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Associations between relative deprivation with opioid use among working-age adults during the great recession

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ABSTRACT

Recessions, poverty, and unemployment have been associated with opioid use. However, these measures of financial hardship may be imprecise, limiting our ability to understand this relationship. We tested associations between relative deprivation and non-medical prescription opioid use (NMPOU) and heroin use among working-age adults (ages 18–64) during the Great Recession. Our sample included working-age adults in the 2005–2013 United States National Survey of Drug Use and Health (n = 320,186). Relative deprivation compared the lowest limit of participants' income category to the national 25th percentile individual income for people with similar socio-demographic characteristics (race and ethnicity, gender, year). We distinguished the period before (1/2005-11/2007), during (12/2007-06/2009), and after (07/2007-12/2013) the Great Recession. We estimated odds of past-year NMPOU and heroin use for each past-year exposure (i.e., relative deprivation, poverty, unemployment) using separate logistic regressions adjusting for individual-level covariates (gender, age, race/ethnicity, marital status, and education) and national-level annual Gini coefficient. Our results show that NMPOU was higher among people experiencing relative deprivation (aOR = 1.13, 95% CI = 1.06–1.20), poverty (aOR = 1.22, 95% CI = 1.16–1.29), and unemployment (aOR = 1.42, 95% CI = 1.32–1.53) between 2005 and 2013, as was heroin use (aORs = 2.54, 2.09, 3.55, respectively). The association between relative deprivation and NMPOU was modified by recession timing, and was significantly higher after the Recession (aOR = 1.21, 95% CI = 1.11–1.33). Relative deprivation was associated with higher odds of NMPOU and heroin use, and higher odds of NMPOU after the Great Recession. Our findings suggest contextual-level factors may modify the relationship between relative deprivation and opioid use, and support the need for new measures of financial hardship.

1. Introduction

Non-medical prescription opioid use (NMPOU) and heroin use affect many people in the United States (US) and may be associated with negative societal and health-related consequences. In 2019 approximately 3.7% of people 12 or older in the US reported past-year NMPOU and/or heroin use, including the 1.6 million people who initiated NMPOU and 50,000 people who initiated heroin use in the past year (Substance Abuse and Mental Health Services Administration; Department of Health and Human Services, 2020). NMPOU and heroin use have been associated with increased risk for several problems including anxiety and depression (Rogers et al., 2021), criminal legal system involvement (Birnbaum et al., 2011; Florence et al., 2016), emergency treatment (Guy et al., 2018), opioid use disorder, and opioid-related overdose death (Centers for Disease Control & Prevention, 2012). Given the problems associated with NMPOU and heroin use, more research is needed to understand contributors of NMPOU and heroin use.

Financial hardship may influence individual NMPOU and heroin use, but current measures of hardship (e.g., poverty and unemployment) may hinder our ability to understand this relationship. Evidence regarding the associations between poverty, unemployment, and drug use support

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potential relationships between financial hardship, NMPOU, and heroin use (Baptiste-Roberts and Hossain, 2018; Ghertner and Groves, 2018; Gu et al., 2022; Han et al., 2017; Henkel, 2011; Matthews et al., 2022; Perlmutter et al., 2017). Relative poverty in the US is defined with respect to the federal poverty line (FPL), a threshold of the standard of living determined by income and number of people in a household (Haveman et al., 2015; Lacour and Tissington, 2011; Piovani and Aydiner-Avsar, 2015). Living below the FPL can be a marker of individual relative deprivation (i.e., resource deprivation relative to others) and financial hardship (Eskelinen, 2011; Mabughi and Selim, 2006), and has been associated with higher opioid use (Ghertner and Groves, 2018). However, relative poverty may be an imperfect marker of individual relative deprivation because it relies on outdated thresholds and may undercount the number of people experiencing financial hardship (Brady, 2021; Fremstad, 2020). This may contribute to measurement error, underestimating the relationships between relative deprivation, NMPOU, and heroin use. Unemployment is also considered a marker of financial hardship (Brady et al., 2017), and has been associated with NMPOU (Han et al., 2015, 2017; Matthews et al., 2022; Perlmutter et al., 2017). However, unemployment may also be an imperfect marker of deprivation, as it does not reflect other available financial resources. Instead, examining an individual's income relative to people with similar socio-demographic characteristics (e.g., race and ethnicity, gender) may provide a more appropriate measure of relative deprivation needed to examine the relationships between individual financial hardship, NMPOU, and heroin use.

The relationships between financial hardship, NMPOU, and heroin use may change in the context of an economic recession (Glei et al., 2019), such as the Great Recession (12/2007-06/2009) (National Bureau of Economic Research, 2021). Economic recessions are marked by decreases in household income and assets, and high rates of unemployment (National Bureau of Economic Research, 2022; Seefeldt et al., 2012), and have been associated with increases in substance use, NMPOU, heroin use, and opioid-related overdose deaths (Azagba et al., 2021; Brown and Wehby, 2019; Carpenter et al., 2017; Hollingsworth et al., 2017; Ruhm, 2015). Economic recessions can also lead to individual income or job loss (Dooley et al., 2000; National Bureau of Economic Research, 2021; Seefeldt et al., 2012), which may contribute to increased distress and depression (Dooley et al., 2000; Glei et al., 2019; Nagelhout et al., 2017; Paul and Moser, 2009), and substance use as a coping mechanism (Aneshensel, 1992; Nagelhout et al., 2017; Sinha, 2001, 2008; Volkow, 2021). Past studies on the effects of deprivation on opioid use may have had measurement error in measures of individual poverty and unemployment, and none explored whether these relationships were modified by the Recession (Compton et al., 2014; Dow et al., 2020; Maclean et al., 2020; Nagelhout et al., 2017). One study that examined this potential interaction showed that the positive relationship between heroin use and state unemployment rates did not vary by recession timing (Carpenter et al., 2017). However, this may reflect the collinearity between state and national unemployment rates used to define a recession, and it remains unclear whether the relationships between individual financial hardship, NMPOU, and heroin use may be modified by recession timing.

