

## Non-Medical Use of Prescription Drugs and Health Services Utilization

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### Abstract

**Objective:** To provide evidence of the economic burden of the non-medical prescription drug (NMPD) use on health services utilization: emergency room (ER) visits and inpatient hospital nights.

**Data:** The 2009 National Survey on Drug Use and Health (NSDUH) cross-section (52,267 observations).

**Study design:** We employ propensity score matching techniques controlling for a rich set of covariates to reduce the potential individual heterogeneity bias.

**Principal findings:** Our results reveal a positive, statistically significant, and robust relationship between NMPD use and health services utilization both in adolescents and adults. The estimated effects for adults are slightly smaller in magnitude than those for adolescents.

**Conclusion:** These results have important policy implications as the burden imposed on society by NMPD use might be greater than initially assumed. Efforts to curb NMPD use such as expansion of Prescription Drug Monitoring Programs (PDMPs), prevention interventions, and increased funds allocated to treat prescription drug abuse might be economically justified.

**Keywords:** Health services utilization; Non-medical prescription drug use; Propensity score matching

### Introduction

Although researchers and policy-makers have traditionally focused on illicit drugs and alcohol use as responsible for substantial negative costs for the society, latest increases in non-medical prescription drug use<sup>1</sup> (NMPD) represents now a growing public health threat. Data suggests that NMPD use is rising within the United States. Mortality rates due to unintentional drug poisonings increased by 18.1% per year between 1990 and 2002; narcotics were identified as the cause of the majority of these deaths [1]. Although heroin and cocaine poisonings increased by 12.4% and 22.8% per year respectively between 1999 and 2002, the number of opioid analgesic poisonings on death certificates increased 91.2% per year in the same period [1]. Additionally, almost 15,000 individuals die annually from prescription pain killer overdoses in the U.S. [2]. Moreover, emergency department (ED) visits due to narcotic drug use increased more than 4 times between 1995 and 2005 according to data from the Drug Abuse Warning Network [3]. Approximately 1.2 million ER visits involved non-medical use of pharmaceuticals or dietary supplements in 2009 [4]. Nearly 50% of NMPD use related ER visits were for opiate/opioid analgesics<sup>2</sup>.

Besides increased health services utilization as a direct and immediate effect of NMPD use (illustrated by the number of ER visits

where NMPD is involved), the long term NMPD use has dangerous effects on the individuals' health that might also lead to increased health care use. Long term use of these drugs can lead to dangerous or life-threatening symptoms<sup>3</sup> [5,6]. When NMPD users utilize health services to seek treatment for these long term effects, the involvement of NMPD use might not be as evident as, for example, in the case of a prescription drug overdose as prescription drugs are not present in the system at the time of the ER visit.

Despite the severity of the NMPD use problem in the U.S., studies examining the consequences of NMPD use are scarce. Some studies have examined the prevalence of NMPD use or the risk and protective factors associated with NMPD use [7-17]. Other studies have looked at the relationship between NMPD use and sexual risk behavior [18], physical pain [19], illicit drug use [20], and subsequent prescription drug abuse and dependence [11]. Moreover, despite its potential to substantially increase health care costs, we are not aware of any study examining the effect of NMPD use on health services utilization.

Thus, the primary contribution of our study is to examine the relationship between NMPD use and a set of health services utilization measures. Several studies find that illicit drug users underutilize preventive and routine health care to avoid scrutiny over their drug use [21-23]. This results in serious and costly health problems that eventually lead to the overutilization of costlier health services such as ER visits and hospital care. We argue that similar reasons might

<sup>1</sup>Non-medical use is typically defined as use of a controlled medication without a doctor's prescription or use of a prescribed medication in ways other than directed by the doctor.

<sup>2</sup>The most frequently reported opioid were single-ingredient formulations (e.g., oxycodone) in 104,490 ER visits; combination forms (e.g., hydrocodone with acetaminophen) in 175,949 ER visits; and methadone in 70,637 ER visits.

