The Role of Friends in the Opioid Epidemic

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Disclaimer: The views expressed in this paper are our own.

Introduction

- Opioids have led to the worst drug overdose epidemic in US history.
- In 2010, **more than 50 percent of opioid misusers obtained opioids from friends or relatives**

Year	All	Non-College	College
	Panel A: Fraction that obtained opioids from friends		
2010	56.35%	56.16%	56.91%
2015	46.32%	46.15%	46.91%
2019	34.83%	33.26%	38.95%
	Panel B: Physical pain as main reason for last misuse of opioids		
2015	59.14%	61.52%	58.42%

Source: National Survey on Drug Use and Health

Introduction

- **Peers** have been highlighted as a potentially important factor in the fight against opioids (Compton et al., 2019; Blanco et al., 2020).
- Yet, the empirical estimation of peer effects is **challenging** due to the unavailability of data and the difficulties in achieving identification.

What we do

- We fill this gap by exploiting rich information on **opioid misuse by individuals between ages 25-34** and their **high school best friends' opioid misuse**, utilizing a comprehensive set of controls that include information on demographics, health, and parental characteristics.
- To estimate the causal impact of peer influence, we employ an **instrumental variable** approach while accounting for state and/or school-specific factors.
- Our identification strategy is that individuals can **develop misuse and addiction as a result of an opioid prescribed for a severe injury**, an exogenous factor, which can then affect their peers.

Related literature

- **Determinants of the opioid epidemic** in the US (Alpert et al., 2018 and 2022; Eichmeyer and Zhang, 2022; Janssen and Zhang, 2023).
- **Peer effects on the consumption of other substances** such as tobacco or alcohol (Card and Giuliano, 2013; Cutler and Glaeser, 2005; Clark and Lohéac, 2007; Kremer and Levy, 2008; Lundborg, 2006; Fletcher, 2012).

Related literature

Studies that estimate **spillovers** in opioid misuse:

- Mäckle and Ruenzi (2022) and Cutler and Donahoe (2024) exploit friendship links (facebook friends) between counties to study network effects on overdose deaths at the **county level**.
- Seamans et al. (2018) study opioid initiation among **household members** using a similar instrument to ours (injury of a family member), distinguishing by injury type (ankle sprain or fracture, with the latter being treated more frequently with opioids).
- Thingholm (2023) documents spillovers in opioid prescriptions among **practitioners** in Denmark and negative consequences on the labor market outcomes of their patients.

- Our paper: individual level behavior among friends.

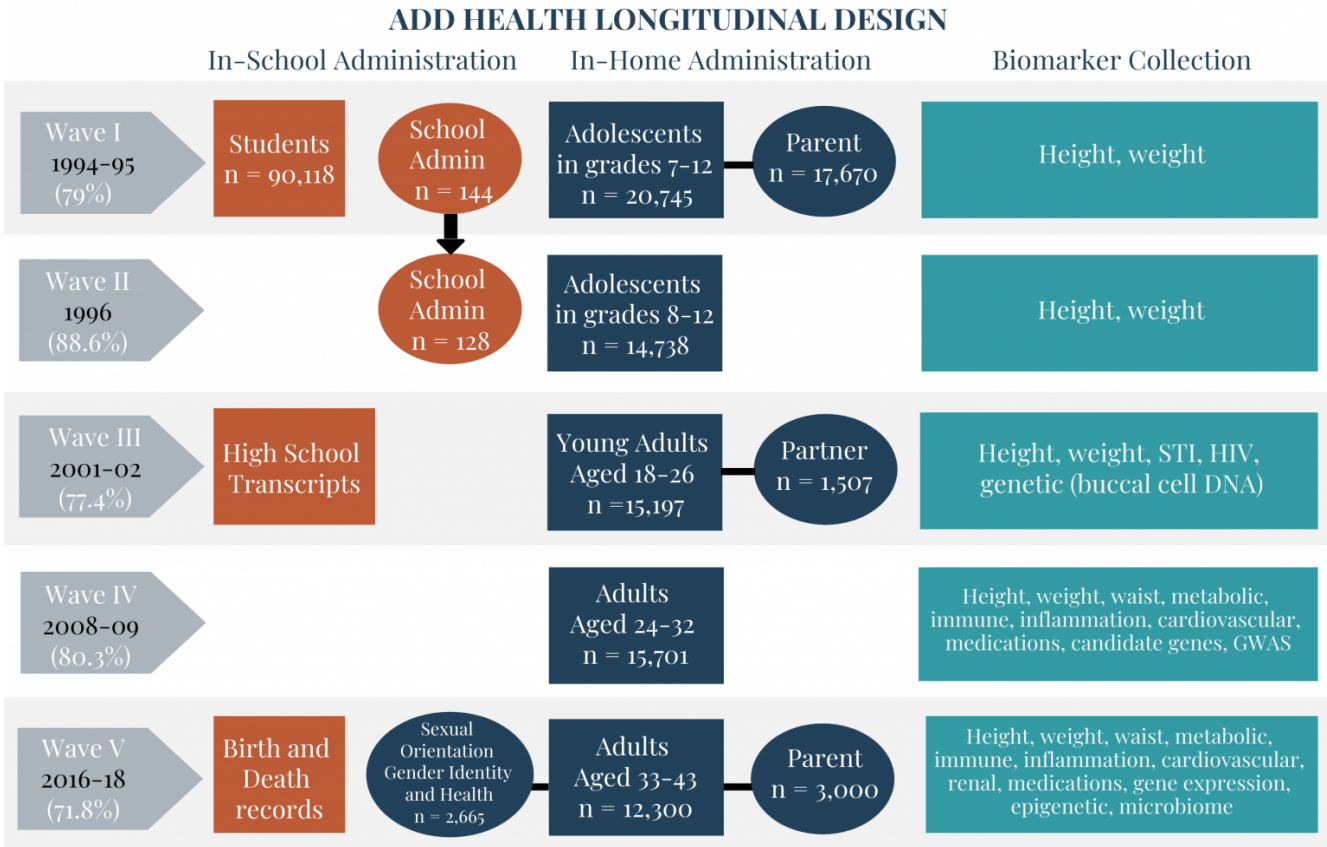


Figure 1: Waves of Add Health Survey

- Use information on **best friends at high school** (Wave I) and **opioid misuse in adulthood** (Wave IV, i.e., 14 years after).
- Use longitudinal survey weights to account for any possible attrition.