This study aims to estimate the association between individual financial hardship, NMPOU, and heroin use among working-age adults during the Great Recession using a novel measure of the social psychological construct of relative deprivation (i.e., income disparity relative to individuals with similar socio-demographic characteristics). This reference income approach (Boyce et al., 2010) assumes that people with lower income relative to others similar to them will experience relative deprivation, and accounts for social context related to the Great Recession (Power et al., 2020). We examined the associations between poverty and unemployment on NMPOU and heroin use to confirm findings from previous studies using more years of data (Ruhm, 2015), and to compare our new relative deprivation measure to established measures of financial hardship. Experiencing deprivation relative to others with similar socio-demographic characteristics may then contribute to increased "escape" behaviors, like alcohol and drug use (Baron, 2004), that represent efforts to cope with one's deprivation (Power et al., 2020). Thus, we hypothesize that financial hardship (measured as individual relative deprivation, poverty, and unemployment), will be associated with higher odds of NMPOU and heroin use, and that this relationship may be modified by the Great Recession that disproportionally affected people with lower socio-economic status (Glei et al., 2019). By understanding whether the relationships between relative deprivation, poverty, and unemployment on opioid use varied by the Great Recession, we can identify populations at greater risk for opioid use, and strengthen economic support for vulnerable populations during times of economic recession. Furthermore, examining the relationships between financial hardship, NMPOU, and heroin use in the context of the Great Recession may offer an opportunity to examine the interaction between contextual factors (i.e., the Great Recession) and individual-level factors (i.e., financial hardship).

2. Methods

2.1. Study design and participants

We analyzed data from 320,186 working-age adults ages 18–64 from the 2005–2013 US National Survey on Drug Use and Health (NSDUH) public-use files. Survey years selected coincided with the period before, during, and after the Great Recession (National Bureau of Economic Research, 2021). The NSDUH is an annual nationally representative cross-sectional household survey designed to provide estimates of drug use and disorders in non-institutionalized individuals 12 years or older in the US (Substance Abuse and Mental Health Services Administration, 2012). The complex sampling frame excludes people who are institutionalized and homeless not in shelters. Weighted interview response rates ranged between 71.7 and 76.0% in 2005–2013 (Center for Behavioral Health Statistics and Quality, 2018a, b, c, d, e, f, g, h, i). Data were collected using computer assisted interviewing (CAI) and audio computer-assisted self-interviewing (ACASI) to encourage honest reporting for sensitive information such as opioid use. The NSDUH substance use questionnaire has been shown to have moderately good validity and reliability for most substances (Jordan et al., 2008; Substance Abuse and Mental Health Services Administration, 2010).

2.2. Measures

Past-year NMPOU and Past-year Heroin Use. Past-year NMPOU was defined as any self-reported use of prescription pain relievers that were not prescribed to the respondent or non-medical use of opioids prescribed to the respondent. Past-year heroin use was defined as any self-reported heroin use.

Great Recession. Defined using a quarter year indicator of participants' interview date to approximate the Great Recession from December 2007 to June 2009 (Q4 [i.e., October–December] 2007 through Q2 [i.e., April-June] 2009) as defined by the National Bureau of Economic Research (National Bureau of Economic Research, 2021). The Great Recession timing was delineated as before (Q1 [i.e., January-March] 2005 to Q3 [i.e., July-September] 2007), during (Q4 2007 to Q2 2009), and after (Q3 2009 to Q4 2013) the Recession.

Relative Deprivation. Annual individual income categories in the public-use NSDUH included <$10,000, $10,000-$19,999, $20,000-$29,999, $30,000-$39,999, $40,000-$49,999, $50,000-$74,999, and $75,000+. We assigned each observation the lowest value of the individual's self-reported income category range (e.g., assigning $10,000 for the $10,000-$19,999 category, $20,000 for the $20,000-$29,999 category, etc.); for the lowest income category, we assigned $0 in annual income. We then compared the respondent's assigned annual income to the 25th percentile of the US Census Bureau Current Population Survey 2020 Annual Social and Economic (ASEC) Supplement individual

income corresponding to the same race and ethnicity, and gender by survey year (Current Population Survey, 2020a). Income distribution was reported in the ASEC as the percent distribution in each income category (i.e., $1-$4,999, $5000-$9,999, $10,000-$14,999, $15,000-$24,999, $25,000-$49,999, $50,000-$74,999, $75,000-$99,999, $100,000+). We identified the income category that included the 25th percentile, then used the midpoint of the income category as the 25th percentile comparator. Average 25th percentile wages ranged from approximately $7500 to $20,000 depending on race and ethnicity, gender, and year.

Employment status. The NSDUH distinguished being employed full-time (≥ 35 hours/week), employed part-time (<35 h/week), unemployed (no job or layoff, but looking for work), or not in the workforce (not actively seeking work). Individuals "not in the workforce'' included retirees before age 65, disabled persons, homemakers, students, and people who previously sought employment but were no longer seeking employment.

Poverty. The NSDUH calculated household income as a percentage of the FPL and created a poverty indicator (below FPL, up to 2x FPL, above 2x FPL) for each observation based on the FPL determined by age, family size, number of children in the household, and total family income.

Individual-level socio-demographic variables. Socio-demographic variables were included because they may affect exposure to relative deprivation and be associated with NMPOU or heroin use. These included gender (male/female), age category (18–25, 26–34, 35–64), race/ethnicity (non-Hispanic white, non-Hispanic Black, Hispanic [any race], Other), marital status (never married, married, previously married [divorced, separated, or widowed]), education (less than high school, high school, some college, college or more), past-year self-reported major depressive episode(s) (yes/no), past-year self-reported psychological distress (yes/no), self-rated health (excellent or very good health, good health, fair or poor health), nicotine dependence (yes/no), and alcohol use disorder (AUD) (yes/no).