<sup>3</sup>According to National Institute on Drug Abuse, opioids can produce flushing, restlessness, fever, nausea, tremors, rhinorrhea, and seizures. Stimulants can create mood swings, craving, paranoia, anxiety, and panic attacks. Tranquilizers can cause insomnia, irritability, twitching, confusion, delirium, and seizures. Sedatives can cause anxiety, vomiting, nausea, cramps, delirium, insomnia, and seizures. Furthermore, combining these drugs with other medications or alcohol can lead to a series of dangerous consequences such as fatal overdoses, cardiac arrhythmias, respiratory depression, as well as different injuries [5,6].

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lead to the overutilization of costly health care by NMPD users. We therefore focus on ER visits and inpatient hospital nights which impose higher costs to society than less costly health services such as outpatient visits.

The main challenge associated with this type of observational data analysis is the potential individual heterogeneity bias issue. In other words, substantial differences in observed covariates between NMPD users and non-users could exist. Failure to account for these differences could lead to biased estimates of the relationship between NMPD use and health care use. To address this issue and reduce the bias, we employ propensity score matching methods. The propensity score for an individual (in our case, the conditional probability of being an NMPD user given the individual's covariates) can be used to balance the covariates in the users and non-users groups and reduce this bias [24].

To obtain results that are generalizable to the U.S. population, we employ a large nationally-representative sample of U.S. residents. Finally, we conduct several sensitivity tests to check the robustness of our results.

## Methods

### Sample

We used data from the National Survey on Drug Use and Health (NSDUH), formerly the National Household Survey on Drug Abuse (NHSDA), an annual nationally representative cross-sectional survey of the civilian non-institutionalized population in the United States. The survey is designed primarily to provide national and state-level data on the prevalence, patterns, and consequences of the use of tobacco, alcohol, illicit drugs (including non-medical use of prescription drugs) and mental health in the United States. The NHSDA was administered by the National Institute on Drug Abuse (NIDA) from 1974 through 1991. In 1991, it was expanded to include college students in dormitories, people living in homeless shelters, and civilians living on military bases. The Substance Abuse and Mental Health Services Administration (SAMHSA) has administered the survey since 1992.

Our analysis used the 2009 NSDUH cross-section, which was the most recent at the time of the analysis. After a random sample of households was selected across the U.S., an interviewer conducted screening during an in-person visit at 143,565 addresses. One or two residents of the household aged 12 and older were selected to participate in an in-home interview and 68,700 interviews were obtained. The survey was conducted from January through December 2009. The interview response rate was 75.7 percent [25]. Our analysis sample consisted of all observations without missing values for the variables used in our analysis (N=52,267).

### Variables

**Health services utilization:** Our dependent variable is one of four measures of health services utilization. The NSDUH survey collected information on the respondents' use of health care. We constructed two dichotomous measures of health services utilization: an indicator of being treated in the emergency room at least once in the past 12 months and an indicator of having stayed overnight as inpatient in the hospital at least once in the past 12 months. Moreover, we constructed two continuous measures of health care use: number of times been treated in the emergency room and number of nights stayed in the hospital overnight in the past 12 months. Although it would have been optimal to include some measures of outpatient care, unfortunately,

the NSDUH survey does not ask respondents about their use of these services.

**NMPD use:** Our key regressor is a measure of NMPD use in the past 12 months. The NSDUH survey asked about the number of days the respondent used prescription drugs non-medically in the past 12 months. The non-medical use is defined as any use of a drug if the drug was not prescribed for the respondent or they took the drug only for the experience or feeling it caused. The interviewer showed respondents pictures of different kinds of prescription drugs and lists of names of some other drugs. Based on responses to questions about specific drugs' frequency of use, the NSDUH administrators constructed frequency of use variables in the past 12 months for four categories of prescription medications: pain relievers, tranquilizers, stimulants, and sedatives. We used this information to construct a dichotomous measure of NMPD use that indicates whether a respondent used any of the prescription drugs in the four categories during the past 12 months.

