



# Opioid use at the transition to emerging adulthood: A latent class analysis of non-medical use of prescription opioids and heroin use

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## ABSTRACT

**Background:** Although rates of nonmedical opioid use are highest in late adolescence and emerging adulthood, efforts to understand the extent of the heterogeneity in opioid misuse during this time have been limited. The current study aimed to derive and define typologies of opioid use in high school students at the onset of emerging adulthood.

**Methods:** Survey responses from a statewide sample of high school students aged 18 and 19 ( $N = 26,223$ ) were analyzed. Group-based comparisons between participants reporting opioid use and those not reporting opioid use were conducted. Among those reporting opioid use ( $n = 1,636$ ), we conducted a latent class analysis (LCA) to identify heterogeneous subgroups of opioid users on the basis of non-medical use of prescription opioids (NMUPO) and heroin use. The resulting classes were then compared across various risk and protective factors using multinomial logistic regression.

**Results:** Consistent differences were observed between participants using opioids and participants not using opioids, with moderate to large effect sizes. Results from LCA revealed three subclasses: NMUPO-Any Use, NMUPO To Get High, and Heroin Use. Subclass differences were observed for non-opioid substance use, mental health, and demographics.

**Conclusions:** Findings from this study underscore the variability of youth who engage in opioid use in late adolescence. Results also indicate that opioid use during adolescence is likely indicative of a broader set of substance use and mental health issues.

## 1. Introduction

The dramatic rise in opioid misuse during the early part of the 21st century has resulted in an international epidemic (Volkow et al., 2019). During this time, the United States and many other countries have experienced prominent increases in opioid-related emergency room visits, hospitalizations, and deaths (Burke, 2016; Sung et al., 2005; Unick et al., 2013; Vashishtha et al., 2017). The economic costs of this epidemic have been estimated to be between \$79-\$179 billion annually in the United States alone (Altarum, 2018; Council of Economic Advisers, 2017; Florence et al., 2016). Identifying ways to combat the

current epidemic, as well as prevent its future occurrence, remain a focal policy issue for federal and state governments.

Efforts to treat, prevent, and educate individuals on opioid-related issues, however, are far from straightforward (Volkow et al., 2019). In contrast to monolithic characterizations of “opioid users” that have dominated the popular press, data from the United States and elsewhere portrays a complex picture of people who misuse opioids (John & Wu, 2019; McCabe et al., 2019), who vary on a range of factors such as age, type of opioid ingested, and motive for use (McCabe et al., 2019). Understanding different types of opioid users is thus necessary to inform the content of treatment and prevention programs that are developed as

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well as their intended audience(s). Capturing this heterogeneity among opioid users appears particularly pertinent among youth transitioning to emerging adulthood, a developmentally distinct period with marked peaks in prevalence of nonmedical use of opioids (Crane, 2015; Guarino et al., 2018) and other substances (Schwartz & Petrova, 2019; Smith, 2017).

To date, opioid-related research, practice, and policy has focused on two main forms of opioid use: non-medical use of prescriptions opioids (NMUPO) and heroin use (Kolodny et al., 2015). Additional research has also considered their co-occurrence (Palamar et al., 2016) and potential transition from NMUPO to heroin (Guarino et al., 2018). As is common with other substances, people who engage in NMUPO and heroin use have been found to possess other co-occurring conditions and behaviors, including worsened mental health (Edlund et al., 2015; Fink et al., 2015; Wu et al., 2010), poor school adjustment (Schepis et al., 2018), and elevated rates of other (non-opioid) substance use, including alcohol and cannabis (Carmona et al., 2020; Osborne et al., 2017).

In addition to these general patterns, a small subset of studies has investigated heterogeneity in opioid use patterns. Most often, these efforts employed person-centered analytic approaches (e.g., latent class analysis) that identify discrete typologies, or classes, based on respondents' similarity on a set of variables (Wu et al., 2010). To date, however, these analyses have sought to define opioid users on the basis of other characteristics (particularly use of other substances; Daniulaityte et al., 2019; Fong et al., 2015; Vaughn et al., 2007) as well as motives for use (Schepis et al., 2020; Votaw et al., 2019). Most of this work, however, has focused on either adults (Carlson et al., 2014; Green et al., 2011) or people in treatment for opioid use disorder (Daniulaityte et al., 2019; Fong et al., 2015), and minimal attention has been given to understanding variability in actual type of opioid used. Consequently, less is known about the nature of distinct classes of NMUPO and heroin use at the transition to emerging adulthood.