Contextual variables. Urbanicity (large metropolitan area, small metropolitan area, non-metropolitan area), was included because potential variations in the cost of living may contribute to financial hardship. The annual US Gini coefficient (Current Population Survey, 2020b) is a marker of income inequality that could also affect an individual's relative deprivation. Lower Gini coefficients have been previously associated with higher substance use rates (Galea et al., 2007).

2.3. Statistical analysis

Analyses were conducted using STATA 17.0 SE (Stata, College Station, TX, USA). All estimates reported are weighted using the NSDUH complex survey design weights, which were divided by the number of years included in the analysis. We first estimated survey-weighted prevalences of key individual-level demographic characteristics of the study sample, urbanicity, poverty, NMPOU, and heroin use. We then estimated the odds of past-year NMPOU and heroin use for each exposure (recession timing, relative deprivation, poverty, employment) using separate logistic regression models to avoid collinearity. We also assessed effect modification of the associations between relative deprivation, poverty, employment, NMPOU, and heroin use by stratifying models by recession time period (i.e., before, during, after) for interpretability. All adjusted odds of NMPOU and heroin use controlled for individual-level covariates (gender, age, race/ethnicity, marital status, education), urbanicity, and the national-level annual Gini coefficient.

2.3.1. Sensitivity analyses

We also conducted five sensitivity analyses in a series of additional models: 1) We assigned the highest value of each income category; for the high value in the highest income category (>$75,000), we assigned the individual $99,999. Then we ran models adjusted for 2) past-year major depressive episode(s), 3) past-year psychological distress, 4) self-rated health, and 5) nicotine dependence and AUD. It is important to adjust for nicotine dependence and AUD in sensitivity analyses because they are associated with financial hardship and drug use (Cohn et al., 2018; Gutkind et al., 2021; Hobkirk et al., 2018; Widome et al., 2015; Witkiewitz and Vowles, 2018; Zale et al., 2014).

3. Results

3.1. Demographic characteristics of study sample

In our study sample, 50.81% were female, 63.16% were 35–64 years old, 65.60% were non-Hispanic White, 56.38% had at least some college education, 53.40% were married, and 54.48% lived in a large metropolitan area (Table 1). These demographics were consistent before (2005–2007), during (2007–2009), and after (2009–2013) the Recession. Approximately 60.71% were employed full time, but this decreased from 63.83% before the Recession to 62.03% during and 58.37% after the Recession. The percentage of people living below the FPL before and during the Recession (12.19% and 12.36%, respectively) increased after the Recession (15.40%). Overall, 41.66% of our sample had an individual income lower than the 25th percentile of the national income distribution for individuals with similar racial and ethnic backgrounds and gender in the same survey year (i.e., experiencing relative deprivation). The overall proportion of people meeting the criteria for relative deprivation was 3 times higher than the proportion living below the FPL and 7.3 times higher than the proportion unemployed (41.66%, 13.85%, 5.71%, respectively).

3.2. Odds of past-year NMPOU and heroin use by recession timing, relative deprivation, poverty and unemployment

The adjusted odds of past-year NMPOU did not change significantly during or after the Recession compared with before the Recession (Table 2). Individuals who experienced deprivation relative to individuals with similar racial and ethnic backgrounds and gender had significantly higher odds of NMPOU (aOR = 1.13, 95% CI = 1.06–1.20). Similarly, the odds of NMPOU were significantly higher among people below the FPL (aOR = 1.22, 95% CI = 1.16–1.29) and people living up to two times above the FPL (aOR = 1.18, 95% CI = 1.11–1.25) compared with individuals living more than two times above the FPL. Past-year NMPOU was also significantly higher among people who were unemployed compared with individuals who were employed full-time (aOR = 1.42, 95% CI = 1.32–1.53), but not part-time or other.

The adjusted odds of past-year heroin use did not change significantly during or after the Recession compared with before the Recession. Compared with individuals who were not relatively deprived, the adjusted odds of past-year heroin use were significantly higher among individuals experiencing deprivation relative to others with similar racial and ethnic backgrounds and gender (aOR = 2.54, 95% CI = 1.86–3.46). Past-year heroin use was 2.09 times higher among people living below the FPL (95% CI = 1.59–2.74) compared with people living more than two times above the FPL, and 34% higher among people living up to twice the FPL (95% CI = 1.03–1.75). The adjusted odds of past-year heroin use were significantly higher among people who were employed part-time (aOR = 1.79, 95% CI = 1.34–2.40), unemployed (aOR = 3.55, 95% CI = 2.74–4.60), or other (aOR = 2.39, 95% CI = 1.84–3.11) compared with individuals who were employed full time.

3.3. Effect modification of the odds of past-year NMPOU and heroin use associated with relative deprivation, poverty and employment by recession timing

The odds of NMPOU among people experiencing relative deprivation were modified by recession timing. In stratified analyses by recession timing, results were only significantly higher after the Recession (aOR = 1.21, 95% CI = 1.11–1.33), and not before or during the Recession (Table 3). The odds of NMPOU among people living below the FPL and

Table 1
Selected characteristics of working-age adults ages 18 to 64, by year, weighted to be nationally representative, National Survey on Drug Use and Health 2005–2013.