Table 1 shows the percentage of respondents NMPD use by drug category. The first column shows that about 5.97 percentage of the adolescents in our sample report non-medical use of pain relievers in the past year. The prevalence is reduced for the other three drug categories: 1.94 percent used tranquilizers, 1.24 used stimulants, and about 0.39 used sedatives in the past year. About 7.77 percent of the adults report non-medical use of pain relievers, 3.55 percent report tranquilizers use, 2.08 percent report stimulants use, and 0.40 percent report sedatives use in the past year.

**Control variables:** As research suggests significant differences between adolescents and adults in NMPD use [11,14,19,26] as well as health services utilization [27,28], we follow the literature and estimate separate models for adolescents (ages 12 to 17) and adults (18 years of age and older).

All of our models include several socio-demographic and economic control variables: gender, race/ethnicity (dichotomous indicators for African-American, Hispanic, Asian, and Other Race, with White as the reference group), total family income (in U.S. dollars), health insurance (dichotomous variable indicating whether respondent is covered by health insurance), urbanicity (dichotomous variable indicating residence in a metropolitan area), pregnancy status, and number of persons in the household. The models also control for age: dichotomous variables for Ages 14-15 and 16-17, with Ages 12-13 as the reference group for the adolescent models and dichotomous variables for Ages 21-25, 26-34, and 35 and older, with Ages 18-20 as the reference group. Besides these controls, the models for adults include the following additional controls: marital status (dichotomous variables for Never Married, Widowed, Divorced, or Separated, with Married as the reference group), education (dichotomous variables for High-School Education, Some College Education, and College Graduate, with Less than High-School Education as the reference group), and employment (dichotomous indicators of being unemployed and not in the labor force).

Because several studies show that behavioral health affects the

Prescription Drug Category	Adolescents	Adults
Pain Relievers (%)	5.97	7.77
Tranquilizers (%)	1.94	3.55
Stimulants (%)	1.24	2.08
Sedatives (%)	0.39	0.40
<b>N</b>	<b>15.751</b>	<b>36.516</b>

Table 1: Non-medical prescription drug use in the past 12 Months by drug category.

use of health care, we include four dichotomous behavioral health control variables indicating alcohol use status, illicit drug use, a major depression episode diagnosis, and anxiety diagnosis, all measured in the past year. Moreover, our analyses include several physical health variables: physical health status (scale ranging from 1–excellent to 4–fair/poor), and diagnoses of diabetes (lifetime), heart disease (lifetime), hypertension (past year), asthma (lifetime), and pneumonia (past year).

**Empirical approach:** The relationship between NMPD use and health services utilization was estimated using propensity score matching (PSM) methods. Simple multivariate analyses (e.g., OLS or probit regression) are likely to produce biased coefficient estimates for several considerations. Unobserved factors (e.g., individual personal characteristics, time preference) could affect the likelihood of NMPD use as well as the individuals' propensity of using health services. As these factors are unobserved and therefore omitted from the models, the coefficient estimates are biased. Moreover, functional form assumptions that usually have no theoretical foundation [29,30], would be required for standard regression models.

Introduced by Rosenbaum and Rubin, PSM can address some of the issues discussed above. It uses a non-parametric approach that does not rely on functional form assumptions. This method creates a quasi-experiment by using the probability that a subject is 'treated' (categorized as NMPD user) to adjust the estimate of the treatment effect (i.e., the effect of NMPD use on health care use). When applied appropriately with large datasets, PSM can help address the issue of endogeneity bias and provide valid estimates of the average treatment effects that perform well compared with experimental designs [24,31,32]. It should be noted however that PSM techniques cannot address reverse causality issues. It is quite possible that some NMPD users rely upon ER visits as a source to acquire prescription drugs. Hence, we caution against interpreting our results as causal.