In response, the current study aimed to describe heterogeneity in opioid use in a community sample of more than 20,000 18–19 year old high school students. The two primary aims of the study were to: (a) to derive empirically distinct classes, or subgroups, of participants based on actual opioid use and motives, and (b) to identify behavioral, contextual, and demographic correlates of class membership. Latent classes were developed based on patterns detected across three variables: general use of NMUPO, NMUPO to get high, and heroin use. The significance of class membership was then examined by comparing groups on indicators of substance use, mental health, schooling, and demographic factors. We were also interested in estimating rates of opioid use and differences between opioid and non-opioid users among this sample of youth at the transition to emerging adulthood.

## 2. Method

### 2.1. Participants

Participants for this study were youth aged 18 and older who participated in an epidemiological survey conducted in schools throughout a Midwestern state between January and June in 2018. A total of 26,223 youth aged 18 and older completed the survey. Nearly all of the sample was in 12th grade (99%) and 18 years old (96%). The sample contained a slight majority of boys (51%). Concerning race and ethnicity, 61% reported being White, 15% reported being Latino/a, 8% African American, 7% multi-racial, and 6% Asian American. More than one-third (36%) of the sample was eligible to receive free or reduced lunch.

### 2.2. Procedures

All public and private schools in the state were eligible to participate. School participation was voluntary and free of cost. Schools were recruited via email, telephone, or community-based organizations. After

registering, school staff were provided instructions about distributing parent opt-out forms 30 days in advance and administering the survey. Surveys were administered during school hours and took approximately 40–45 min to complete. Surveys could be completed using paper/pencil or online formats and in English or Spanish. A total of 30,354 youth aged 18 or older completed the survey; 4,141 (13.6%) were removed during data cleaning (e.g., reporting any use of a fake drug validity check question, completing <40% of the survey), resulting in the final sample of 26,223 as well as a subsample of 1,636 youth who endorsed using opioids in the past year to be utilized in the LCA. Youth assent was included at the beginning of the survey. All protocols for the survey were approved through the IRB by the sponsoring research university (#11126) as well as Research Review Board of a large metropolitan public-school system (#648).

### 2.3. Measures

#### 2.3.1. Opioid use variables

Three questions were asked with respect to participants' opioid use. The first question asked "During the past 12 months, how often have you used prescription pain medicine without a doctor's prescription or differently than how a doctor told you to use it? (Count drugs such as Codeine/"Lean", Vicodin, OxyContin, Hydrocodone, and Percocet)". The second question asked, "During the past 12 months, how often have you used prescription painkillers to get high? (e.g., OxyContin, Vicodin, Lortab, etc.)". Response options for these items ranged from 1 = Never to 4 = 6 or more times. The third opioid-related question was "In the past year, on how many occasions (if any) have you used heroin?", with response options ranging from 1 = 0 occasions to 6 = 20 or more occasions. Measures were each dichotomized with 0 indicating no use and 1 indicating any use in the past year. No additional information was collected regarding youths' frequency or motives for opioid use (NMUPO or Heroin) as part of the survey.

#### 2.3.2. Other substance use variables

Participants' past-year use of other substances was assessed with respect to alcohol, cannabis, and illicit drugs. For alcohol use, participants were asked "In the past year, on how many occasions (if any) have you had beer, wine or liquor?". For cannabis use, participants were asked "In the past year, on how many occasions (if any) have you used marijuana?" Illicit drug use was assessed from four separate questions asking "In the past year, on how many occasions (if any) have you used: (1) MDMA ("ecstasy"), (2) LSD or other psychedelics?", (3) Cocaine or crack?", and (4) Meth (methamphetamine)?" Response options for all questions ranged from 1 = 0 occasions to 6 = 20 or more occasions. For each substance, measures were dichotomized with 0 indicating no use and 1 indicating any use in the past year.

#### 2.3.3. Problematic substance use

Participants' problematic substance use was assessed using the CRAFFT screening instrument (Knight et al., 2002). Sample items from the 6-item instrument included: "During the past 12 months, did you ever use alcohol or other drugs to relax, feel better about yourself, or fit in?" (1 = Yes; 0 = No). Items were summed, with higher scores indicating more problematic use.

#### 2.3.4. Mental health

Two questions were used to gauge mental health from a variation of the Columbia-Suicide Rating Scale (Posner et al., 2011). The first question, assessing depressive episode occurrence, asked "During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?". The second question, assessing suicide ideation, asked "During the past 12 months, did you ever seriously consider attempting suicide?". Response options for both items were 1 = Yes, 0 = No.