Characteristic	Overall	Before Recession (Q1 2005- Q3 2007)	During Recession (Q4 2007- Q2 2009)	After Recession (Q3 2009- Q4 2013)
	N (wt. col %)	N (wt. col %)	N (wt. col %)	N (wt. col %)
Overall N (wt. row %)	320,186 (100)	96,701 (30.2)	62,219 (19.4)	161,266 (50.2)
Gender				
Male	149,769 (49.19)	45,123 (49.32)	29,073 (49.31)	75,573 (49.09)
Female	170,417 (50.81)	51,578 (50.68)	33,146 (51.69)	85,693 (50.94)
Age Group				
18 to 25	167,168 (17.77)	50,017 (17.60)	33,015 (17.76)	84,136 (17.88)
26 to 34	50,359 (19.07)	15,510 (19.11)	9650 (18.79)	25,199 (19.15)
35 to 64	102,659 (63.16)	31,174 (63.28)	19,554 (63.45)	51,931 (62.97)
Race/Ethnicity				
NH White	200,555 (65.60)	62,405 (67.29)	39,071 (66.69)	99,079 (64.20)
NH Black	40,367 (12.14)	11,808 (12.01)	7707 (11.85)	20,852 (12.32)
Hispanic	51,479 (15.28)	14,831 (14.24)	10,044 (14.92)	26,604 (16.02)
Other	27,785 (6.98)	7657 (6.46)	5397 (6.54)	14,731 (7.45)
Education				
Less than HS	52,764 (13.78)	17,049 (14.72)	10,789 (14.00)	24,926 (13.14)
HS Graduate	104,250 (29.84)	31,788 (30.35)	20,412 (30.26)	52,050 (29.38)
Some College	95,285 (27.05)	28,134 (26.58)	18,317 (26.69)	48,834 (27.47)
College Graduate	67,887 (29.33)	19,730 (28.36)	12,701 (29.05)	35,456 (30.01)
Marital Status				
Married	111,862 (53.40)	35,973 (55.41)	21,705 (54.24)	54,184 (51.89)
Widowed, Separated, Divorced	31,784 (15.82)	9617 (15.55)	6105 (15.31)	16,062 (16.17)
Never Married	176,540 (30.78)	51,111 (29.04)	34,409 (30.45)	91,020 (31.94)
Past-year Major Depressive Episode(s)				
No Past-year Major Depressive Episode(s)	290,885 (91.71)	87,904 (91.96)	56,602 (91.75)	146,379 (91.55)
Past-year Major Depressive Episode(s)	26,585 (7.50)	7988 (7.28)	5108 (7.45)	13,489 (7.65)
Missing	2716 (0.78)	809 (0.76)	509 (0.80)	1398 (0.79)
Past-year Psychological Distress				
No Past-Year Psychological Distress	270,967 (88.16)	82,057 (88.35)	52,621 (88.19)	132,289 (88.03)
Past-year Psychological Distress	49,219 (11.84)	14,644 (11.65)	9598 (11.81)	24,977 (11.97)
Self-Rated Health Status				
Excellent or Very Good	210,267 (62.37)	63,913 (62.95)	40,813 (62.65)	105,541 (61.92)
Good Health	81,826 (26.49)	24,599 (26.38)	16,066 (26.47)	41,161 (26.55)
Fair or Poor Health	28,041 (11.15)	8174 (10.67)	5330 (10.88)	14,537 (11.15)
Nicotine Dependence				
No Nicotine Dependence	264,772 (83.89)	78,737 (82.63)	51,093 (83.59)	134,942 (84.74)
Nicotine Dependence	55,414 (16.11)	17,964 (17.37)	11,126 (16.41)	26,324 (15.26)
Alcohol Use Disorder				
No Alcohol Abuse or Dependence	282,323 (91.34)	84,154 (90.97)	54,197 (91.04)	142,972 (91.68)
Alcohol Abuse or Dependence	38,863 (8.66)	12,547 (9.03)	8022 (8.96)	18,294 (8.32)
Urbanicity				
Large Metropolitan Area	141,884 (54.48)	43,094 (54.92)	27,537 (54.15)	71,253 (54.35)
Small Metropolitan Area	110,885 (29.80)	33,050 (29.09)	21,011 (29.44)	56,824 (30.36)
Non-metropolitan Area	67,417 (15.72)	20,557 (15.99)	13,671 (16.41)	33,189 (15.29)
Employment				
Employed Full-time	167,955 (60.71)	55,161 (63.83)	32,867 (62.03)	79,927 (58.37)
Employed Part-time	62,181 (14.26)	17,789 (13.57)	12,146 (14.05)	32,246 (14.75)
Unemployed	26,199 (5.71)	5623 (3.88)	4926 (5.27)	15,650 (6.95)
Other	63,851 (19.32)	18,128 (18.72)	12,280 (18.65)	33,443 (19.93)
Poverty[a]				
Below FPL	62,644 (13.85)	16,561 (12.19)	11,320 (12.36)	34,763 (15.40)
Up to 2x FPL	70,336 (18.48)	20,045 (17.36)	13,429 (17.55)	36,862 (19.50)
Above 2x FPL	180,422 (67.11)	58,019 (69.87)	35,977 (69.49)	86,426 (64.58)
Individual Annual Income				
<$10,000	125,997 (25.48)	36,437 (24.93)	23,955 (24.05)	65,605 (26.35)
$10,000-$19,999	66,613 (17.35)	20,498 (17.39)	12,790 (16.77)	33,325 (17.54)
$20,000-$29,999	41,517 (13.58)	13,669 (14.31)	8410 (14.03)	19,438 (12.98)
$30,000-$39,999	28,397 (11.25)	9175 (11.88)	5811(11.73)	13,411 (10.69)
$40,000-$49,999	19,268 (9.03)	6126 (9.56)	3822 (9.27)	9320 (8.62)
$50,000-$74,999	21,684 (11.99)	6330 (11.55)	4332(12.92)	11,022 (11.88)
$75,000+	16,710 (11.34)	4466 (10.37)	3099 (11.23)	9145 (11.94)
Relative Deprivation				
Income <25th Percentile	188,277 (41.66)	56,295 (41.82)	35,599 (39.28)	96,383 (42.46)
Opioid Use (Oxycontin or Pain Reliever)				
PY Opioid Use	25,682 (5.42)	8204 (5.55)	5407 (5.57)	12,071 (5.29)
Heroin Use				
PY Heroin Use	1393 (0.28)	332 (0.21)	254 (0.27)	807 (0.32)