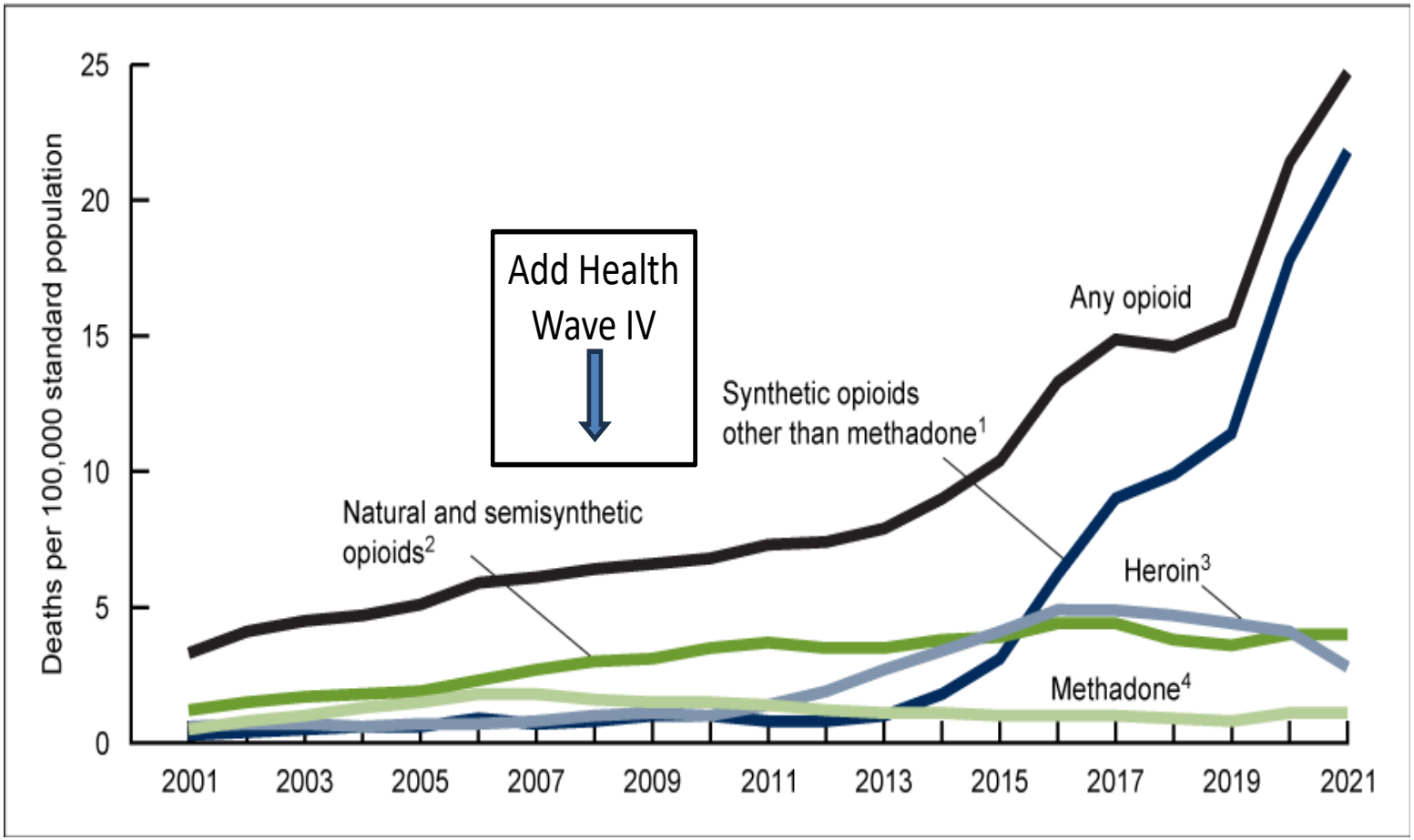
Add Health survey

- Wave I of the survey took place in 1994/1995 and entailed in-home interviews of a representative sample of high school students (aged 11-19) in the US.
  - Respondents were asked to nominate up to five male and five female friends.
  - Nominations were made starting from the closest friend to the most distant friend.
  - We focus on the **first male and female nominations**, i.e., the best friends.
  - Given that, in most cases, individuals and their best friends were attending the same school, they were all part of the Add Health in-home interview $\Rightarrow$ we can retrieve a rich set of information both for the individuals and their best friends.

Add Health survey

- After Wave I, respondents (individuals and their friends) were followed up to adulthood.
- Wave III took place in 2001/2002 and Wave IV took place in 2008/2009.
- A question that allows us to directly measure opioid misuse was asked for the first time in Wave IV. At that time, the respondents were between **25 and 34 years old**.

Stages of the opioid epidemic



- Wave IV: **Limited knowledge** regarding the risk of addiction and death due to opioid misuse, **prescriptions** for opioids as painkillers were **very common** (Guy, 2017).

Information on opioid misuse

- Question in Wave IV that allows us to directly measure **opioid misuse**.
  - Q: "Which of the following types of prescription drugs have you ever taken that were not prescribed for you, taken in larger amounts than prescribed, more often than prescribed, for longer periods than prescribed, or that you took only for the feeling or experience they caused? Pain killers or opioids, such as Vicodin, OxyContin, Percocet, Demerol, Percodan, or Tylenol with codeine."
- Question in Wave IV that allows to determine the **timing** and the **intensity** of the misuse:
  - Q: "During the past 12 months, on how many days did you use pain killers?: none, 1 or 2 days, once a month or less, 2 or 3 days a month, 1 or 2 days a week, 3 to 5 days a week, every day or almost every day."