### 2.3.5. School factors

Two measures assessed dimensions of the school environment. The first measure assessed performance and asked “Putting them all together, what were your grades like for the last year?” (1 = Mostly A; 8 = Mostly F; reversed coded). The second measure assessed bullying victimization and was comprised of four items. A sample question is “During the past 12 months, has another student at school: Bullied you by calling you names?” (1 = Yes) and were summed and then dichotomized with 1 indicating any bullying victimization in the past year.

### 2.4. Plan of analysis

We began analyses by examining overall percentages of opioid use in the sample as well as comparing youth reporting opioid use and those not reporting opioid use in the past year. Effect sizes were calculated using Cohen’s  $d$ ; for dichotomous variables, this was calculated by taking the natural log of the Odds Ratio and dividing by 1.81 (Chinn, 2000).

We then conducted a latent class analysis (LCA) from the subsample of youth who endorsed using opioids in the past year ( $n = 1,636$ ) using Mplus Version 8.3 (Muthén & Muthén, 2017). LCA creates groups based on the similarity of participants’ patterns of responses to a set of dichotomous variables. To identify the optimal number of classes, we examined the Bayesian information criterion (BIC), Lo-Mendell-Rubin (LMR) likelihood ratio test (Lo et al., 2001), and entropy. When comparing models, relatively lower BIC scores suggest a better fitting model. The LMR likelihood ratio test compares the estimated model with a model having one class less than the estimated model. If the LMR has a  $p$ -value of  $<0.05$ , the model with one class less is rejected in favor of the estimated model. A final criterion was entropy, which refers to accuracy in assigning participants to classes; values range from 0 to 1. The closer entropy is to 1, the more likely the participants are to belong to the classes to which they have been assigned. Optimal models were chosen based on goodness of fit and parsimony. Missing data were minimal among for indicators of latent classes (1.5% of cases) and handled via full information maximum likelihood in Mplus.

After identifying the optimal number of groups from the LCA, we then examined correlates of class membership, comparing participants assigned to different classes on factors such as other (i.e., non-opioid) substance use, mental health, school factors, and demographics. These analyses were conducted using procedures outlined by Asparouhov and Muthén (2014) that account for potential classification error, with group differences compared using multinomial logistic regression. Missing data for correlate analyses were minimal (2.3%;  $n = 306$ ) and excluded listwise for each test.

## 3. Results

### 3.1. Descriptive statistics and opioid vs non-opioid use comparisons

From the entire sample of 26,223 youth, 5.6% ( $n = 1468$ ) reported past year use of prescription painkillers without a prescription. In addition, 2.6% ( $n = 682$ ) reported past year prescription pain medicine use to get high, and 0.4% ( $n = 105$ ) reported using heroin in the past year. Supplemental Table S1 provides frequencies for ordinal response options.

Table 1 presents analyses comparing youth reporting opioid use and youth not reporting opioid use in the past year. Given the sample size in these preliminary analyses, discussion of the results focuses only on those differences with effect sizes greater than 0.20. Results indicated moderate to large differences on numerous measures. Specifically, youth with opioid use in the last year reported greater likelihood of using other substances (i.e., alcohol [ $d = 0.86$ ], cannabis [ $d = 0.98$ ], illicit substances [ $d = 0.98$ ]), higher CRAFFT scores ( $d = 1.40$ ), greater likelihood of past year depressed mood ( $d = 0.54$ ), greater suicidal ideation ( $d = 0.67$ ), lower grades ( $d = 0.50$ ), as well as greater likelihood of bullying

victimization at school ( $d = 0.51$ ). With these general patterns identified, we then proceeded with our LCA to better understand heterogeneity in patterns of opioid use among the youth in the study.

### 3.2. Latent class analysis

Table 2 displays fit statistics for the LCA. Results indicated that BIC values decreased until the number of classes reached the 3-class solution, and then increased with the 4-class solution. LMR statistics indicated that model fit improved with additional classes through a 3-class solution. Entropy values were above 0.90 for the 3- and 4-class solutions. A comparison of the models led to selecting the 3-class solution.

Table 3 summarizes the item response probabilities for each class. Based on item response probabilities, the following labels were applied to the three latent classes: (1) *NMUPO-Any Use* (56%), (2) *NMUPO-Use To Get High* (40%), and (3) *Heroin Use* (4%).<sup>1</sup> Participants in the *NMUPO-Any Use* class all reported prescription painkiller use without a prescription, yet participants in this class reported neither using prescription painkillers to get high nor heroin use. Concerning the *NMUPO-Use To Get High* class, participants in this class all reported prescription painkiller use to get high; these participants also had a 78% probability of prescription painkiller use without a prescription and a 5% probability of heroin use in the past year. Lastly, participants in the *Heroin Use* class all reported heroin use within the past year, and participants had 12% and 13% probabilities of past year prescription painkiller use without a prescription and prescription painkiller use to get high, respectively.

