Pierce et al. [18] found that, when adjusting for cocaine use, sex/gender, age, and birth cohort, individuals testing positive for opioid use had higher rates of criminality. Sexual minorities, such as those identifying as gay/lesbian or bisexual, have also been situationally reported to be at risk of opioid misuse. [19-21]. For instance, Duncan et al. [19] found that those identifying as bisexual or gay/lesbian were at 78% or 115% increased odds for opioid misuse than heterosexuals, respectively.

When considering opioid misuse and/or use disorder general health and health access have been found to have a role, although it is not clearly understood outside the context of physical pain or noninstitutionalized populations. Nicholson et al. [13] found that those who identified as being in poor health were more likely to misuse opioids. The relationship between opioid misuse and use disorder in the context of mental health is unclear. Epidemiological studies have not focused solely on the role of mental health indicators such as depression, anxiety, or suicidality. Opioid misuse and/or use disorder have been found to be associated with severe mental illness [22, 23] and suicidality [23-25]. Health insurance has also been identified as having a role in opioid misuse, but the relationship is not well defined. Schatman [26] argues that health insurance companies may perpetuate suboptimal pain management that facilitates opioid misuse whereby health insurance may in turn facilitate opioid misuse. On the other hand, Wettstein [27] observed a dose-response relationship with access to insurance on opioid overdose deaths in which an increase of health insurance coverage among young adults reduced opioid related deaths.

The role of other substance dependence, abuse, and/or misuse, whether legal, illicit, or prescribed, has also been linked to opioid misuse and/or use disorder. Concurrent substance use such as nicotine and tobacco dependence [28, 29], alcohol [30], sedatives [31], methamphetamines [32], tranquilizers [33-35], other analgesics [36], and marijuana [37] have been positively associated with opioid misuse and use disorder [37, 38]. Marijuana may be context dependent as it has a mixed relationship with opioid use, misuse, and use disorder.[39] Medical cannabis use, specifically, has been suggested to reduce opioid use in general, and may also reduce opioid overdose deaths in states with medical cannabis laws.[39]

While epidemiologic studies have examined the relationship of various risk factors on opioid misuse and use disorder among non-institutionalized populations, comprehensive models are relatively absent. To ameliorate the effect of the opioid epidemic, we must identify the risk factors associated with the etiology of misuse to intervene and prevent the distal events of use disorder like overdose. Secondly, it is crucial to understand biopsychosocial characteristics in the presence of multiple sociodemographic factors and other substance dependence or abuse that underpin the risk profiles of misuse and use disorder at the population-level in order to stem overdose deaths. Biopsychosocial characteristics for our research purposes include socioecological (e.g., criminality) and health factors (e.g., self-reported general health; mental health, suicidality; access to health services). Therefore, to understand what factors are contributing to the increasing opioid epidemic, we comprehensively examined the relationship of opioid misuse and/or use disorder and biopsychosocial characteristics using four domains: (1) sociodemographic factors; (2) socioecological factors; (3) health factors; and (4) other substance dependence or abuse. We took this approach to determine the most salient risk factors for opioid misuse and/or use disorder in a representative, noninstitutionalized US adult sample.

We hypothesized that sociodemographic factors, while crucial to the comprehensive risk model, would not be critical predictors when included with socioecological and health factors, or other substance dependence or abuse. The purpose of this study was to add to a critical gap in the literature to improve population-level prevention strategies by identifying the most salient predictors of opioid misuse and/or use disorder.

Methods

We used multivariate logistic regression on the combined 2017[40] and 2018[41] National Survey on Drug Use and Health (NSDUH) to examine the relationship of biopsychosocial characteristics and opioid misuse and/or use disorder. Opioid misuse was characterized as heroin use and/or prescription pain reliever misuse in the past year based on NSDUH definitions.[42] Individuals taking prescribed pain relievers may develop a tolerance to pain relief that can lead to taking the prescription at higher doses and/or more frequently, which would constitute misuse.[42] Furthermore, heroin was included with misuse as any opioid creates the same adverse effects as prescription pain relievers, which in turn may develop into opioid use disorder.[42] Use disorder was characterized by heroin use disorder, prescription pain reliever use disorder, or heroin and prescription pain reliever use disorder as they may not be mutually exclusive in the NSDUH.[42]

Biopsychosocial characteristics, as well as sociodemographic and other substance dependence or abuse were tested independently in unadjusted models. Adjusted models were then built using a block entry method to test biopsychosocial characteristics on opioid misuse and/or misuse disorder in the following order: (Model 1) sociodemographic indicators; (Model 2) socioecological indicator; (Model 3) health indicators; and (Model 4) other substance dependence or abuse. All variables were retained as controls and covariates in subsequent models. We accounted for the complex survey design of the NSDUH by the strata and clusters provided, as well as adjusting the analytical weights to account for two years. All analyses were conducted on Stata 16 (StataCorp LLC, College Station, TX). The study received exemption from the Institutional Review Board as no human participants were involved in this research. The analysis was not pre-registered, and the results should be considered exploratory.