Information on injuries

- Additionally, respondents in Wave IV were asked whether they **suffered a serious injury in the previous year**. The question was:
  - Q: "In the past 12 months, have you suffered any serious injuries? For example, broken bones, cuts or lacerations, burns, torn muscles, tendons or ligaments, or other injuries that interfered with your ability to perform daily tasks."

Table 1: Final sample statistics

	N (1)	mean (2)	sd (3)
Outcomes (Wave IV)			
Opioid misuse	2,826	**0.169**	0.375
Any best friend opioid misuse	2,826	0.192	0.394
Severely injured	2,826	**0.138**	0.345
Any best friend severely injured	2,826	0.161	0.368
Current self-perceived health status	2,826	2.731	0.918
Opioid addiction	2,521	0.035	0.184
Stimulants misuse	2,826	0.080	0.272
Smoking	2,817	0.697	0.460
Additional outcomes (as of 2021)			
Death due to poisoning from toxic substances or suicide	2,826	0.007	0.081
Death due to medical factors	2,826	0.013	0.112
Characteristics (Wave IV)			
Female	2,826	0.523	0.500
College	2,826	0.370	0.483
African American	2,826	0.123	0.329
Hispanic	2,826	0.081	0.273
Age	2,826	28.63	1.771
Ever diagn. depressed	2,826	0.150	0.357
Ever diagn. post-traumatic stress	2,826	0.029	0.169
Ever diagn. anxiety	2,826	0.126	0.332
Characteristics (Wave I)			
Cigarette avail. in parental home	2,826	0.312	0.463
Alcohol avail. in parental home	2,826	0.312	0.463

Note: Characteristics of individuals in the Add Health regression sample. Survey weights used.

Empirical challenges

Estimating peer effects entails several empirical challenges (Manski 1993 and 2000, Angrist, 2014):

1. Endogenous friendship formation/termination (**"homophily"**).

- $\Rightarrow$ focus on friendships formed during high school (best friends, who are likely to maintain contacts after high school graduation)
- $\Rightarrow$ Estimate an intention to treat without conditioning on current friendships.

Empirical challenges

2. Simultaneity or **"reflection problem"**.

- $\Rightarrow$ study opioid use at least 14 years after friendship formation
- $\Rightarrow$ use an instrument: best friends' serious injury.
  - Instrumental variables approach widespread in the literature that causally estimates peer effects (Cappellari and Tatsiramos, 2015; Dahl et al., 2014; De Giorgi et al., 2010; Fletcher, 2012; Kim et al., 2024).

3. **Correlated effects** (both individuals and their friends are often subject to common factors/environment).

- $\Rightarrow$ Include different sets of fixed effects (state in WIII/school in WI).

Reduced form

$$\begin{aligned}\text{Opioid misuse}_{is} = \beta_1(\text{any best friend serious injury})_{is} \\ + \beta_2(\text{serious injury})_{is} + \beta_3 X_{is} + \eta_s + u_{is}.\end{aligned} \tag{1}$$

$\Rightarrow$Directly regress own opioid misuse on best friends' serious injuries.

The 2SLS model consists of:

- **Second stage equation for individual i in state s**

$$\text{Opioid misuse}_{is} = \beta_1(\text{any best } \widehat{\text{friend opioid misuse}})_{is} + \beta_2(\text{serious injury})_{is} + \beta_3 X_{is} + \eta_s + u_{is}, \tag{2}$$

- **First stage regression**

$$\text{Any best friend opioid misuse}_{is} = \gamma_1(\text{any best friend serious injury})_{is} + \gamma_2(\text{serious injury})_{is} + \gamma_3 X_{is} + \mu_s + e_{is}, \tag{3}$$

- **Exclusion restriction**

$$cov(\text{any best friend serious injury}_{is}, u_{is} \mid X_{is}, \eta_s) = 0 \tag{4}$$

Exclusion restriction

- Identification based on the presumption that a best friend's injury affects own opioid misuse only through its effect on the best friend's opioid misuse (and **not directly**).
- Exclusion restriction could be violated if the individual was **injured together** with their best friend (e.g., joint accident) or if the individual started misusing opioids due to the stress caused by the best friend's injury.

Exclusion restriction

- $\Rightarrow$ Control for whether individuals **suffered a serious injury themselves** and for whether the individual has ever been diagnosed with depression, post-traumatic stress, or anxiety.
- $\Rightarrow$ Exclude individuals who had **previous experience with illegal drugs or non-prescribed painkillers** AND
  - Only consider severe injuries that **did not involve a vehicle accident**
  - Exclude individuals (and their best friends) who are **risk lovers**, who report that they have ever put themselves or others **at risk under the influence of a drug**, or who **suffered a severe injury themselves**.
  - **Regress own injuries on best friends' injuries**.

Control variables

- The vector X_{is} in the **benchmark specification** includes:
  - age, gender, education, race
  - an indicator for having ever been diagnosed with depression, post-traumatic stress or anxiety
  - an indicator for the availability of cigarettes or alcohol at the parental home while at high school.
- **Additional controls**
  - Big 5 personality traits (extraversion, neuroticism, agreeableness, openness, conscientiousness)
  - availability of drugs at the parental home while at high school
  - occupation dummies
  - family of origin controls (maternal education, gross household parental income during high school, living with both parents during high school).
- We cluster standard errors at the school level.

Covariate Balance

- We will use the experience of having at least one best friend who suffered a serious injury to study its effect on the probability of opioid misuse.
- The exposure should be plausibly exogenous, meaning that individuals with and without an injured best friend should be similar in predetermined characteristics.