### 3.3. Correlates of group membership

With the optimal number of classes identified, we next investigated correlates of class membership. As noted in the Method section, class differences were investigated with respect to non-opioid substance use, mental health, school factors, and demographics. Descriptive statistics of each class, as well as comparisons on the basis of multinomial logistic regression results, are summarized in Table 4.

Controlling for mean levels of other correlates and potential classification error, results indicated that participants in the *Heroin Use* class reported lower levels of past year alcohol and cannabis use than participants in the *NMUPO-Any Use* class and *NMUPO-Use To Get High*. In contrast, for illicit drugs, the highest levels of use were evident in the *Heroin Use* group and lowest levels of use in the *NMUPO-Any Use*, with *NMUPO-Use To Get High* in between these two groups. Participants in the *NMUPO-Use To Get High* class also reported higher CRAFFT scores compared to participants in the *NMUPO-Any Use* and *Heroin Use* classes.<sup>2</sup> With respect to mental health, no significant group differences were observed for past year depressive episodes, but participants in the *NMUPO-Use To Get High* class were more likely to report considering suicide in the past year compared to participants in the *NMUPO-Any Use* class. No group difference were observed for school factors. With respect to demographic factors, only biological sex was significant, with the *Heroin Use* class containing the highest percentage of males and the *NMUPO-Any Use* class having the fewest percentage of males amongst the three classes.

<sup>1</sup> Although the heroin use class was a small percentage of the sample of youth using opioids, fit statistics strongly indicated the preference of a 3-class solution relative to a 2-class or 4-solution. Moreover, class profile characteristics were meaningful and had clear interpretability for understanding group patterns in opioid use, further informing our decision to select a 3-class solution as optimal.

<sup>2</sup> Supplemental Table S2 displays frequency of use of other substances by opioid use class.

**Table 1**

Substance Use Prevalence Rates, Mental Health, School Factors, and Demographics among 18 and Older Students Reporting and Not Reporting Opioid Use (N = 26,223).

	Reporting Opioid Use (N = 1,613)		Not Reporting Opioid Use (N = 24,610)		t-test		Effect
	Mean / %	SD	Mean / %	SD	Statistic	p-value	Size <sup>a</sup>
<b>Substance Use</b>							
Past Year Alcohol	85%	–	54%	–	32.14	<0.001	0.86
Past Year Cannabis	74%	–	32%	–	36.52	<0.001	0.98
Past Year Illicit drugs	38%	–	4%	–	27.80	<0.001	1.50
CRAFFT score	2.93	1.92	0.91	1.41	40.91	<0.001	1.40
<b>Mental Health</b>							
Depressive Episode	56%	–	31%	–	18.55	<0.001	0.54
Considered Suicide	35%	–	14%	–	16.93	<0.001	0.67
<b>School Factors</b>							
Performance/Grades	5.69	1.77	6.44	1.47	16.07	<0.001	0.50
Bullying	44%	–	24%	–	15.45	<0.001	0.51
<b>Demographics</b>							
Male	57%	–	50%	–	5.17	<0.001	0.15
Free/Reduced Lunch	41%	–	36%	–	3.77	<0.001	0.11
White	62%	–	61%	–	0.19	ns	0.01
Black	8%	–	8%	–	1.16	ns	0.06
Latino	14%	–	15%	–	1.70	ns	–0.07
Multiracial	9%	–	7%	–	2.66	<0.001	0.15

Note: <sup>a</sup> Effect sizes were calculated using Cohen’s d.

**Table 2**

Model fit statistics for latent class solutions (N = 1636).

	Model-fit indices					Percentage of sample in class			
	Log likelihood	BIC	Entropy	LMR LRT	p	1	2	3	4
One class	–2059	4140	–	–	–	100			
Two class	–1907	3866	0.78	293	<0.01	86	14		
<b>Three class</b>	<b>–1831</b>	<b>3744</b>	<b>0.91</b>	<b>146</b>	<b>&lt;0.01</b>	<b>56</b>	<b>40</b>	<b>4</b>	
Four class	–1831	3773	0.92	0	0.60	56	40	4	0

**Table 3**

Item response probabilities (N = 1636).