Sociodemographic variables and factors. Five age categories were used: (1) 18 to 25; (2) 26 to 34; (3) 35 to 49; (4) 50 to 64; and (5) 65 and older. The binary category of male and female was used for sex/gender. Race/ethnicity was divided into seven categories: (1) non-Hispanic white; (2) non-Hispanic Black/African American; (3) non-Hispanic Native American/Alaska Native; (4) non-Hispanic Native Hawaiian/other Pacific Islander; (5) non-Hispanic Asian; (6) non-Hispanic more than one race; and (7) Hispanic. Sexual identity had three categories: (1) heterosexual; (2) gay/lesbian; and (3) bisexual. Place of residence was based on 2009 Core-Based Statistical Areas (CBSAs) defined by the Office of Management and Budget[43]: (1) CBSA with 1 million or more persons; (2) CBSA with fewer than 1 million persons; and (3) segment not in a CBSA. Total family income was divided into four categories: (1) less than \$20,000; (2) \$20,000 to \$49,999; (3) \$50,000 to \$74,999; and (4) \$75,000 or more. Employment status was divided into five categories: (1) full-/part-time job; (2) unemployed; (3) retired; (4) disabled; and (5) other which included keeping house full time and in school/training. Educational attainment was divided into four categories: (1) less than high school; (2) high school graduate; (3) some college/associate's degree; and (4) college graduate.

Socioecological factors. Criminality was assessed if the participant had been arrested and booked for breaking the law; excluding minor traffic violations. Booked was defined as taken into custody and processed by the legal system, even if later released.

Health factors. Health factors included overall perceived health and having access to private health insurance, and included mental health indicators as well. Overall self-reported health was categorized as: (1) excellent; (2) very good; (3) good; and (4) fair/poor. The private health insurance category was based on if respondent had obtained it through: (1) employment by paying premiums to an insurance company; (2) the Health Insurance Marketplace; or (3) a health maintenance organization (HMO), fee-for-service plans, or single-service plans. Mental health indicators were assessed by severe psychological distress and suicidality. A severe psychological distress indicator within the past year was based on responses from past-month Kessler-6 (K6) items and the worst month in the past-year K6 items. K6 items are from a screening instrument for nonspecific psychological distress developed by Furukawa, Kessler, Slade, and Andrews,[44] and Kessler et al.[45] The K6 measures how frequently participants experience psychological distress during the past 30 days and during a month in the past year where they felt more depressed, anxious, or emotionally stressed than in the past month. Participants who had a score of 13 and above were in severe psychological distress. Suicidality was assessed if at any time in the past year a participant had seriously thought about trying to commit suicide.

Substance misuse, dependence, and/or abuse factors. Opioid misuse and/or use disorder was defined as misuse and/or dependence or abuse of prescription pain relievers and/or heroin use in the past year. Respondents were defined as having past year opioid misuse if they reported heroin use, prescription pain relievers misuse, or both heroin use and prescription pain reliever misuse during this time period based on NSDUH methodology and terminology. Opioid use disorder was classified using the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) criteria for dependence or abuse criteria based on heroin use disorder, prescription pain reliever use disorder, or heroin and prescription pain reliever use disorder in the past year based on NSDUH methodology and terminology [See <https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/NSDUHMethodsSummDefs2018/NSDUHMethodsSummDefs2018.pdf>]. Respondents were not counted as having opioid use disorder if they did not meet the full dependence or abuse criteria individually for either heroin or prescription pain relievers. While opioid substance use disorder was classified under the DSM-V, the NSDUH used the DSM-IV criteria of dependence or abuse, as such we opted to use the DSM-V terminology.[15,18] Nicotine dependence in the past month was assessed using Nicotine Dependence Syndrome Scale scores and the Fagerstrom Test of Nicotine Dependence scale in the past month. Alcohol dependence and abuse in the last year was also ascertained. Dependence and abuse in the past year for the following substances were also determined: marijuana, cocaine, hallucinogens, inhalants, methamphetamine, tranquilizers, stimulants (i.e., independent of methamphetamine), and sedatives.[46]

Statistical Analysis

We performed descriptive analyses to detail the characteristics of NSDUH sample participants. We checked the data for normality of the residuals, homoscedasticity, multicollinearity, outliers and influence. After the data were found to be adequate for the logistic regression model, four weighted multivariate models were built using Stata survey procedure. All models were weighted and accounted for clustering and

stratification of the complex survey design. All findings are reported in odds ratios (ORs) or adjusted odds ratios (AORs) using a 95% confidence interval (CI) and *p*-value for significance criteria.