To test covariate balance we regress:

$$\text{Covariate}_i = \delta_1(\text{Injured best friend})_i + \varepsilon_i, \tag{5}$$

where Covariate_i is each baseline characteristic of individual i, and $(\text{Injured best friend})_i$ is the indicator variable.

Table 2: Covariate balance tests

Covariate	Coefficient	Std. Error
College	-0.066*	(0.035)
Female	-0.068*	(0.038)
Age	0.096	(0.141)
Hispanic	0.024	(0.022)
African American	-0.007	(0.025)
Ever depressed	0.032	(0.029)
Post-traumatic stress	0.011	(0.012)
Anxiety	0.004	(0.025)
Cigarettes at home	0.048	(0.036)
Alcohol at home	-0.048	(0.034)
Observations	2,826	
Joint F-test	$F(10, 2815) = 1.32$, $p = 0.214$	

Note: Each coefficient is from a separate regression of the covariate on the indicator for having an injured best friend. Robust standard errors in parentheses. $^{*}p < 0.1$.

- The joint F-test for all covariates shows that the covariates, considered jointly, are not predictive of friends' injuries.
- Although not based on a randomized experiment, these results indicate that **individuals with and without an injured best friend are comparable** in their predetermined characteristics.

REDUCED FORM

Friends' injuries $\Rightarrow \uparrow$ own prob(opioid misuse)

Dep. var.:	Prob(Opioid misuse)
	(1)
Any best friend severely injured	0.073**
	(0.029)
Severely injured	0.091***
	(0.030)
Observations	2,826
State FE	Yes
Mean	0.169

Note: Robust standard errors clustered at the school level in parentheses. Survey weights used. *p<0.10; **p<0.05; ***p<0.01.

- If any best friend gets severely injured, the probability of own opiod misuse increases by 7.3 pp.
- This effect is substantial: about 80 percent of the estimated effect of experiencing a severe injury oneself.

Placebo effect on the probability of engaging in other risky behavior (smoking, drinking, unprotected sex)

$$\begin{aligned}\text{Risky behavior}_{is} = \beta_1(\text{any best friend serious injury})_{is} \\ + \beta_2(\text{serious injury})_{is} + \beta_3 X_{is} + \eta_s + u_{is}.\end{aligned} \tag{6}$$

$\Rightarrow$test whether estimates capture some general risky behavior among friends rather than a pure peer effect.

Friends' injuries ⇒ ↑ own prob(opioid misuse) but NOT the likelihood of other risky behavior

Dep. var.:	Prob(Smoking)	Prob(Drunk)	Prob(Unprotected sex)
	(1)	(2)	(3)
Any best friend severely injured	0.004	0.023	0.036
	(0.031)	(0.037)	(0.036)
Severely injured	0.029	0.009	-0.019
	(0.039)	(0.042)	(0.041)
Observations	2,817	2,111	2,418
State FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Mean	0.697	0.705	0.460

Note: Robust standard errors clustered at the school level in parentheses. Survey weights used. *p<0.10; **p<0.05; ***p<0.01.

2SLS

Table 3: First stage regression

	Dep. var.: Prob(Any best friend opioid misuse)
Any best friend severely injured	0.156***
	(0.036)
Severely injured	-0.033
	(0.026)
College	0.029
	(0.029)
Female	-0.025
	(0.024)
Age	-0.018***
	(0.007)
Hispanic	-0.052
	(0.036)
African American	-0.113***
	(0.028)
Ever diagn. depressed	0.057*
	(0.034)
Ever diagn. post-traumatic stress	-0.056
	(0.055)
Ever diagn. anxiety	0.002
	(0.031)
Cigarette avail. at parental home in WI	0.001
	(0.022)
Alcohol avail. at parental home in WI	0.036
	(0.027)
Observations	2,826
State FE	Yes

Note: Robust standard errors clustered at the school level in parentheses. Survey weights used. *p<0.10; **p<0.05; ***p<0.01.

Table 4: Peer effects in opioid misuse-2SLS

	Dep. var.: Prob(Opioid misuse)					
	(1)	(2)	(3)	(4)	(5)	(6)
Any best friend opioid misuse	0.576**	0.613***	0.519**	0.495**	0.471**	0.472**
	(0.227)	(0.225)	(0.203)	(0.196)	(0.198)	(0.196)
Severely injured		0.132***	0.124***	0.115***	0.106***	0.106***
		(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
College				-0.038*	-0.033	-0.032
				(0.023)	(0.022)	(0.023)
Female				-0.024	-0.040**	-0.040**
				(0.020)	(0.020)	(0.020)
Age				-0.009	-0.008	-0.009
				(0.007)	(0.007)	(0.007)
Hispanic				0.000	-0.002	-0.000
				(0.042)	(0.040)	(0.039)
African American				-0.002	0.002	0.005
				(0.037)	(0.036)	(0.036)
Ever diagn. depressed					0.071*	0.070*
					(0.042)	(0.042)
Ever diagn. post-traumatic stress					0.100	0.099
					(0.064)	(0.063)
Ever diagn. anxiety					0.041	0.042
					(0.044)	(0.045)
Cigarette avail. at parental home in WI						0.021
						(0.031)
Alcohol avail. at parental home in WI						0.023
						(0.028)
Observations	2,846	2,846	2,843	2,830	2,830	2,826
State FE	No	No	Yes	Yes	Yes	Yes
Kleibergen-Paap Wald rk F statistic	17.43	17.21	16.90	18.58	18.27	18.44

Note: Robust standard errors clustered at the school level in parentheses. Survey weights used. *p<0.10; **p<0.05; ***p<0.01.