To conduct PSM, we first estimated the respondents' propensity scores. The propensity score is the probability of receiving treatment (i.e., being classified as NMPD user) conditional on a vector of observed covariates. In other words, the propensity score is a balancing score representing a vector of covariates. Probit models were used to estimate the likelihood of NMPD use based on a set of covariates. The literature on PSM emphasizes the importance of carefully choosing appropriate conditioning variables in the probit models [33]. The right control variables should simultaneously determine treatment and outcomes, but they should not include variables that are influenced by participation to treatment [34]. Omitting appropriate variables could lead to bias estimates [31]. We are not able to establish whether some of our control variables preceded treatment. For example, unemployment could be a consequence of NMPD use. Therefore, we use a method recommended by Rosenbaum and Rubin (1984) to select our control variables. We apply stepwise probit regression to seek the best conditioning variables that potentially create an imbalance between the treated and control groups. Average treatment effects on the treated are then estimated for each set of controls.

We used the propensity scores obtained to match 'treated' individuals (i.e., categorized as NMPD users) with 'control' participants (i.e., not classified as NMPD users). The objective is to make the two groups as alike as possible in terms of estimated propensity scores. Several different algorithms have been developed to match individuals with similar propensity scores. In our core models, we used the nearest neighborhood matching method with 3 neighbors ( $k=3$ ) which matched each 'treated' respondent with

the 3 'untreated' respondents with the closest propensity scores. We tested the robustness of our core model by using other matching algorithms: single nearest neighbor with and without replacement, nearest neighborhood matching with 5 neighbors, radius matching with caliper of 0.0005 and stratified matching. The results of these alternative methods are discussed in the Sensitivity Analyses section below.

The resample based on propensity scores balances observed covariates and controls for selection bias on observed measures. We used t or z-tests to check the balance between the 'treatment' and 'control' groups. Statistical matching was satisfied in all cases<sup>4</sup>. Finally, we estimated the average difference in health services utilization between the treatment and control groups (i.e., the average treatment effect of the treated-ATT).

The analysis was conducted using the Stata 11 statistical software package [35]. To execute PSM, we used the module *psmatch2* [36] which estimates the propensity scores, matches the treated and untreated groups, tests the balance between the two groups, estimates the difference in average treatment effects, and calculates the standard errors. As mentioned above, we estimate separate models for adolescents (ages 12 to 17) and adults (18 years of age and older).

## Results

### Descriptive statistics

(Table 2A) (adolescents) and (Table 2B) (adults) present summary statistics for the variables used in the analysis. The means and standard deviations are computed using the NSDUH sampling weights so that the data are representative of the U.S. population.

Table 2A reports weighted variable means for 15,751 adolescents, by NMPD use status. All control variables reveal highly significant differences in median values (Kruskal-Wallis rank-sum tests [36,37]) by NMPD use status. Of particular interest are the statistically significant differences in median values for health services utilization measures across groups. While 44.25 percent of the adolescent NMPD users had an ER visit in the past year, only 30.93% of the non-NMPD users had an ER visit in the same period. Moreover, 10.12% of the NMPD users stayed overnight at the hospital as an inpatient in the past year, whereas only 4.43% of the non-NMPD users had stayed in the hospital in the same period. When we look at the continuous health care measures, NMPD users had, on average, 1.158 ER visits and 0.454 inpatient hospital nights in the past year, whereas the non-NMPD users had only 0.608 ER visits and 0.153 hospital nights on average.

Table 2B reports weighted variable means and standard deviations for 36,516 adults by NMPD use status. Non-parametric Kruskal-Wallis [37] rank-sum tests show statistically significant differences between the two groups for most variables. While 29.34% of the adult non-NMPD users had an ER visit in the past year, 40.46% of the adult NMPD users had an ER visit in the same period. Moreover, looking at the number of ER visits, NMPD users had, on average, 0.864 ER visits in the past year, while the non-NMPD users had only 0.576 ER visits on average in the past year. For adults, although we find statistically significant differences across groups in the inpatient hospital nights measures, the differences seem small in magnitude.