Results

Sample Characteristics

The sample consisted of 85,580 individuals (weighted *N* = 248,008,986) over the age of 18. Male and female participants were represented about equally—48% male (weighted *N* = 119,711,438) and 52% female (weighted *N* = 119,711,438). The majority of the weighted sample was non-Hispanic white (63.6%), resided in a high population density CBSA (54.1%), identified as heterosexual (94.8%), had a family income of \$75,000 or more (38.9%), were college graduates (32.1%), were employed (62.7%), had no history of arrest and booking (83.4%), were in very good health (36.1%), had private health insurance (66.6%), had no serious psychological distress in past year (88.6%), and displayed no suicidality (95.7%). See Table 1 for a detailed breakdown of the sample’s characteristics.

Table 1. Descriptive characteristics of biopsychical indicators using the 2017-2018 NSDUH (N=85,580; Weighted N=248,008,986)

	N	Weighted N	%
Age Groups			
18-25 years old	27,477	34,171,330	13.8%
26-34 years old	17,580	39,791,188	16.0%
35-49 years old	22,902	61,084,084	24.6%
50-64 years old	9,935	62,285,999	25.1%
65 or older	7,686	50,676,385	20.4%
Sex/Gender			
Male	40,156	119,711,438	48.3%
Female	45,424	128,297,548	51.7%
Race/Ethnicity			
Non-Hispanic White	51,704	157,708,305	63.6%
Non-Hispanic Black/African American	10,630	29,520,476	11.9%
Native American/Alaska Native	1,220	1,387,749	0.6%
Native Hawaiian/other Pacific Islander	417	939,268	0.4%
Non-Hispanic Asian	4,190	14,061,853	5.7%
Non-Hispanic more than one race	2,786	4,250,536	1.7%
Hispanic	14,633	40,140,798	16.2%
Area of Residence by Population Density			
Segment in a CBSA > 1 million	36,272	134,292,992	54.1%
Segment in a CBSA < 1 million	42,433	99,166,152	40.0%
Segment not in a CBSA	6,875	14,549,842	5.9%
Sexual Identity			
Heterosexual, i.e., straight	77,811	230,292,107	94.8%
Lesbian or gay	1,884	4,774,123	2.0%
Bisexual	4,204	7,875,005	3.2%
Family Income			
Less than \$20,000	16,488	39,520,535	15.9%
\$20,000-\$49,999	26,460	72,948,368	29.4%
\$50,000-\$74,999	13,376	38,994,110	15.7%
\$75,000 or more	29,256	96,545,973	38.9%
Level of Education			
Less than high school	10,832	30,482,047	12.3%
High school graduate	22,532	61,032,429	24.6%
Some college/associate's degree	28,608	76,994,245	31.0%
College graduate	23,608	79,500,265	32.1%
Employment Status (past week)			
Employed full/part-time	57,686	153,914,559	62.7%
Unemployed	4,840	10,241,227	4.2%
Retired	6,329	41,374,848	16.9%
Disabled	3,035	11,545,013	4.7%
Other	12,717	28,404,275	11.6%
Ever Arrested and Booked			
No	70,625	205,996,442	83.4%
Yes	14,628	41,013,634	16.6%
Overall Health Status			
Fair/poor	9,675	34,313,374	13.8%
Good	23,960	72,114,751	29.1%
Very good	32,368	89,447,218	36.1%
Excellent	19,555	52,070,096	21.0%
Covered by Private Health Insurance			
No	30,721	82,568,583	33.4%
Yes	54,422	164,350,599	66.6%
Serious Psychological Distress Indicator (past year)			
No	72,141	219,851,056	88.6%
Yes	13,439	28,157,930	11.4%
Suicidality (past year)			
No	79,598	235,697,531	95.7%
Yes	5,327	10,703,135	4.3%

Of the sample, 865 individuals (weighted $N = 1,976,471$) reported opioid misuse. Other substances that the sample had dependence on or abused were nicotine, alcohol, marijuana, cocaine, inhalants, methamphetamine, tranquilizers, stimulants, hallucinogens, and sedatives. See Table 2 for a complete report of the sample's substance dependence and abuse profile.