	Probability of Class Member Reporting Item		
	Class 1 NMUPO-Any Use (n = 915, 56%)	Class 2 NMUPO-Use To Get High (n = 649, 40%)	Class 3 Heroin Use (n = 72, 4%)
Past Year Prescription Painkiller use	1.00	0.78	0.12
Past Year Prescription Painkiller use to get high	0.00	1.00	0.13
Past Year Heroin Use	0.00	0.05	1.00

**4. Discussion**

Given the scope and complexity in patterns of use for the opioid epidemic, accurately capturing the heterogeneity in opioid use during the transition to emerging adulthood is crucial for developing appropriately tailored treatment, prevention, and education programming during this important developmental window. The current study informs this effort by elucidating classes of youth using opioids (prescription opioids, heroin) from a sample of more than 20,000 18 and older high school students. In addition to replicating previous work on differences between opioid and non-opioid users, current results provide new insights into subclasses of opioid users and unique characteristics of each class.

Overall rates of use were generally similar to, or slightly lower than, prior research with this age demographic (Osborne et al., 2017; Palamar et al., 2016; Rose et al., 2018), with moderate to large effects observed between people who use opioids and those who do not with respect to

heightened use of other (non-opioid) substances, mental health concerns, and school performance, also aligning with previous research (Osborne et al., 2017; Schepis et al., 2018; Wu et al., 2010). LCA indicated three distinct classes of opioid users that reliably differed on the basis of levels of any NMUPO, NMUPO to get high, as well as heroin use. The two NMUPO classes contained a much higher percentage of respondents than the Heroin Use class, indicating that prescription drug misuse continues to remain a much more common means of opioid use among youth compared to heroin (Palamar et al., 2016). In reviewing correlates of class membership, unique, distinct group differences were observed even when controlling for levels of other covariates. For instance, participants in the Heroin Use class reported lower levels of alcohol and cannabis use than participants in the other two classes, yet higher levels of illicit drug use. Highlighting the importance of taking motive of use into account, participants in the NMUPO-Use To Get High class also reported higher CRAFFT scores as well as suicide ideation compared to participants in the NMUPO-Any Use class. Areas with non-significant group differences were also notable, illustrating the ways in which participants across all classes evinced similarly heightened levels of depressive symptoms and bullying victimization as well as worse grades compared to their peers who did not report past year opioid use.

Item response probabilities indicated very little co-occurrence, or overlap, as participants who were assigned to one of the two NMUPO classes report low to no probability of heroin use (0% and 5%) and, conversely, participants who were assigned to the heroin use class reported low rates of any NMUPO and NMOPU to get high (12% and 13%, respectively). Although prior research has indicated a transition from NMUPO to heroin use (Guarino et al., 2018), it is not clear whether or not this is a development pattern that occurs in adults or appears in adolescence as well. One possibility is that, upon using heroin, youth cease NMUPO; the other possibility is that heroin use patterns in

**Table 4**  
Group Means (Standard Deviations) and Between Class Comparisons (N = 1636).

Variable	Class 1	Class 2	Class 3	Class Comparisons <sup>a</sup>		
	NMUPO-Any Use M/% (SD)	NMUPO-Use To Get High   M/% (SD)	Heroin Users M/% (SD)	1 vs 2	1 vs 3	2 vs 3
<b>Substance Use</b>						
Past Year Alcohol	85%	86%	71%	1.01	1.34*	1.33*
Past Year Cannabis	68%	84%	62%	0.94	1.94**	2.06**
Past Year Illicit	25%	52%	75%	0.46**	0.02**	0.04**
CRAFFT Score	2.53 (1.88)	3.57 (1.78)	2.25 (2.09)	0.82**	1.16	1.42*
<b>Mental Health</b>						
Depressive Episode	53%	57%	57%	1.00	0.55	0.55
Considered Suicide	29%	43%	41%	0.61**	0.92	1.51
<b>School Factors</b>						
Performance/Grades	5.82 (1.68)	5.52 (1.85)	5.51 (2.09)	0.98	1.03	1.06
Bullying	41%	48%	47%	0.90	0.67	0.75
<b>Demographics</b>						
Male	52%	62%	79%	0.68**	0.18**	0.27*
Free/Reduced Lunch	43%	38%	37%	0.91	1.35	1.48
White	60%	66%	44%	0.83	1.89	2.29
Black	9%	8%	13%	0.82	4.46	5.48
Latino	16%	10%	13%	1.34	1.89	1.42
Multiracial	8%	10%	10%	0.95	1.32	1.39

Note: \* 95% Confidence Interval of log-odds parameter estimate did not contain zero; \*\* 99% Confidence Interval log-odds parameter estimate did not contain zero (estimated from 5,000 bootstrapped samples). <sup>a</sup> Group comparisons calculated from multinomial logistic regressions accounting for potential classification error (n = 1330 given listwise deletion applied to auxiliary variables). Second class listed is the reference class (i.e., for '1 vs 2', Class 2 is the reference class).

emerging adulthood differ. Future prospective research is needed to address this question.