Note: N = number of observations; wt. col = column percentages weighted using survey weights; wt. row = row percentages weighted using survey weights; Q1 = quarter 1 (January–March); Q2 = quarter 2 (April–June); Q3 = quarter 3 (July–September); Q4 = quarter 4 (October–December); NH = non-Hispanic; HS = high school; FPL = federal poverty line; PY = past year. Relative deprivation is defined by comparing the lowest end of an individual's income category to the 25th percentile of the national income distribution for a person with a similar racial and ethnic background and gender in the corresponding survey year.

[a] Missing: 6784 total (2076 in 2005-Q3 2007, 1493 in Q4 2007 - Q2-2009, 3215 in Q3 2009–2013).

Table 2
Odds of Past-Year Non-Medical Prescription Opioid Use (NMPOU), and Past-Year Heroin Use by different financial hardship measures including relative deprivation, poverty, and employment status, National Survey on Drug Use and Health 2005–2013.

Exposure	PY Non-Medical Prescription Opioid Use (Oxycontin and Pain Relievers)				PY Heroin Use			
	Unadjusted		Adjusted[a]		Unadjusted		Adjusted[a]	
	OR	95% CI	aOR	95% CI	OR	95% CI	aOR	95% CI
Time effects								
Before the Great Recession (2005 Q1- 2007 Q3)	1.00	–	1.00	–	1.00	–	1.00	–
During the Great Recession (2007 Q4- 2009 Q2)	1.01	0.93, 1.08	1.02	0.95, 1.09	1.28	0.99, 1.66	1.23	0.95, 1.60
After the Great Recession (2009 Q3- 2013)	0.95	0.90, 1.01	1.00	0.93, 1.08	**1.52**	**1.22, 1.89**	1.26	0.95, 1.68
Relative Deprivation								
Individual income equal or more than 25th percentile individual income	1.00	–	1.00	–	1.00	–	1.00	–
Individual relative deprivation	**1.72**	**1.64, 1.81**	**1.13**	**1.06, 1.20**	**4.13**	**3.12, 5.46**	**2.54**	**1.86, 3.46**
Poverty								
More than 2X Above the FPL	1.00	–	1.00	–	1.00	–	1.00	–
Below the FPL	**1.62**	**1.54, 1.71**	**1.22**	**1.16, 1.29**	**3.35**	**2.65, 4.23**	**2.09**	**1.59, 2.74**
Up to 2X the FPL	**1.43**	**1.35, 1.52**	**1.18**	**1.11, 1.25**	**1.97**	**1.53, 2.53**	**1.34**	**1.03, 1.75**
Employment								
Employed Full Time	1.00	–	1.00	–	1.00	–	1.00	–
Employed Part Time	**1.31**	**1.24, 1.38**	1.00	0.94, 1.05	**2.26**	**1.73, 2.96**	**1.79**	**1.34, 2.40**
Unemployed	**2.04**	**1.90, 2.19**	**1.42**	**1.32, 1.53**	**6.37**	**5.00, 8.10**	**3.55**	**2.74, 4.60**
Other	1.01	0.95, 1.07	0.96	0.91, 1.03	**2.47**	**1.95, 3.13**	**2.39**	**1.84, 3.11**

Note: OR = odds ratio; aOR = Adjusted odds ratio, PY=Past year, CI = confidence interval; Q1 = quarter 1 (January–March); Q2 = quarter 2 (April–June); Q3 = quarter 3 (July–September); Q4 = quarter 4 (October–December); FPL=Federal Poverty Line. The odds of each exposure were assessed in separate regression models to avoid co-linearity.

[a] Adjusted for population level characteristics: US gini coefficient, and socio-demographic variables including gender, age, race, education, and marital status, county urbanicity. Reference category: before the Recession, Male, 18–25, non-Hispanic white, high school education, married, large-metropolitan area.

people who were unemployed remained relatively consistent before, during, and after the Recession.

In stratified analyses by recession timing, the odds of heroin use among people experiencing relative deprivation were significantly higher before and after the Recession (aOR = 2.82, 95% CI = 1.56–5.08, and aOR = 2.67, 95% CI = 2.00–3.56, respectively). The odds of heroin use among people living below the FPL were also higher before and after the Recession (aOR = 2.40, 95% CI = 1.43–4.02, and aOR = 2.23, 95% CI = 1.72–2.88, respectively). Odds of heroin use among people who were unemployed remained consistent before, during, and after the Recession.

3.4. Sensitivity analyses

In sensitivity analyses varying the relative deprivation measure to the highest point of the individual's self-reported income category, relative deprivation was associated with 1.09 times higher odds of NMPOU (95% CI = 1.04–1.14) (Table 4a). The adjusted measure of relative deprivation was also associated with 2.13 times higher odds of heroin use (95% CI = 1.67–2.71).

Consistent with main analyses, the odds of NMPOU were higher after the Recession (aOR = 1.15, 95% CI = 1.07–1.24), and the odds of heroin use among people experiencing relative deprivation remained higher before and after the Recession in sensitivity analyses varying the deprivation measure (Table 4b).

Results remained largely consistent in additional sensitivity analyses independently adjusting for past-year major depressive episode(s) or psychological distress (Supplemental Table 1), and self-rated health, nicotine dependence and AUD (Supplemental Table 2). However, relative deprivation was no longer significantly associated with NMPOU after adjusting for psychological distress (Supplemental Table 1), and living up to two times above the FPL was no longer significantly associated with increased odds of past-year heroin use (Supplemental Table 2).