Table 2. Descriptive characteristics of substance dependence or abuse from the 2017-2018 NSDUH (N=85,580; Weighted N=248,008,986)

	N	Weighted N	%
Nicotine dependence (past month)			
No	75,397	221,362,313	89.26%
Yes	10,183	26,646,673	10.74%
Alcohol dependence or abuse (past year)			
No/Unknown	79,239	133,842,026	94.29%
Yes	6,341	14,166,959	5.71%
Marijuana dependence or abuse (past year)			
No/Unknown	83,439	244,355,720	98.53%
Yes	2,141	36,532,266	1.47%
Cocaine dependence or abuse (past year)			
No/Unknown	85,147	247,063,145	99.62%
Yes	433	945,841	0.38%
Inhalant dependence or abuse (past year)			
No	85,535	247,914,187	99.96%
Yes	45	94,798	0.04%
Methamphetamine dependence or abuse (past year)			
No	85,146	246,985,929	99.59%
Yes	434	1,023,057	0.41%
Tranquilizer dependence or abuse (past year)			
No	85,260	247,362,108	99.74%
Yes	320	646,877	0.26%
Stimulant dependence or abuse (past year)			
No	85,309	247,499,633	99.79%
Yes	271	509,353	0.21%
Sedative dependence or abuse (past year)			
No	85,519	247,855,708	99.94%
Yes	61	153,278	0.06%
Opioid dependence or abuse (past year)			
No	84,715	246,032,515	99.20%
Yes	865	1,976,471	0.80%

Logistic Regression

Independent unadjusted models. All sociodemographic and biopsychosocial characteristics, as well as other substance dependence or abuse were tested independently in unadjusted models to examine the relationship of each characteristic on opioid misuse. All characteristics tested with exception of residence at some level were found to be a significant factor predictive of opioid misuse. See Table 3 for all associations.

Table 3. Odds ratios, 95% confidence intervals, and p-values of independent biopsychosocial indicators and other substance dependence or abuse on opioid misuse: 2017-2018 National Survey on Drug Use and Health

	95% CI			
	OR	Lower	Upper	p-value
Age				
18-25 years old	6.55	3.10	13.83	0.000
26-34 years old	7.97	3.77	16.84	0.000
35-49 years old	4.95	2.33	10.52	0.000
50-64 years old	4.86	2.35	10.04	0.000
65 years and older	ref.	-	-	-
Sex/Gender				
Male	1.43	1.14	1.80	0.003
Female	ref.	-	-	-
Race/Ethnicity				
Non-Hispanic White	5.15	2.31	11.46	0.000
Non-Hispanic Black/African American	3.95	1.60	9.77	0.004
Native American/Alaska Native	8.64	3.28	22.75	0.000
Native Hawaiian/Pacific Islander	3.39	0.65	17.61	0.142
Non-Hispanic more than one race	7.48	2.84	19.65	0.000
Hispanic	3.18	1.42	7.12	0.006
Non-Hispanic Asian	ref.	-	-	-
Sexual Identity				
Lesbian or gay	1.21	0.70	2.08	0.484
Bisexual	2.70	1.89	3.84	0.000
Heterosexual, i.e., straight	ref.	-	-	-
Educational attainment				
Less than high school	4.01	2.54	6.34	0.000
High school grad	3.55	2.30	5.49	0.000
Some college/associate's degree	2.75	1.79	4.24	0.000
College graduate	ref.	-	-	-
Family Income				
Less than \$20,000	3.55	2.57	4.91	0.000
\$20,000-\$49,999	1.95	1.44	2.64	0.000
\$50,000-\$74,999	1.56	1.08	2.26	0.020
\$75,000 or more	ref.	-	-	-
Population Density				
Segment in a CBSA > 1 million	0.80	0.55	1.17	0.248
Segment in a CBSA < 1 million	0.99	0.69	1.40	0.936
Segment not in a CBSA	ref.	-	-	-
Employment (past week)				
Employed full/part-time	ref.	-	-	-
Unemployed	4.23	3.11	5.76	0.000
Retired	0.29	0.14	0.59	0.001
Disabled	4.10	2.88	5.84	0.000
Other	1.85	1.44	2.37	0.000
Arrested and Booked for Breaking the Law				
No	ref.	-	-	-
Yes	7.73	6.18	9.68	0.000
Overall Health Status				
Fair/Poor	10.70	7.25	15.78	0.000
Good	6.15	4.17	9.05	0.000
Very Good	3.52	2.49	4.96	0.000
Excellent	ref.	-	-	-
Serious Psychological Distress in Past Year				
No	ref.	-	-	-
Yes	9.15	7.55	11.08	0.000
Suicidality in Past Year				
No	ref.	-	-	-
Yes	8.14	6.61	10.04	0.000
Private Health Insurance				
No	4.14	3.34	5.14	0.000
Yes	ref.	-	-	-
Nicotine Dependence (past month)				
No	ref.	-	-	-
Yes	10.46	8.44	12.96	0.000
Alcohol Dependence or Abuse (past year)				
No/Unknown	ref.	-	-	-
Yes	5.80	4.72	7.13	0.000