With respect to specific implications for prevention and treatment efforts for opioid use, our findings suggest these efforts may require a broader focus on substance misuse more generally and not retain a singular focus on opioids (also see Tucker et al., 2020). All three latent classes, for instance, had elevated CRAFFT scores indicative of the need for further assessment and treatment. Second, when discussing opioid use, the results also highlight the importance of distinguishing motive of use (also see Schepis et al., 2020; Votaw et al., 2019). Clear differences existed between youth with NMUPO to get high and those not endorsing this motive. At this stage of development, people who engage in NMUPO – particularly with the motive to get high – is indicative of broader concerns with respect to other substance use and mental health. Lastly, class sizes suggest that efforts focused on NMUPO rather than heroin will reach a larger audience.

Various limitations should be considered when interpreting study findings. First, data from this study are cross-sectional, thus precluding the ability to examine patterns of change over time. Second, given brief time requirements of the survey, more detailed information on opioid use (e.g., additional motives for use) was unavailable. Third, data were measured via self-report, which can be limited by under-reporting and inaccurate responding. Data cleaning practices, as well as data response patterns, however, abate some of these concerns in the current dataset. These limitations notwithstanding, current results underscore the heterogeneity among youth who use opioids at the onset of emerging adulthood and highlight how opioid use during this time includes a broader set of co-occurring substance use and mental health problems.

#### CRedit authorship contribution statement

**Allen W. Barton:** Investigation, Writing - original draft, Conceptualization, Methodology, Formal analysis. **Crystal A. Reinhart:** Conceptualization, Methodology, Resources, Investigation. **Corey C. Campbell:** Writing - review & editing, Methodology. **Doug C. Smith:** Funding acquisition, Conceptualization, Methodology, Investigation. **Dolores Albarracín:** Writing - review & editing.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.addbeh.2020.106757>.

#### References

- Altarum. (2018). Economic toll of opioid crisis In U.S. exceeded \$1 trillion since 2001. Altarum.
- Asparouhov, T., & Muthén, B. (2014). Auxiliary variables in mixture modeling: three-step approaches using mplus. *Structural Equation Modeling: A Multidisciplinary Journal*, 21(3), 329–341. <https://doi.org/10.1080/10705511.2014.915181>.
- Burke, D. S. (2016). Forecasting the opioid epidemic. *Science*, 354(6312), 529 LP – 529. <https://doi.org/10.1126/science.aal2943>.
- Carlson, R. G., Nahhas, R. W., Daniulaityte, R., Martins, S. S., Li, L., & Falck, R. (2014). Latent class analysis of non-opioid dependent illegal pharmaceutical opioid users in Ohio. *Drug and Alcohol Dependence*, 134(1), 259–266. <https://doi.org/10.1016/j.drugalcdep.2013.10.004>.
- Carmona, J., Maxwell, J. C., Park, J. Y., & Wu, L. T. (2020). Prevalence and Health Characteristics of Prescription Opioid Use, Misuse, and Use Disorders Among U.S. Adolescents. *Journal of Adolescent Health*, 66(5), 536–544. <https://doi.org/10.1016/j.jadohealth.2019.11.306>.
- Chinn, S. (2000). A simple method for converting an odds ratio to effect size for use in meta-analysis. *Statistics in Medicine*, 19(22), 3127–3131. [https://doi.org/10.1002/1097-0258\(20001130\)19:22<3127::AID-SIM784>3.0.CO;2-M](https://doi.org/10.1002/1097-0258(20001130)19:22<3127::AID-SIM784>3.0.CO;2-M).
- Council of Economic Advisers. (2017). The underestimated cost of the opioid crisis.
- Crane, E. H. (2015). The CBHSQ Report: Emergency Department Visits Involving Narcotic Pain Resileivers.
- Daniulaityte, R., Juhascik, M. P., Strayer, K. E., Sizemore, I. E., Zatreh, M., Nahhas, R. W., ... Carlson, R. G. (2019). Trends in fentanyl and fentanyl analogue-related overdose deaths – Montgomery County, Ohio, 2015–2017. *Drug and Alcohol Dependence*, 198, 116–120. <https://doi.org/10.1016/j.drugalcdep.2019.01.045>.
- Edlund, M. J., Forman-Hoffman, V. L., Winder, C. R., Heller, D. C., Kroutil, L. A., Lipari, R. N., & Colpe, L. J. (2015). Opioid abuse and depression in adolescents: Results from the National Survey on Drug Use and Health. *Drug and Alcohol Dependence*, 152, 131–138. <https://doi.org/10.1016/j.drugalcdep.2015.04.010>.
- Fink, D. S., Hui, R., Cerdá, M., Keyes, K. M., Marshall, B. D. L., Galea, S., & Martins, S. S. (2015). Patterns of major depression and nonmedical use of prescription opioids in the United States. *Drug and Alcohol Dependence*, 153, 258–264. <https://doi.org/10.1016/j.drugalcdep.2015.05.010>.
- Florence, C. S., Zhou, C., Luo, F., & Xu, L. (2016). The economic burden of prescription opioid overdose, abuse, and dependence in the United States, 2013. *Medical Care*, 54(10), 901–906. <https://doi.org/10.1097/MLR.0000000000000625>.
- Fong, C., Matusow, H., Cleland, C. M., & Rosenblum, A. (2015). Characteristics of Non-Opioid Substance Misusers among Patients Enrolling in Opioid Treatment Programs: A Latent Class Analysis. *Journal of Addictive Diseases*, 34(2–3), 141–150. <https://doi.org/10.1080/10550887.2015.1059226>.