Table 5: Peer effects on opioid misuse-conditional independence

	Dep. var.: Prob(Opioid misuse)		
	(1)	(2)	(3)
Any best friend opioid misuse	0.468**	0.449**	0.420**
	(0.201)	(0.208)	(0.195)
Observations	2,633	2,598	2,476
Controls	Yes	Yes	Yes
FE	State	State	State
Description	Not at risk under drugs by WIV	No risk lovers	No own severe injury in WIV
Kleibergen-Paap Wald rk F statistic	17.18	16.60	19.67

Note: The estimated coefficients of equation 2 and the F-statistic of equation 3 for different sample restrictions. Robust standard errors in parentheses are clustered at the school level. Survey weights are used. *p<0.10; **p<0.05; ***p<0.01. The sample is restricted to individuals who had not used any illegal drugs in Wave I or any painkillers in Wave III. See Table 4, column 6 for the list of controls.

- The instrument should be independent of potential outcomes $\Rightarrow$ need to assure that severe injuries are not caused by risky behavior due to opioid misuse.

Table 6: Testing the exclusion restriction: friends' injuries do NOT lead to own injuries

	Dep. var.: Prob(Severely injured)	
	(1)	(2)
Any best friend severely injured	-0.023	-0.034
	(0.027)	(0.024)
Observations	2,131	2,118
Controls	No	Yes
State FE	Yes	Yes
Mean	0.117	0.116

Note: Robust standard errors clustered at the school level in parentheses. Survey weights used. *p<0.10; **p<0.05; ***p<0.01. Sample restricted to individuals who had not used any illegal drugs in Wave I or any pain killers in Wave III.

Main result

- We find **significant positive peer effects** on opioid misuse.
- In terms of economic significance:
  - The coefficient of the first stage is 0.15⇒ if the best friend had a serious injury, the probability of them misusing opioids ↑ by 15pp.
  - The coefficient of the second stage is 0.47⇒ if the best friend had a serious injury, the probability of the respondent misusing opioids ↑ by 0.15×0.47=**7pp**.
  - This is substantial given that the average incidence of misusing opioids is 17%.

Robustness checks I

- Different fixed efffects (school, school and state)

Control for:

- Drug availability at parental home
- Peer average characteristics
- Big5 personality traits, risk aversion
- Occupation
- Family of origin controls: maternal education, parental income in Wave I, two-parent household in Wave I.

Exclude from the analysis:

- individuals (and their best friends) who are risk lovers
- individuals (and their best friends) who report that they have ever put themselves or others at risk under the influence of a drug.

Peer effects in opioid misuse-2SLS robustness

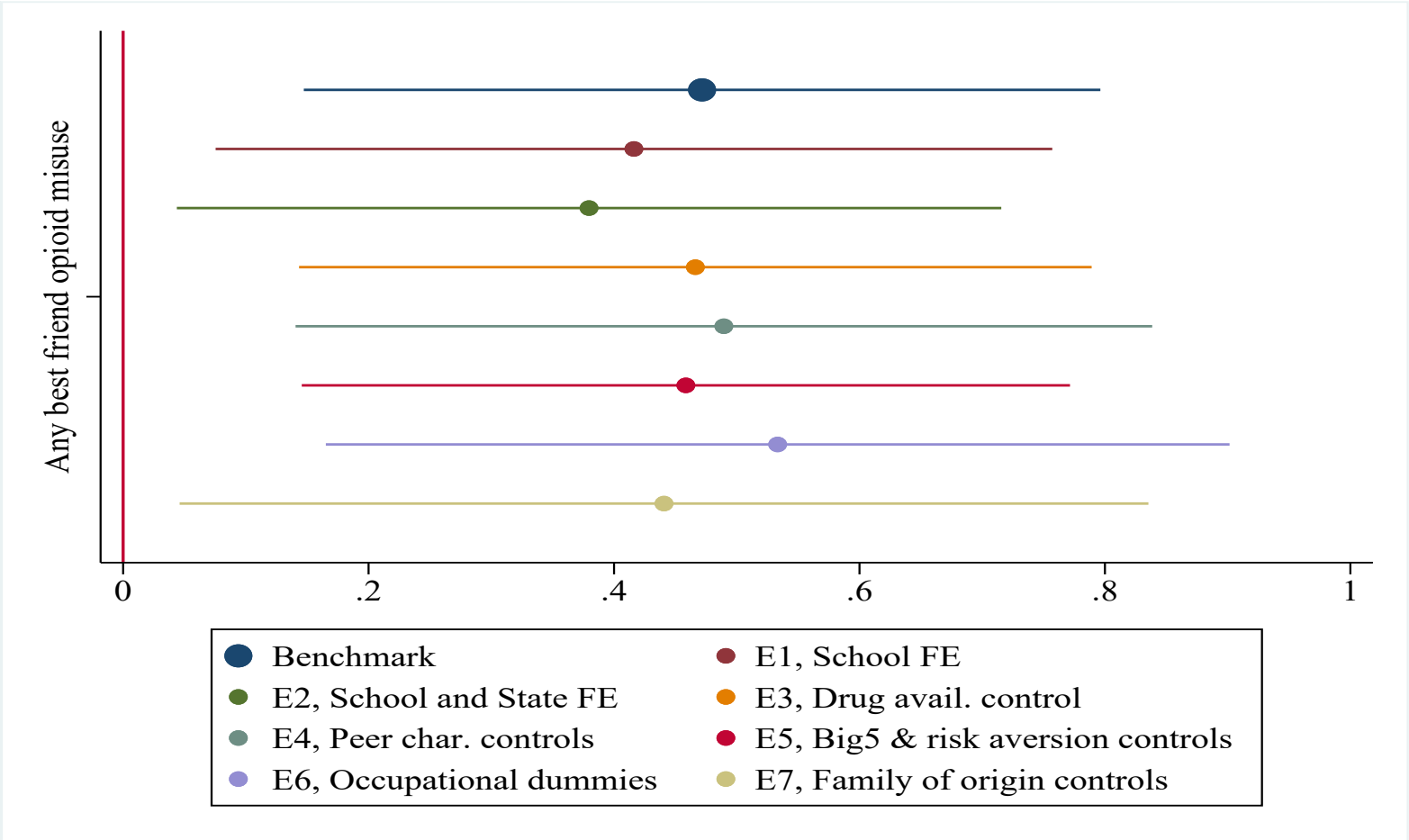


Figure 2: Estimated peer effects and 90% confidence intervals

Robustness checks II

- Different measures of peer influence
  - Any best friend (benchmark)
  - Percentage of best friends
  - Number of best friends
  - Dyads of best friends