Marijuana Dependence or Abuse (past year)				
No/Unknown	ref.	-	-	-
Yes	12.82	9.33	17.62	0.000
Cocaine Dependence or Abuse (past year)				
No/Unknown	ref.	-	-	-
Yes	45.16	31.87	64.00	0.000
Inhalant Dependence or Abuse (past year)				
No	ref.	-	-	-
Yes	51.00	18.24	142.58	0.000
Methamphetamine Dependence or Abuse (past year)				
No	ref.	-	-	-
Yes	51.88	36.77	73.21	0.000
Tranquilizer Dependence or Abuse (past year)				
No	ref.	-	-	-
Yes	145.51	112.02	189.02	0.000
Stimulant Dependence or Abuse (past year)				
No	ref.	-	-	-
Yes	68.84	40.61	116.67	0.000
Sedative Dependence or Abuse (past year)				
No	ref.	-	-	-
Yes	67.08	30.53	147.40	0.000

Note. ref. = reference group; CI = confidence interval

Adjusted multivariate logistic regression models. Model 1 found that sociodemographic factors such as age, sex/gender, race/ethnicity, sexual identity, educational attainment, family income, and employment status were positively predictive of opioid misuse. In Model 2, we added the socioecological factor of past criminality, which was predictive of opioid misuse, while controlling for sociodemographic factors. In Model 3, health factors such as overall reported health, serious psychological distress in past year, suicidality in the past year, and not having private health insurance were added (while controlling for sociodemographic and socioecological factors) and were predictive of opioid misuse. In Model 4, other substance dependence and abuse were added to the model, which was controlled for sociodemographic, socioecological, and health factors. Model 4 was selected for interpretation.

Comprehensive model of opioid misuse. Compared to no prior history, having past criminality was a positive predictor of opioid misuse (adjusted odds ratio [AOR] = 2.58, 95% confidence interval [CI]: 1.98-3.37, $p < 0.001$). Overall self-reported health status was associated with opioid misuse when individuals reported fair/poor (AOR = 3.71, 95% CI: 2.19-6.29, $p < 0.001$), good (AOR = 3.43, 95% CI: 2.20-5.34, $p < 0.001$), and very good health (AOR = 2.75, 95% CI: 1.90-3.98, $p < 0.001$) compared to those that reported excellent health. Among individuals with no private health insurance, there was 2.12 increased adjusted odds (95% CI: 1.55-2.89, $p < 0.001$) of opioid misuse compared to participants with health insurance. Similarly, participants who experienced past serious psychological distress or suicidality had 3.05 adjusted odds (95% CI: 2.20-4.23, $p < 0.001$) and 1.58 odds (95% CI: 1.17-2.14, $p = 0.004$) of opioid misuse, respectively, when compared to those with no history. Participants exhibiting substance dependence or abuse, with the notable exception of inhalants and sedatives, were positively associated with increased adjusted odds of opioid misuse compared to those with no substance dependence or abuse (nicotine: AOR = 3.01, 95% CI: 2.30-3.93, $p < 0.001$; alcohol: AOR = 1.40, 95% CI: 1.02-1.92, $p = 0.038$; marijuana: AOR = 2.24, 95% CI: 1.40-3.58, $p = 0.001$; cocaine: AOR = 3.92, 95% CI: 2.14-7.17, $p < 0.001$; methamphetamine: AOR = 3.32, 95% CI: 1.96-5.64, $p < 0.001$; tranquilizers: AOR = 16.7, 95% CI: 9.75-28.7, $p < 0.001$; stimulants: AOR = 2.45, 95% CI: 1.03-5.87, $p = 0.044$). See Table 4 for more detail.