- Green, T. C., Black, R., Serrano, J. M., Budman, S. H., & Butler, S. F. (2011). Typologies of prescription opioid use in a large sample of adults assessed for substance abuse treatment. *PLoS ONE*, 6(11). <https://doi.org/10.1371/journal.pone.0027244>.
- Guarino, H., Mateu-Gelabert, P., Teubl, J., & Goodbody, E. (2018). Young adults' opioid use trajectories: From nonmedical prescription opioid use to heroin, drug injection, drug treatment and overdose. *Addictive Behaviors*, 86, 118–123. <https://doi.org/10.1016/j.addbeh.2018.04.017>.
- John, W. S., & Wu, L.-T. (2019). Sex differences in the prevalence and correlates of emergency department utilization among adults with prescription opioid use disorder. *Substance Use & Misuse*, 54(7), 1178–1190. <https://doi.org/10.1080/10826084.2019.1568495>.
- Knight, J. R., Sherritt, L., Shrier, L. A., Harris, S. K., & Chang, G. (2002). Validity of the CRAFFT Substance Abuse Screening Test Among Adolescent Clinic Patients. *Archives of Pediatrics & Adolescent Medicine*, 156(6), 607–614. <https://doi.org/10.1001/archpedi.156.6.607>.
- Kolodny, A., Courtwright, D. T., Hwang, C. S., Kreiner, P., Eadie, J. L., Clark, T. W., & Alexander, G. C. (2015). The Prescription Opioid and Heroin Crisis: A Public Health Approach to an Epidemic of Addiction. *Annual Review of Public Health*, 36(1), 559–574. <https://doi.org/10.1146/annurev-publhealth-031914-122957>.
- Lo, Y., Mendell, N. R., & Rubin, D. B. (2001). Testing the number of components in a normal mixture. *Biometrika*, 88(3), 767–778. <https://doi.org/10.1093/biomet/88.3.767>.
- McCabe, S. E., Veliz, P. T., Boyd, C. J., Schepis, T. S., McCabe, V. V., & Schulenberg, J. E. (2019). A prospective study of nonmedical use of prescription opioids during adolescence and subsequent substance use disorder symptoms in early midlife. *Drug and Alcohol Dependence*, 194, 377–385. <https://doi.org/10.1016/j.drugalcdep.2018.10.027>.
- Muthén, L. K., & Muthén, B. O. (2017). *Mplus User's Guide* ((8th ed.).). Muthén & Muthén.
- Osborne, V., Serdarevic, M., Crooke, H., Striley, C., & Cottler, L. B. (2017). Non-medical opioid use in youth: Gender differences in risk factors and prevalence. *Addictive Behaviors*, 72, 114–119. <https://doi.org/10.1016/j.addbeh.2017.03.024>.
- Palamar, J. J., Shearston, J. A., Dawson, E. W., Mateu-Gelabert, P., & Ompad, D. C. (2016). Nonmedical opioid use and heroin use in a nationally representative sample of U.S. high school seniors. *Drug and Alcohol Dependence*, 158, 132–138. <https://doi.org/10.1016/j.drugalcdep.2015.11.005>.
- Posner, K., Brown, G. K., Stanley, B., Brent, D. A., Yershova, K. V., Oquendo, M. A., ... Mann, J. J. (2011). The Columbia-Suicide Severity Rating Scale: Initial Validity and Internal Consistency Findings From Three Multisite Studies With Adolescents and Adults. *American Journal of Psychiatry*, 168(12), 1266–1277. <https://doi.org/10.1176/appi.ajp.2011.10111704>.
- Rose, R. A., Evans, C. B. R., Smokowski, P. R., Howard, M. O., & Stalker, K. L. (2018). Polysubstance Use Among Adolescents in a Low Income, Rural Community: Latent Classes for Middle- and High-School Students. *The Journal of Rural Health*, 34(3), 227–235. <https://doi.org/10.1111/jrh.12268>.