<sup>4</sup>Results of these tests are not presented here, but are available from the authors upon request.



Variables	NMPD user (N=1.096)	Non-NMPD user (N=14.655)
<b>Health Services Utilization (past year)</b>		
Any ER Visit (%)***	44.25	30.93
Any Inpatient Hospital Night (%)***	10.12	4.43
Number of ER Visits***	1.158 (2.590)	0.608 (1.544)
Number of Inpatient Hospital Nights***	0.454 (2.512)	0.153 (1.229)
<b>Socio-Demographics and Economic Variables</b>		
Male (%)***	44.43	50.93
Age 12-13 (%)***	11.13	29.88
Age 14-15 (%)***	32.20	34.55
Age 16-17 (%)***	56.66	35.55
White (%)***	61.95	59.51
African-American (%)***	10.85	13.81
Hispanic (%)***	17.70	17.03
Asian (%)***	1.73	3.61
Other race (%)***	7.75	6.01
Family income***	54,411 (33,175)	58,350 (33,479)
Health insurance (%)***	92.42	93.41
Reside in urban area (%)**	78.74	78.66
Pregnant (%)	1.55	0.42
Number of persons in the household***	4.043 (1.175)	4.192 (1.138)
<b>Behavioral Health Variables</b>		
Alcohol user <sup>2</sup> (%)***	76.18	28.05
Illicit drug user <sup>3</sup> (%)***	55.93	11.04
Major depression episode diagnosis in past year (%)**	22.26	7.59
Anxiety disorder in past year (%)***	6.84	1.66
<b>Physical Health Variables</b>		
Health status <sup>4</sup> ***	2.184 (0.858)	1.921 (0.817)
Diabetes (%)***	1.18	0.65
Heart disease (%)***	0.27	0.28
Hypertension in past year (%)***	1.82	1.03
Asthma (%)***	17.51	16.41
Pneumonia in past year (%)***	1.27	0.88

Notes: Mean values are reported for all variables. Standard deviations are reported in parentheses for continuous variables.

<sup>1</sup>Respondents between the ages of 12 and 17.

<sup>2</sup>Used alcohol during the past year.

<sup>3</sup>Used illicit drugs during the past year.

<sup>4</sup>Health status is measured as a scale ranging from 1=excellent to 4=fair/poor.

\*\*\*Statistically significant difference in variable medians across the alcohol use categories,  $p < 0.01$ , Kruskal-Wallis equality of populations rank test.

\*\*Statistically significant difference in variable medians across the alcohol use categories,  $p < 0.05$ , Kruskal-Wallis equality of populations rank test.

\*Statistically significant difference in variable medians across the alcohol use categories,  $p < 0.10$ , Kruskal-Wallis equality of populations rank test.

**Table 2A:** Descriptive statistics for adolescents<sup>1</sup>.

## PSM analysis

Although we find significant bivariate differences in health care measures between the NMPD users and non-users, these differences could be attenuated by confounding factors. As expected, the propensity to be an NMPD user is positively correlated to alcohol use, illicit drug use, a depression or anxiety diagnosis, and diabetes. It is negatively correlated with being a male, physical health, and total family income. After matching, all the control variables used in the PSM analysis satisfied the balance property.

(Table 3A) (adolescents) and (Table 3B) (adults) present the PSM results. Average treatment effects on the treated (ATT) are reported. In other words, we report the difference in health services utilization measures between the treated group (NMPD users) and the untreated

group that was matched in propensity scores (has similar control variables measures) to treated respondents. Each column pertains to a different set of control variables. Overall, the estimates reveal