Table 7: Peer effects in opioid misuse-different measures of peer influence

	Dep. var.: Opioid misuse			
	(1)	(2)	(3)	(4)
Best friend opioid misuse	0.472**	0.544**	0.451**	0.530**
	(0.196)	(0.266)	(0.193)	(0.235)
Observations	2,826	2,826	2,826	3,257
Controls	Yes	Yes	Yes	Yes
FE	State	State	State	State
Description	**Any best friend (Benchmark)**	**Percentage of best friends**	**Number of best friends**	**Dyads of best friends**
Kleibergen-Paap Wald rk F statistic	18.44	12.72	16.98	12.10

Note: Robust standard errors clustered at the school level in parentheses. Survey weights used. *p<0.10; **p<0.05; ***p<0.01.

Timing and intensity of opioid misuse

- Exclude from the analysis individuals with previous (Wave I or Wave III) experience with illegal drugs or non-prescribed pain killers

and

- Use Wave IV information on intensity of opioid misuse in the last 12 months.
  - Any
  - Once per month or more
  - 2-3 days per month or more
  - 1-2 days per week or more

Table 8: Peer effects in opioid misuse-by timing and intensity of misuse

	Dep. var.: Prob(Opioid misuse)				
Intensity	**Ever misused**	**Any in the last 12 months**	**Once per month or more in the last 12 months**	**2-3 days per month or more in the last 12 months**	**1-2 days per week or more in the last 12 months**
	(1)	(2)	(3)	(4)	(5)
Any best friend opioid misuse	0.505***	0.314**	0.291**	0.283**	0.258**
	(0.174)	(0.124)	(0.118)	(0.112)	(0.123)
Observations	2,118	2,010	1,985	1,967	1,950
Controls	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Mean	0.110	0.0584	0.0419	0.0311	0.0152
Kleibergen-Paap Wald rk F statistic	13.46	13.77	13.54	12.80	10.65

Note: Robust standard errors clustered at the school level in parentheses. Survey weights used. *p<0.10; **p<0.05; ***p<0.01. **Sample restricted to individuals who had not used any illegal drugs in Wave I or any pain killers in Wave III.**

Heterogeneity I: by education and race

Table 9: Share of opioid misusers by education and race

By education		By race	
College	Non-College	Non-Hispanic white	Others
(1)	(2)	(3)	(4)
0.127	0.165	0.189	0.073

Note: Characteristics of individuals in the Add Health regression sample. Survey weights used.

- Opioid misuse is more common among the **non-college educated** and the **non-hispanic white** in the period of our analysis.

Table 10: Peer effects in opioid misuse-2SLS by education and race

	Dep. var.: Prob(Opioid misuse)			
	By education		By race	
	College	Non-College	Non-Hispanic white	Others
	(1)	(2)	(3)	(4)
Any best friend opioid misuse	0.206	0.597**	0.395*	0.691
	(0.300)	(0.238)	(0.223)	(0.485)
Observations	1,072	1,747	1,726	1,095
Controls	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Mean	0.127	0.165	0.189	0.0728
Kleibergen-Paap Wald rk F statistic	9.829	12.42	12.31	9.177

Note: Robust standard errors clustered at the school level in parentheses. Survey weights used. *p<0.10; **p<0.05; ***p<0.01.

- Significant and large peer effects among the **non-college educated**.
- No significant difference by race.