Table 4. Multivariate logistic regression examining opioid misuse and/or use disorder: 2017-2018 NSDUH

Model 1 Sociodemographic Indicators				Model 2 Socioecological Indicator				Model 3 Health Indicators				Model 4 Other Substance Abuse or Dependence							
95% CI		95% CI		95% CI		95% CI		95% CI		95% CI		95% CI		95% CI		95% CI			
AOR	Lower	Upper	p-value	AOR	Lower	Upper	p-value	AOR	Lower	Upper	p-value	AOR	Lower	Upper	p-value	AOR	Lower	Upper	p-value
Age																			
18-25 years old	4.06	1.53	10.77	0.006	4.08	1.54	10.85	0.006	2.52	0.96	6.63	0.060	1.69	0.60	4.73	0.311			
26-34 years old	6.65	2.55	17.30	0.000	4.58	1.74	12.11	0.003	2.88	1.12	7.43	0.029	2.07	0.78	5.49	0.142			
35-49 years old	4.43	1.71	11.46	0.003	2.99	1.14	7.81	0.026	2.06	0.80	5.33	0.132	1.75	0.65	4.70	0.261			
50-64 years old	3.57	1.47	8.69	0.006	2.65	1.09	6.47	0.033	2.30	0.95	5.55	0.065	1.90	0.73	4.92	0.182			
65 years and older	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-			
Sex/Gender																			
Male	1.45	1.13	1.85	0.004	1.02	0.82	1.27	0.855	1.26	1.00	1.59	0.055	1.17	0.90	1.52	0.241			
Female	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-			
Race/Ethnicity																			
Non-Hispanic White	4.31	1.89	9.84	0.001	3.16	1.37	7.33	0.008	2.87	1.18	6.97	0.021	2.23	0.87	5.76	0.095			
Non-Hispanic Black/African American	1.90	0.72	5.00	0.189	1.40	0.53	3.74	0.493	1.46	0.52	4.09	0.463	1.47	0.49	4.42	0.482			
Native American/Alaska Native	3.87	1.47	10.19	0.007	2.49	0.93	6.63	0.067	2.53	0.91	7.01	0.074	1.65	0.53	5.10	0.376			
Native Hawaiian/Pacific Islander	1.66	0.31	8.88	0.547	1.55	0.30	7.98	0.592	1.47	0.27	7.95	0.647	1.06	0.19	5.75	0.949			
Non-Hispanic more than one race	4.60	1.67	12.67	0.004	2.99	1.04	8.63	0.043	2.40	0.79	7.27	0.119	1.95	0.60	6.33	0.258			
Hispanic	1.56	0.69	3.55	0.281	1.40	0.60	3.24	0.425	1.34	0.56	3.19	0.506	1.38	0.55	3.46	0.486			
Non-Hispanic Asian	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-			
Sexual Identity																			
Lesbian or gay	1.04	0.59	1.83	0.887	0.99	0.55	1.78	0.978	0.71	0.40	1.27	0.243	0.56	0.28	1.09	0.088			
Bisexual	1.96	1.36	2.81	0.001	1.75	1.24	2.48	0.002	0.99	0.69	1.44	0.965	0.80	0.51	1.26	0.333			
Heterosexual, i.e., straight	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-			
Educational Attainment																			
Less than high school	2.93	1.81	4.75	0.000	2.11	1.30	3.43	0.003	1.58	0.97	2.57	0.067	1.21	0.71	2.07	0.484			
High school grad	2.59	1.65	4.05	0.000	1.99	1.28	3.09	0.003	1.55	1.00	2.41	0.049	1.34	0.79	2.28	0.268			
Some college/associate's degree	2.08	1.32	3.26	0.002	1.61	1.02	2.53	0.040	1.28	0.82	2.02	0.272	1.19	0.71	1.99	0.496			
College graduate	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-			
Population Density of Residence																			
In a CBSA > 1 million	1.26	0.84	1.88	0.257	1.31	0.87	1.98	0.187	1.31	0.86	2.02	0.208	1.31	0.83	2.07	0.242			
In a CBSA < 1 million	1.15	0.79	1.67	0.450	1.18	0.81	1.71	0.392	1.14	0.78	1.68	0.483	1.16	0.78	1.73	0.450			
Not in a CBSA	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-			
Family Income																			
Less than \$20,000	2.24	1.53	3.28	0.000	1.84	1.26	2.67	0.002	1.06	0.73	1.56	0.741	0.83	0.55	1.27	0.390			
\$20,000-\$49,999	1.58	1.13	2.21	0.009	1.40	1.00	1.96	0.051	0.93	0.67	1.30	0.679	0.85	0.59	1.22	0.374			
\$50,000-\$74,999	1.32	0.91	1.92	0.145	1.22	0.83	1.79	0.311	1.01	0.68	1.49	0.966	0.91	0.59	1.40	0.649			
\$75,000 or more	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-			
Employment Status																			
Employed full/part-time	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-	ref.	-	-	-			
Unemployed	3.02	2.17	4.21	0.000	2.80	2.02	3.88	0.000	1.89	1.34	2.65	0.000	1.47	0.99	2.16	0.054			
Retired	0.71	0.28	1.84	0.478	0.73	0.28	1.88	0.509	0.60	0.24	1.47	0.256	0.62	0.24	1.63	0.324			
Disabled	2.68	1.67	4.30	0.000	2.31	1.42	3.77	0.001	1.01	0.62	1.67	0.952	1.07	0.63	1.83	0.797			
Other	1.58	1.17	2.14	0.003	1.65	1.21	2.25	0.002	1.36	1.00	1.86	0.049	1.24	0.86	1.79	0.252			