4. Discussion

This study examined the extent to which experiencing relative deprivation, poverty, or unemployment was associated with past-year NMPOU or heroin use among working-age adults before, during, and after the Great Recession. We observed that deprivation relative to individuals with similar socio-demographic characteristics (i.e., race and ethnicity, and gender) was associated with a higher likelihood of past-year NMPOU and heroin use. Unlike the FPL or unemployment, our novel measure of relative deprivation was sensitive to changing economic conditions, as relative deprivation was only associated with NMPOU after the Great Recession. This study adds to the literature regarding the effect of financial hardship on NMPOU and heroin use, and may provide support for the interaction between contextual level factors, such as the Great Recession, and individual relative deprivation on NMPOU.

We believe that our measure of relative deprivation is an improvement over other markers of financial hardship, such as the FPL or unemployment. These other markers have different thresholds for hardship, do not account for socio-demographic characteristics, and do not attempt to assess the social psychological construct of relative deprivation (Brady, 2021; Fremstad, 2020). Our measure has a lower threshold for hardship, and three times as many people met our criteria for relative deprivation compared with the poverty measure (41.66% vs. 13.85% living below the FPL, respectively). This may be because our measure relies on individual income rather than household income, and may be capturing a different construct of financial hardship. Our individual measure of relative deprivation is similar to previous studies using individual demographic characteristics such as income to construct a measure of relative deprivation (Boyce et al., 2010; D'Ambrosio and Frick, 2007; Smith et al., 2012). Our measure was based on a previously published population-level income index, which compared a state's median income to the national median income to measure income inequality at the population level (Piovani and Aydiner-Avsar, 2015). Our measure aimed to measure income inequality at the individual level, and our results suggest that individual relative deprivation was associated with significant changes in the odds of NMPOU and heroin use. Although relative deprivation on the individual level measures a different construct than income inequality at the population level, our findings are also consistent with literature suggesting income inequality was associated with increased risk for mood and substance

Table 3
Adjusted Odds Ratios of Past-Year Non-Medical Prescription Opioids Use (NMPOU), and Past-Year Heroin Use associated with relative deprivation, poverty, and employment, stratified by Recession time period, National Survey on Drug Use and Health 2005–2013.

	Before Recession (Q1 2005- Q3 2007)		During Recession (Q4 2007- Q2 2009)		After Recession (Q3 2009- Q4 2013)	
	aOR[a]	95% CI	aOR[a]	95% CI	aOR[a]	95% CI
PY Non-Medical Prescription Opioid Use (Oxycontin and Pain Relievers)						
Relative Deprivation						
Individual income equal or more than 25th percentile individual income	1.00	–	1.00	–	1.00	–
Individual relative deprivation	1.03	0.94, 1.14	1.10	0.99, 1.22	**1.21**	**1.11, 1.33**
Poverty						
More than 2x Above the FPL	1.00	–	1.00	–	1.00	–
Below the FPL	**1.18**	**1.06, 1.31**	**1.25**	**1.11, 1.41**	**1.25**	**1.16, 1.35**
Up to 2x the FPL	**1.16**	**1.04, 1.28**	1.03	0.90, 1.18	**1.25**	**1.15, 1.37**
Employment						
Employed Full Time	1.00	–	1.00	–	1.00	–
Employed Part Time	0.97	0.87, 1.07	0.95	0.80, 1.13	1.03	0.94, 1.14
Unemployed	**1.37**	**1.12, 1.69**	**1.59**	**1.35, 1.87**	**1.41**	**1.25, 1.59**
Other	0.92	0.84, 1.01	1.05	0.92, 1.21	0.97	0.88, 1.07
PY Heroin Use						
Relative Deprivation						
Individual income equal or more than 25th percentile individual income	1.00	–	1.00	–	1.00	–
Individual relative deprivation	**2.82**	**1.56, 5.08**	1.93	0.95, 3.95	**2.67**	**2.00, 3.56**
Poverty						
More than 2x Above the FPL	1.00	–	1.00	–	1.00	–
Below the FPL	**2.40**	**1.43, 4.02**	1.44	0.71, 2.92	**2.23**	**1.72, 2.88**
Up to 2x the FPL	1.50	0.99, 2.27	1.06	0.60, 1.87	1.38	0.98, 1.95
Employment						
Employed Full Time	1.00	–	1.00	–	1.00	–
Employed Part Time	1.52	0.86, 2.67	1.46	0.79, 2.71	**1.95**	**1.35, 2.79**
Unemployed	**4.34**	**2.01, 9.39**	**4.38**	**2.16, 8.86**	**3.09**	**2.23, 4.29**
Other	**2.56**	**1.45, 4.51**	**2.46**	**1.53, 3.96**	**2.28**	**1.64, 3.17**

Note: aOR = Adjusted odds ratio, PY=Past year, CI = confidence interval; Q1 = quarter 1 (January–March); Q2 = quarter 2 (April–June); Q3 = quarter 3 (July–September); Q4 = quarter 4 (October–December); FPL=Federal Poverty Line. The odds of each exposure were assessed in separate regression models to avoid co-linearity.

[a] Adjusted for population level characteristics: US gini coefficient, and socio-demographic variables including gender, age, race, education, and marital status, urbanicity. Reference category: Male, 18–25, non-Hispanic white, high school education, married, large metropolitan area.

use disorders (Cifuentes et al., 2008; Henderson et al., 2004; Messias et al., 2011; Pabayo et al., 2017; Piovani and Aydiner-Avsar, 2015). Consistent with previous studies showing increased "escaping" behaviors associated with relative deprivation (Baron, 2004; Smith et al., 2012), our findings may suggest that the stress associated with relative deprivation and income inequality (Lynch et al., 2000; Marmot and Wilkinson, 2001) may be associated with stress-related coping behaviors such as substance use . Considering the relationship between relative deprivation and NMPOU was modified by the Great Recession, it is also possible that the stress associated with relative deprivation may have been more pronounced during the time of economic recovery following the Recession, when some individuals experienced upward mobility and others continued to face financial hardship.