Heterogeneity II: by strength of friendships

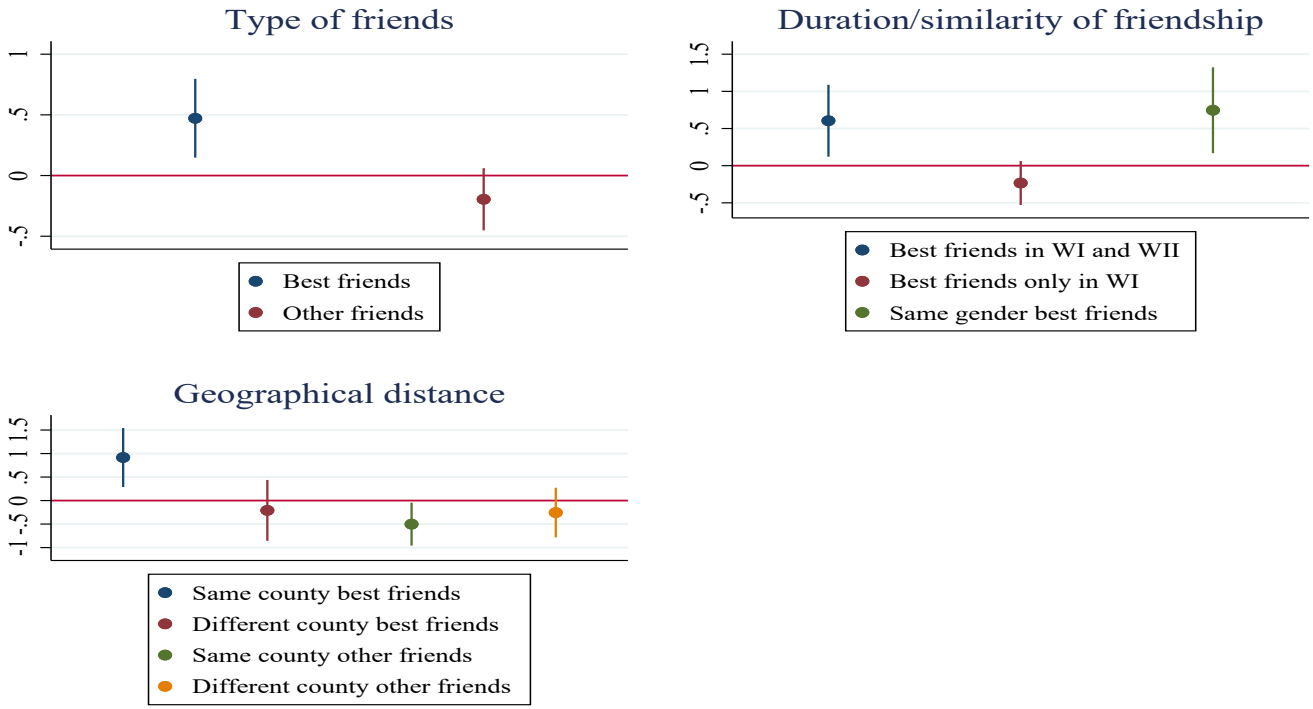


Figure 3: Estimated peer effects and 90% confidence intervals (Table)

- Peer effects among **strong ties**.
- No effect on same county other friends rules out that a common shock affects everyone in the county.

Heterogeneity III: by characteristics of the network

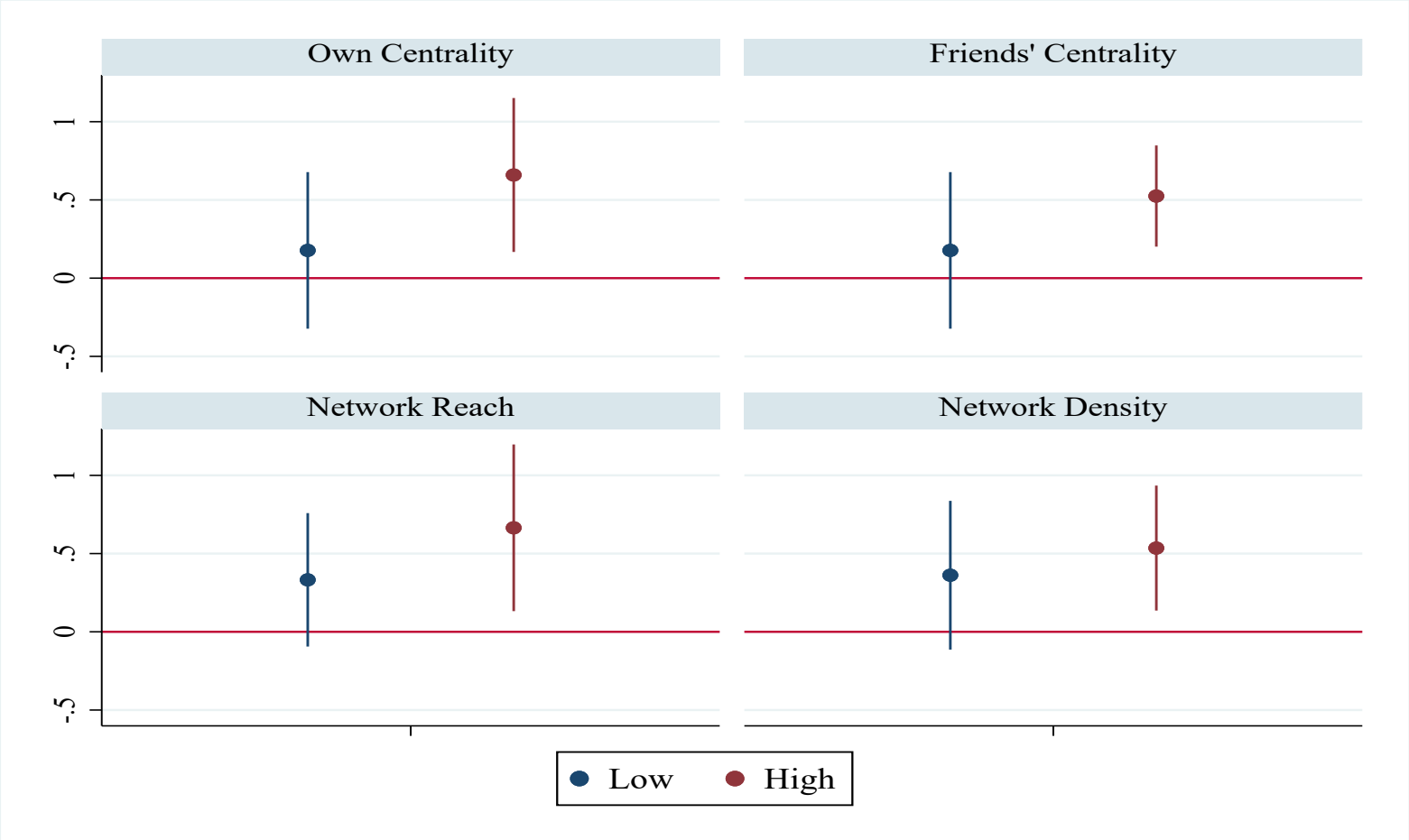


Figure 4: Estimated peer effects and 90% confidence intervals

- Peer effects on individuals who were **central** and with a **high reach**.