Arrested and Booked	5.40	4.26	6.84	0.000	4.19	3.34	5.25	0.000	2.58	1.98	3.37	0.000
Overall Health												
Fair/poor	4.58	2.89	7.26	0.000	3.71	2.19	6.29	0.000				
Good	4.06	2.76	5.96	0.000	3.43	2.20	5.34	0.000				
Very good	2.94	2.07	4.16	0.000	2.75	1.90	3.98	0.000				
Excellent	ref.	-	-	-	ref.	-	-					
No Private Health Insurance	2.29	1.73	3.04	0.000	2.12	1.55	2.89	0.000				
Serious Psychological Distress ^a	4.20	3.25	5.44	0.000	3.05	2.20	4.23	0.000				
Suicidality in Past Year ^a	2.14	1.64	2.79	0.000	1.58	1.17	2.14	0.004				
Nicotine Dependence ^a	3.01	2.30	3.93	0.000								
Alcohol Dependence or Abuse ^a	1.40	1.02	1.92	0.038								
Marijuana Dependence or Abuse ^a	2.24	1.40	3.58	0.001								
Cocaine Dependence or Abuse ^a	3.92	2.14	7.17	0.000								
Inhalant Dependence or Abuse ^a	1.80	0.23	14.23	0.571								
Methamphetamine Dependence or Abuse ^a	3.32	1.96	5.64	0.000								
Tranquilizer Dependence or Abuse ^a	16.72	9.75	28.65	0.000								
Stimulant Dependence or Abuse ^a	2.45	1.03	5.87	0.044								
Sedative Dependence or Abuse ^a	3.16	0.52	19.21	0.206								

Notes. ref. = reference group; AOR = adjusted odds ratio; CI = confidence interval

^a Compared to those not experiencing the condition.

Discussion

Opioid misuse and use disorder prevention strategies and programs must focus on multiple associated misuse factors in the context of the person and their environment to ameliorate the ongoing epidemic. Epidemics do not occur in a vacuum, as such we accounted for the biopsychosocial characteristics associated with opioid misuse in context of sociodemographic factors and substance use. Analyses revealed sociodemographic, socioecological, and health factors, as well as other substance dependence or abuse, were significant biopsychosocial risk factors for opioid misuse. Specifically, we found that socioecological indicators like criminality and health status factors, including serious psychological distress and suicidality, as well as private health insurance were significant risk characteristics. Nicotine, alcohol, marijuana, cocaine, methamphetamine, tranquilizer, and stimulant substance dependence or abuse were also significant predictors of opioid misuse.

Sociodemographic factors have generally been identified as a definitive risk factors in opioid misuse, and overdose death.[8, 9, 17, 47, 48] In the presence of biopsychosocial factors and other substance abuse we found that sociodemographic characteristics were no longer significant predictors but served as controls for our comprehensive opioid misuse model. Our model further revealed that socioecological and health factors are significant predictors. Examining opioid misuse using nationally representative data, Mojtabai, Amin-Esmaeili, Nejat, and Olfson [49] also found that prescribed-opioid misuse was associated with criminality, mental health distress, and other substance abuse or dependence. Similarly, Grigsby and Howard [37] and found that prescription opioid and polysubstance users had the greatest probability of past-year criminality and mental health distress. Moreover, Prince [23] found that individuals with opioid misuse disorder who had a severe mental illness were at an increased risk of criminality and suicidality. The risk increased between those using only heroin, both heroin and prescription opioids, and all other substance use disorders, in that order.