Variables	NMPD user (N=3.583)	Non-NMPD user (N=32.933)
<b>Health Services Utilization (past year)</b>		
Any ER Visit (%)***	40.46	29.34
Any Inpatient Hospital Night (%)***	10.24	9.27
Number of ER Visits***	0.864 (1.890)	0.576 (1.513)
Number of Inpatient Hospital Nights***	0.474 (2.421)	0.399 (2.072)
<b>Socio-Demographics and Economic Variables</b>		
Male (%)***	51.21	46.03
Age 18-20 (%)***	28.80	18.77
Age 21-25 (%)***	41.69	28.68
Age 26-34 (%)	13.73	14.88
Age 35-older (%)***	15.76	37.66
Married (%)***	17.44	37.82
Widowed, divorced, or separated (%)***	7.92	11.65
Never married (%)***	74.63	50.51
White (%)***	74.32	63.10
African-American (%)***	7.34	12.64
Hispanic (%)***	10.94	15.75
Asian (%)***	1.81	4.03
Other race (%)***	5.58	4.45
Less than high-school education (%)***	18.55	15.80
High-school education (%)***	33.68	32.62
Some college education (%)***	32.15	29.27
College graduate (%)***	15.60	22.29
Unemployed (%)***	14.93	9.34
Not in the labor force (%)***	20.34	23.28
Family income***	44,625 (33,694)	49,784 (33,686)
Health insurance (%)***	71.67	79.06
Reside in urban area (%)**	80.07	78.39
Pregnant (%)	1.84	2.36
Number of persons in the household***	3.186 (1.385)	3.197 (1.405)
<b>Behavioral Health Variables</b>		
Alcohol user <sup>2</sup> (%)***	93.46	73.88
Illicit drug user <sup>3</sup> (%)***	65.61	15.24
Major depression episode diagnosis in past year (%)***	16.43	7.05
Anxiety disorder in past year (%)***	12.33	4.98
<b>Physical Health Variables</b>		
Health status <sup>4</sup> ***	2.300 (0.884)	2.164 (0.927)
Diabetes (%)***	2.62	4.56
Heart disease (%)***	0.72	2.63
Hypertension in past year (%)***	6.27	10.39
Asthma (%)***	15.46	12.40
Pneumonia in past year (%)***	1.47	0.98

Notes: Mean values are reported for all variables. Standard deviations are reported in parentheses for continuous variables.

<sup>1</sup>Respondents between the ages of 12 and 17.

<sup>2</sup>Used alcohol during the past year.

<sup>3</sup>Used illicit drugs during the past year.

<sup>4</sup>Health status is measured as a scale ranging from 1=excellent to 4=fair/poor.

\*\*\*Statistically significant difference in variable medians across the alcohol use categories,  $p < 0.01$ , Kruskal-Wallis equality of populations rank test.

\*\*Statistically significant difference in variable medians across the alcohol use categories,  $p < 0.05$ , Kruskal-Wallis equality of populations rank test.

\*Statistically significant difference in variable medians across the alcohol use categories,  $p < 0.10$ , Kruskal-Wallis equality of populations rank test.

**Table 2B:** Descriptive statistics for adults<sup>1</sup>.

Explanatory Variables	N	(1) <sup>2</sup>	(2) <sup>3</sup>	(3) <sup>4</sup>
Emergency Room Visit	15,751	0.146*** (0.024)	0.078*** (0.020)	0.082*** (0.020)
Inpatient Hospital Night	15,751	0.061*** (0.013)	0.034*** (0.012)	0.036*** (0.011)
Number of ER visits <sup>5</sup>	5,019	0.625*** (0.190)	0.398** (0.187)	0.452** (0.179)
Number of inpatient hospital nights <sup>6</sup>	761	0.820 (0.721)	0.288 (0.812)	1.084 (0.827)

<sup>1</sup>Average treatment effects on the treated estimated using propensity score matching with nearest three neighbors are reported.

<sup>2</sup>Models control for: gender, age, race/ethnicity, family income, health insurance, urbanicity, pregnancy status, and number of persons in the household.

<sup>3</sup>Models control for: gender, age, race/ethnicity, family income, health insurance, urbanicity, pregnancy status, and number of persons in the household, alcohol use, illicit drug use, depression and anxiety diagnoses.