Poverty and unemployment were associated with higher odds of NMPOU and heroin use, which is consistent with prior literature on this relationship (Baptiste-Roberts and Hossain, 2018; Ghertner and Groves, 2018; Gu et al., 2022; Han et al., 2017; Henkel, 2011; Matthews et al., 2022; Perlmutter et al., 2017), and aligns with the pattern we observed with our relative deprivation measure. In a previous study using 2016 NSDUH data, individuals living below the FPL were more likely to report past-year opioid (NMPOU or heroin) misuse than individuals above 200% of the FPL (Ghertner and Groves, 2018). In our study, living below 200% of the FPL was associated with higher odds of past-year NMPOU and heroin use. Our study expands the literature by examining NMPOU and heroin use separately, and examining different levels of poverty separately. Our findings are also consistent with previous studies showing associations between unemployment and higher NMPOU, compared with full-time employment (Matthews et al., 2022; Perlmutter et al., 2017). Expanding upon this prior literature, both unemployment and part-time employment were associated with higher past-year heroin use. Our poverty and unemployment results also provide context for our relative deprivation measure, because all measures were associated with NMPOU and heroin use. These data on poverty, unemployment, and relative deprivation support our hypothesis that financial hardship may be associated with increased NMPOU and heroin use. Together, our findings support the need for expanded economic supports and harm reduction services among people who are unemployed, or experiencing poverty or relative deprivation.

Consistent with previous studies examining the associations between economic recessions, opioid use, and opioid-related deaths (Brown and Wehby, 2019; Carpenter et al., 2017; Hollingsworth et al., 2017), our study found the Recession was associated with higher unadjusted odds of heroin use. We expanded this research by examining the interaction between the Great Recession, poverty, unemployment, and our novel measure of relative deprivation. The relationships between poverty, unemployment, and NMPOU did not vary by the Recession timing. Similar to a previous study examining changes in the relationship between state-level unemployment rates and substance use during the Great Recession, our results show that the relationships between individual unemployment, NMPOU, and heroin use were not modified by the Great Recession (Carpenter et al., 2017). This study builds upon prior work by extending the number of years included in the post-recession comparison group, which is critical as changing the time horizon of data analysis may alter results (Ruhm, 2015). Furthermore, our relative deprivation measure was sensitive to the timing of the Great Recession and highlights the potential interplay between contextual factors such as the Recession and individual financial hardship. Findings also support a potential psychological distress mechanism linking macro-economic changes (i.e., the Recession), and changes in opioid use (Nagelhout et al., 2017). Sensitivity analyses adjusting for psychological distress suggest that the relationship between relative deprivation and opioid use may be mediated by psychological distress (Nagelhout et al., 2017), though more research using longitudinal study designs is necessary to confirm this relationship. These findings suggest that our relative deprivation measure may improve measurement of financial hardship compared with poverty and unemployment.

Examining economic and financial predictors of NMPOU and heroin use during economic downturns may offer insights for current opioid use trends during and following the coronavirus disease (COVID-19) epidemic. Despite efforts to curb the opioid epidemic and decreases in the prevalence of opioid use disorder between 2015 and 2019 (Substance Abuse and Mental Health Services Administration; Department of Health and Human Services, 2020), the COVID-19 pandemic precipitated another surge in opioid-related overdose deaths (Ahmad et al.,

Table 4a
Odds of Past-Year Non-Medical Prescription Opioid Use (NMPOU), and Past-Year Heroin Use, relative deprivation sensitivity analysis, National Survey on Drug Use and Health 2005–2013.

Exposure	PY Non-Medical Prescription Opioid Use (Oxycontin and Pain Relievers)				PY Heroin Use			
	Unadjusted		Adjusted*		Unadjusted		Adjusted*	
	OR	95% CI	aOR*	95% CI	OR	95% CI	aOR*	95% CI
Relative Deprivation (high SA)								
Individual income equal or more than 25th percentile individual income	1.00	–	1.00	–	1.00	–	1.00	–
Individual relative deprivation	**1.82**	**1.74, 1.90**	**1.09**	**1.04, 1.14**	**4.13**	**3.40, 5.01**	**2.13**	**1.67, 2.71**

Note: aOR = Adjusted odds ratio, PY=Past year, CI = confidence interval; Q1 = quarter 1 (January–March); Q2 = quarter 2 (April–June); Q3 = quarter 3 (July–September); Q4 = quarter 4 (October–December); high SA = highest point of income category sensitivity analysis.
* Adjusted for population level characteristics: US gini coefficient, and socio-demographic variables including gender, age, race, education, and marital status, urbanicity. Reference category: before the Recession, Male, 18–25, non-Hispanic white, high school education, married, large metropolitan area.

Table 4b
Adjusted Odds Ratios of Past-Year Non-Medical Prescription Opioids Use (NMPOU), and Past-Year Heroin Use, relative deprivation sensitivity analysis stratified by Recession time period, National Survey on Drug Use and Health 2005–2013.