- Schepis, T. S., De Nadai, A. S., Ford, J. A., & McCabe, S. E. (2020). Prescription opioid misuse motive latent classes: Outcomes from a nationally representative US sample. *Epidemiology and Psychiatric Sciences*, 29, Article e97. <https://doi.org/10.1017/S2045796020000037>.
- Schepis, T. S., Teter, C. J., & McCabe, S. E. (2018). Prescription drug use, misuse and related substance use disorder symptoms vary by educational status and attainment in U.S. adolescents and young adults. *Drug and Alcohol Dependence*, 189, 172–177. <https://doi.org/10.1016/j.drugalcdep.2018.05.017>.
- Schwartz, S. J., & Petrova, M. (2019). Prevention Science in Emerging Adulthood: A Field Coming of Age. In *Prevention Science* (Vol. 20, Issue 3, pp. 305–309). Springer New York LLC. <https://doi.org/10.1007/s11121-019-0975-0>.
- Smith, D. C. (2017). *Emerging Adults and Substance Use Disorder Treatment: Developmental Considerations and Innovative Approaches*. Oxford University Press.
- Sung, H.-E., Richter, L., Vaughan, R., Johnson, P. B., & Thom, B. (2005). Nonmedical use of prescription opioids among teenagers in the United States: Trends and correlates. *Journal of Adolescent Health*, 37(1), 44–51. <https://doi.org/10.1016/j.jadohealth.2005.02.013>.
- Tucker, J. S., Davis, J. P., Seelam, R., Stein, B. D., & D'Amico, E. J. (2020). Predictors of Opioid Misuse During Emerging Adulthood: An Examination of Adolescent Individual, Family and Peer Factors. *Drug and Alcohol Dependence*, 214, Article 108188. <https://doi.org/10.1016/j.drugalcdep.2020.108188>.
- Unick, G. J., Rosenblum, D., Mars, S., & Ciccarone, D. (2013). Intertwined Epidemics: National Demographic Trends in Hospitalizations for Heroin- and Opioid-Related Overdoses, 1993–2009. *PLOS ONE*, 8(2), Article e54496. <https://doi.org/10.1371/journal.pone.0054496>.
- Vashishtha, D., Mittal, M. L., & Werb, D. (2017). The North American opioid epidemic: Current challenges and a call for treatment as prevention. *Harm Reduction Journal*, 14(1), 7. <https://doi.org/10.1186/s12954-017-0135-4>.
- Vaughn, M. G., Ollie, M. T., McMillen, J. C., Scott, L., & Munson, M. (2007). Substance use and abuse among older youth in foster care. *Addictive Behaviors*, 32(9), 1929–1935. <https://doi.org/10.1016/j.addbeh.2006.12.012>.
- Volkow, N. D., Icaza, M.-E.-M.-M., Poznyak, V., Saxena, S., Gerra, G., & Network, the U.-W. I. S. (2019). Addressing the opioid crisis globally. *World Psychiatry*, 18(2), 231–232. <https://doi.org/10.1002/wps.20633>.
- Votaw, V. R., McHugh, R. K., & Witkiewitz, K. (2019). Alcohol use disorder and motives for prescription opioid misuse: A latent class analysis. *Substance Use & Misuse*, 54(9), 1558–1568. <https://doi.org/10.1080/10826084.2019.1594904>.
- Wu, L. T., Woody, G. E., Yang, C., & Blazer, D. G. (2010). Subtypes of nonmedical opioid users: Results from the national epidemiologic survey on alcohol and related conditions. *Drug and Alcohol Dependence*, 112(1–2), 69–80. <https://doi.org/10.1016/j.drugalcdep.2010.05.013>.