<sup>4</sup>Models control for: gender, age, race/ethnicity, family income, health insurance, urbanicity, pregnancy status, and number of persons in the household, alcohol use, illicit drug use, depression and anxiety diagnoses, physical and mental health status, and diagnoses of diabetes, heart disease, hypertension, asthma, and pneumonia.

<sup>5</sup>Analysis uses reduced sample with respondents that report at least 1 ER visit in the past year.

<sup>6</sup>Analysis uses reduced sample with respondents that report at least 1 inpatient hospital night in the past year.

\*Statistically significant,  $p \leq 0.10$ ; \*\*Statistically significant,  $p \leq 0.05$ ; \*\*\*Statistically significant,  $p \leq 0.01$ .

**Table 3A:** Effect of NMPD Use on Health services utilization for adolescents<sup>1</sup>.

Explanatory Variables	N	(1) <sup>2</sup>	(2) <sup>3</sup>	(3) <sup>4</sup>
Emergency Room Visit	36,516	0.112*** (0.011)	0.081*** (0.011)	0.060*** (0.011)
Inpatient Hospital Night <sup>1</sup>	36,516	0.031*** (0.006)	0.031*** (0.007)	0.022*** (0.007)
Number of ER visits <sup>5</sup>	11,113	0.216*** (0.081)	0.077 (0.089)	0.124 (0.085)
Number of inpatient hospital nights <sup>6</sup>	3,422	0.466 (0.385)	-0.231 (0.447)	-0.092 (0.444)

<sup>1</sup>Average treatment effects on the treated estimated using propensity score matching with nearest three neighbors are reported.

<sup>2</sup>Models control for: gender, age, race/ethnicity, family income, health insurance, urbanicity, pregnancy status, education, marital status, employment, and number of persons in the household.

<sup>3</sup>Models control for: gender, age, race/ethnicity, family income, health insurance, urbanicity, pregnancy status, education, marital status, employment, and number of persons in the household, alcohol use, illicit drug use, depression and anxiety diagnoses.

<sup>4</sup>Models control for: gender, age, race/ethnicity, family income, health insurance, urbanicity, pregnancy status, education, marital status, employment, and number of persons in the household, alcohol use, illicit drug use, depression and anxiety diagnoses, physical and mental health status, and diagnoses of diabetes, heart disease, hypertension, asthma, and pneumonia.

<sup>5</sup>Analysis uses reduced sample with respondents that report at least 1 ER visit in the past year.

<sup>6</sup>Analysis uses reduced sample with respondents that report at least 1 inpatient hospital night in the past year.

\*Statistically significant,  $p \leq 0.10$ ; \*\*Statistically significant,  $p \leq 0.05$ ; \*\*\*Statistically significant,  $p \leq 0.01$ .

**Table 3B:** Effect of Heavy NMPD Use on Health Services Utilization for Adults<sup>1</sup>.

that NMPD use is positively related to all measures of health care utilization both for adolescents and adults. Most estimates are statistically significant at conventional levels.

We first review Table 3A for adolescents. The first column shows the ATT from models that control only for the socio-demographic and economic variables. NMPD use is associated with 14.6 percentage points increase in the probability of an ER visit in the past year, 6.1 percentage points increase in the probability of staying overnight in the hospital in the past year, and an increase in the number of ER visits with 0.625. The ATT for the number of hospital nights in

statistically significant. As expected, the addition of the behavioral health control variables reduces almost in half the magnitude of the estimates (column 2). When the physical health control variables are added (column 3), the estimated effects don't change substantially. NMPD use is associated with 8.2 percentage points increase in the probability of an ER visit in the past year and with 3.6 percentage points increase in the probability of staying overnight in the hospital in the past year. When we analyze the effect of NMPD use on the continuous health care measures (number of ER visits and hospital nights), we restrict the sample to respondents with at least one ER visit and at least one hospital night respectively in the past year. This drastically reduces our sample size to 5,019 observations for the number of ER visits and 761 observations for the number of hospital nights. We find that NMPD use is associated with an increase in the number of ER visits with 0.452, but NMPD use does not seem to be related to the number of inpatient hospital nights, as the estimate is not statistically significant at conventional levels. The lack of statistical significance of our estimates might be the result of the reduction in the sample size.