	Before Recession (Q1 2005- Q3 2007)		During Recession (Q4 2007- Q2 2009)		After Recession (Q3 2009- Q4 2013)	
	aOR[a]	95% CI	aOR[a]	95% CI	aOR[a]	95% CI
PY Non-Medical Prescription Opioid Use (Oxycontin and Pain Relievers)						
Relative Deprivation (High SA)						
Individual income equal or more than 25th percentile individual income	1.00	–	1.00	–	1.00	–
Individual relative deprivation	1.01	0.93, 1.10	1.10	1.00, 1.20	**1.15**	**1.07, 1.24**
PY Heroin Use						
Relative Deprivation (High SA)						
Individual income equal or more than 25th percentile individual income	1.00	–	1.00	–	1.00	–
Individual relative deprivation	**2.64**	**1.61, 4.35**	1.77	0.99, 3.15	**2.04**	**1.61, 2.58**

Note: aOR = Adjusted odds ratio, PY=Past year, CI = confidence interval; Q1 = quarter 1 (January–March); Q2 = quarter 2 (April–June); Q3 = quarter 3 (July–September); Q4 = quarter 4 (October–December); high SA = highest point of income category sensitivity analysis.
[a] Adjusted for population level characteristics: US gini coefficient, and socio-demographic variables including gender, age, race, education, and marital status, urbanicity. Reference category: Male, 18–25, non-Hispanic white, high school education, married, large metropolitan area.

2021). Rising opioid-related deaths increase the urgency to understand how opioid use is influenced by economic changes related to the pandemic, such as growing rates of unemployment (Kochhar, 2021; US Bureau of Labor Statistics, 2021), and financial hardship (American Psychological Association, 2022). Although the underlying features of the COVID-19-related economic recession differ from the Great Recession, the stress associated with economic downturn coupled with increased rates of financial hardship may provide context for increased opioid use during the pandemic. Future studies should further examine this relationship.

4.1. Limitations

Our findings should be interpreted in light of several limitations. Drug use (e.g., NMPOU and heroin use) has been shown to contribute to and be a result of unemployment and financial hardship (Bennett et al., 2013; Bray et al., 2000; Kalousova and Burgard, 2014; Maclean et al., 2015; Nagelhout et al., 2017). Our measure of association captures the total effect of the bi-directional relationships between relative deprivation, poverty, and unemployment, with opioid use. While the cross-sectional design limits our ability to infer temporality of relative deprivation, poverty, or unemployment on opioid use, our findings are consistent with longitudinal studies showing that financial hardship precedes increased subsequent drug use (Kalousova and Burgard, 2014; Maclean et al., 2015). Future studies should leverage longitudinal data to understand the effect of unemployment and income loss on opioid use and related outcomes. There is also potential underreporting of NMPOU or heroin use due to social desirability bias using general population surveys (Nesoff et al., 2022), especially for heroin use, which is heavily stigmatized and relatively rare (Midgette et al., 2021; Reuter et al., 2021). However, NSDUH study protocols collect substance use information using computer assisted methods, including audio computer-assisted self-interviewing, to encourage honest reporting of stigmatized behavior (Center for Behavioral Health Statistics and Quality, 2018a, b, c, d, e, f, g, h, i). Furthermore, if NMPOU or heroin use were differentially underreported among people experiencing financial hardship, then our estimates may be conservative. Although we were able to compare the respondents' income with people of the same race, ethnicity, and gender for each year included in the analysis, we were not able to additionally account for the respondents' age or education beyond controlling for these variables in our analyses. There may be income variability within the population depending on age and education. While we adjusted for differences in cost-of-living between urban and more rural areas, the NSDUH public-use dataset does not contain census-level or state-level indicators, limiting our ability to adjust for more localized measures of income inequality (e.g., state Gini coefficient), economic disparity, or differences in cost-of-living that should be included in future studies (Chen and Crawford, 2012; Hollingsworth et al., 2017). NSDUH excludes institutionalized populations and unstably housed people not living in shelters who may be disproportionately affected by relative deprivation and substance use concerns (Ternes et al., 2018), suggesting that our measures of association may be underestimated. Lastly, although these findings align with results from various other countries (Nagelhout et al., 2017), they may not be generalizable to other contexts because of the variation in socio-demographic characteristics between countries, country-specific experiences of the Great Recession, differences in social support programs, and other country-specific correlates that may alter these associations (Power et al., 2020). Despite limitations, findings support relationships between individual economic measures (i.e., relative deprivation, unemployment, poverty) and opioid use.

5. Conclusion

Efforts to reduce the negative effects of relative deprivation could be particularly critical after economic recessions, as relative deprivation, unemployment, and poverty were associated with increased odds of

opioid use in that time. Our findings suggest the need for new measures of financial hardship and expanded economic support and harm reduction services for people experiencing financial hardship and relative deprivation. Given the devastating toll of the ongoing drug overdose epidemic, it is important to understand economic predictors of NMPOU and heroin use to better inform screening for substance use risk, and financial assistance programs and policy interventions that target risk factors among marginalized populations. In learning from the Great Recession, our study offers valuable insight into the potential effects of future economic downturns on NMPOU and heroin use trends.

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Role of the funder/sponsor

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Contributors

All authors have made substantive contributions to the study. SG conceived the study and analyzed the data. SG and SM interpreted the data and drafted the manuscript. All authors contributed to the critical review of the manuscript and have approved the final manuscript.

Author credit statement

Sarah Gutkind: Conceptualization; Data curation; Formal analysis; Project administration; Roles/Writing - original draft; Writing - review & editing. **Melanie S. Askari:** Conceptualization; Writing - review & editing. **Alexander Perlmutter:** Conceptualization; Data curation; Writing - review & editing. **Elizabeth D. Nesoff:** Conceptualization; Data curation; Writing - review & editing. **Pia M. Mauro:** Conceptualization; Data curation; Formal analysis; Project administration; Roles/Writing - original draft . **Silvia S. Martins:** Funding acquisition; Resources; Software; Supervision; Conceptualization; Data curation; Formal analysis; Project administration; Roles/Writing - original draft; Writing - review & editing.

Declaration of competing interest

All authors declare that they have no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2023.02.010.

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