Heterogeneity IV: by local-level factors

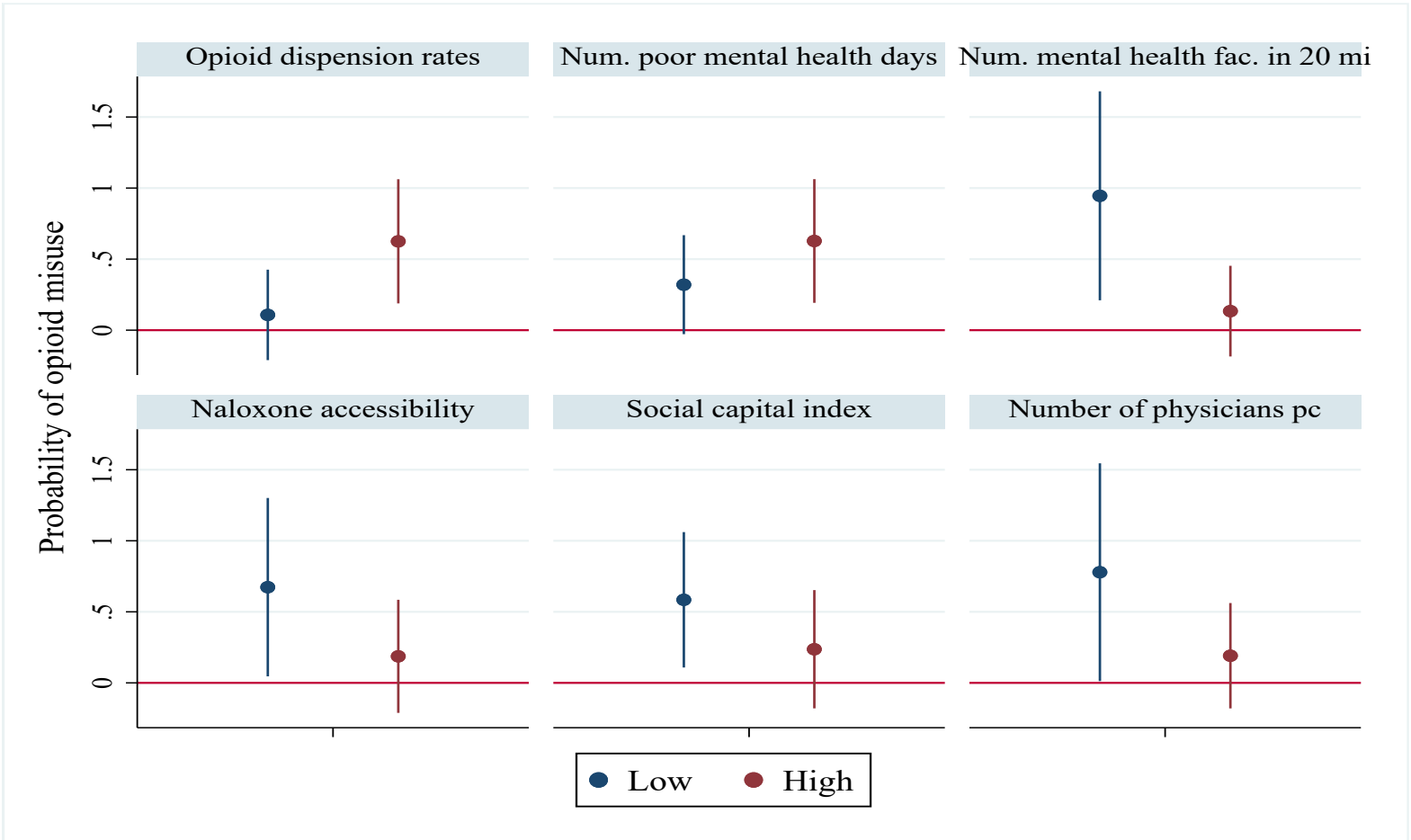


Figure 5: Estimated peer effects and 90% confidence intervals

- Peer effects in states with high opioid dispensing rates and late implementation of naloxone access laws.

Peer opioid misuse $\Rightarrow$ Health $\downarrow$, Prob(stimul. misuse) $\uparrow$, Prob(opioid addiction) $\uparrow$

Table 11: Welfare and broader implications

Dep. Var.:	Self-perceived health status	Stimulants misuse	Opioid addiction	Death due to medical factors	Death due to poisoning from toxic substances, suicide
	(1)	(2)	(3)	(4)	(5)
Any best friend opioid misuse	-0.847*	0.251*	0.177*	-0.044	0.087
	(0.453)	(0.137)	(0.097)	(0.044)	(0.080)
Observations	2,118	2,118	1,958	2,118	2,118
State FE	Yes	Yes	Yes	Yes	Yes
Mean	2.775	0.052	0.015	0.010	0.003
Kleibergen-Paap Wald rk F statistic	13.46	13.46	10.29	13.46	13.46

Note: The dependent variable is current self-perceived health status (5-point scale ranging from poor to excellent) in column 1; the probability of stimulants misuse in column 2; the probability of opioid addiction (continued opioid use despite mental and/or health problems due to it) in column 3; death due to medical factors (e.g., HIV, cancer, diabetes, CVD, parasitic, respiratory or digestive diseases) in column 4; and death due to poisoning from toxic substances or suicide in column 5. Reference period of opioid addiction/stimulants misuse: ever in life. Robust standard errors in parentheses are clustered at the school level. Survey weights are used. *p<0.10; **p<0.05; ***p<0.01. The sample is restricted to individuals who had not used any illegal drugs in Wave I or any painkillers in Wave III. See Table 4, column 6 for the list of controls.

Conclusions

- Using data from Add Health and a novel instrument, we causally identify peer effects on opioid misuse between friends at the micro level.
- We find **significant positive peer effects** on opioid misuse, especially among individuals **without a college degree** and **strong ties**
  $\Rightarrow$ health $\downarrow$, Prob(opioid addiction or death) $\uparrow$.
- Our findings have implications for the design of policies that are meant to reduce opioid dependence.
- The **large social multiplier** that we identify suggests that **policies targeted** on selected individuals (e.g., central, with a high reach or in a dense network) may be particularly effective.