Other substance dependence or abuse has been associated with opioid misuse based on varying risk factors.[13, 28, 33, 47, 50] In this study, we specifically found that nicotine,[28, 29] alcohol,[28, 30] cocaine,[50] methamphetamine,[32] tranquilizers,[34, 35, 51] other illicit stimulants

[20], and marijuana [28] have a positive relationship with opioid misuse and use disorder. The stimulant effect from nicotine, cocaine, methamphetamine, and other illicit stimulants have been stipulated to mitigate the depressive effects of opioids and may increase the “high” effect.[32] Substances such as tranquilizers have been reported to be used to heighten, maintain, and extend the effect of the “high” [34-36], which may explain the elevated odds ratio of 16.7 when compared to all other substance dependence or abuse. Further research would be necessary to capture this context. Tranquilizer dependence and abuse is also of particular note as most opioid overdose reports in the US involved some type of tranquilizer, i.e., benzodiazepine.[52]

Although the present study revealed an increased association of opioid misuse with marijuana compared to non-marijuana users, the relationship in the literature has been mixed. In the cases of marijuana dependence or abuse there is a positive relationship with opioid misuse.[37] A more recent review, however, found that medical marijuana use may decrease the probability of opioid use.[39] Campbell et al. [39] further revealed that medical cannabis laws may slow the increase of opioid overdose deaths in states with medical cannabis laws compared to states with none. Alcohol has been another substance with mixed associations for opioid misuse and use disorder. For instance, Fernandez et al. [30] reported that alcohol dependence or abuse was not associated with opioid misuse. We found, however, in our comprehensive adjusted model that alcohol dependence or abuse was associated with a higher probability for opioid misuse, in line with the findings of Witkiewitz et al. [53] Overall, prevention strategies and prevention programs must focus on both the combined use of legal and illicit substances.

Although comprehensive models can be cumbersome, they provide the ability to examine multiple risk factors in context to understand profiles of misuse and use disorder at a population level. Our study took a comprehensive approach to understand how multiple biopsychosocial characteristics in context relate to opioid misuse and/or use disorder. Since the current opioid crisis is not unlike prior substance use disorder crises of the past, our goal was to provide etiological data that can be used to inform preventive intervention efforts along the continuum from opioid misuse to use disorder. By identifying risk factors within our model, we were able to contextually examine biopsychosocial characteristics to inform future research and prevention strategies to intervene upon opioid use disorder and related distal outcomes for noninstitutionalized US adults.

Limitations

To our knowledge, this is the first US population-level study to comprehensively address risk profiles of opioid misuse using the latest national survey data available. Like most surveys of this kind, there are limitations to the NSDUH. The most prominent limitation is the use of self-reported data. These data are subject to the individual participant’s bias, truthfulness, recollection, and knowledge. Second, although the data are nationally representative, it is cross-sectional, excludes some subsets of the population, and does not directly account for pain. The NSDUH only targets noninstitutionalized US citizens, so active-duty military members and institutionalized groups (e.g., prisoners, hospital patients, treatment center patients, and nursing home members) are excluded. Thus, if substance use differs between US noninstitutionalized and institutionalized groups by more than 3%, data may be problematic for the total US population.[46] Another issue that may have introduced bias is participant knowledge or lack thereof concerning opioids and other substances.[54] Moreover, heroin is a less commonly used opioid and there are issues in accounting for the true prevalence of this substance use.[54, 55] Finally, the opioid misuse data does not fully account for synthetic opioids like fentanyl.

Conclusion

This study provides the most recent and comprehensive risk assessment of possible biopsychosocial characteristics indicative of opioid misuse. Findings provide the population-level risk factors to improve risk assessments and to tailor future interventions to stem and ameliorate the opioid epidemic. For instance, at-risk individuals had a history of criminality, serious psychological distress, suicidality, no private health insurance, and substance dependence or abuse. Individuals, however, are not variables representative of risk factors on an outcome to opioid misuse and/or use disorder. At a population-level analysis, we must acknowledge that results of a person-centered approach such as this work only represent findings based on a population average.[56] More specialized approaches, such as variable-centered ones, are necessary to study specific at-risk groups. Thus, these findings serve as a population-level risk profile using the most recent US nationally-representative data to inform epidemiological trends and possible large-scale interventions.

List Of Abbreviations

AOR Adjusted odds ratio

CBSA Core-based statistical areas

OR Odds ratio

Declarations

Ethics approval and consent to participate

The study received exemption from the Texas A&M University Institutional Review Board as no human participants were involved in this research.

Consent for publication

Not applicable.

Availability of data and materials

All National Survey on Drug Use and Health datasets analyzed during the current study are available in the Substance Abuse & Mental Health Data Archive (SAMHDA) repository, <https://www.datafiles.samhsa.gov/study-series/national-survey-drug-use-and-health-nsduh-nid13517>

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

FAMI and TG conceived the study. FAMI designed the study. FAMI acquired, cleaned, managed, and analyzed the data under supervision of TG. All authors interpreted the results. FAMI and BS drafted the manuscript, supervised by TG and FW. TG and FW substantially modified and approved the submitted version of the manuscripts. All authors read and approved the final version of the manuscript. The content is solely the responsibility of the authors and does not necessarily reflect the views of the National Institutes of Health.

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