Turning to Table 3B, the estimation results for adults are slightly smaller in magnitude than those for adolescents. Similar to adolescents, most estimates reveal a positive and statistically significant relationship between NMPD use and health services utilization and the estimated effects decrease in magnitude as additional control variables are added. Focusing on column 3, NMPD use is associated with 6.0 percentage points increase in the probability of an ER visit in the past year and with 2.2 percentage points increase in the probability of staying overnight in the hospital in the past year. Turning to the continuous health care measures, similarly with the analysis for adolescents, we restrict the sample to those with at least one ER visit and hospital night which reduces our analysis sample to 11,113 observations for ER visits and 3,422 observations for hospital nights. We find that NMPD use is associated with an increase in the number of ER visits with 0.124, although, in contrast to the findings for adolescents, the estimate is not statistically significant for adults. NMPD use does not seem to be related to the number of inpatient hospital nights, as the estimate is small in magnitude and is not statistically significant at conventional levels.

### Sensitivity analyses

To check the robustness of our core findings, we re-estimate the ATT using alternative PSM methods. Using the same three sets of controls from our core models, we used the following methods: matching on the three nearest neighbors with bootstrapped standard errors, matching on the five nearest neighbors, matching on the nearest neighbor (one-on-one matching) with and without replacement, and radius matching with caliper of 0.0005. The results were similar in sign, magnitude, and statistical significance with our core model. The results are not presented here, but are available from the authors upon request.

### Limitations

The current study is not without limitations and simplifying assumptions. First, as mentioned before, when applied correctly, PSM methods have the potential to reduce the estimation bias associated with this type of analysis using observational data. Nevertheless, PSM techniques might not eliminate entirely the endogeneity of NMPD use in the presence of unobserved heterogeneity that is uncorrelated with the measured adjusters. As mentioned above, reverse causality running from health services utilization to NMPD use is possible where some NMPD users might rely upon ER visits to get their prescription drugs.

PSM methods cannot address this issue. Although PSM estimates are a step further in understanding the relationship between NMPD use and health care use, they do not necessarily imply causality. We therefore caution against regarding the results of our study as causal effects. Rather, the PSM estimates provide useful information about the direction and strength of the association between NMPD use and health services utilization.

Second, both NMPD use and health care utilization were self-reported. The presence of any misreporting within our sample is impossible to verify and measure, but the likely impact (if present) is lower coefficient estimates. Even if misreports in NMPD use and health care use are independent, measurement error can bias coefficients towards zero [38].

Third, the current study uses the 2009 cross-section of the NSDUH because it was the latest available at the time of data analysis. Currently, the 2011 cross-section is available. While we recognize that more recent data would be better, the number and percentage of persons aged 12 or older who were current NMPD users in 2011 (6.1 million or 2.4 percent) were very close to those in 2009 (7.0 million or 2.8 percent).

Finally, it would be interesting to examine the effect of NMPD use on outpatient visits for preventive and acute care besides its effect on ER visits and hospitalizations. Unfortunately, the NSDUH dataset does not provide this kind of information.

## Discussion

Despite national awareness regarding the rising prevalence of NMPD use, little is known about its impact on health services utilization. The present study is one of few studies that provided empirical evidences of the economic burden of NMPD use on health services utilization in a large nationally-representative dataset. Moreover, the current study is, to the best of our knowledge, the first to examine the relationship between NMPD use and health services utilization by employing propensity score matching techniques to address the potential individual heterogeneity bias problem that represents the main challenge associated with this type of observational data analysis.

Our results reveal a positive, statistically significant, and robust relationship between NMPD use and health services utilization both in adolescents and adults. The estimated effects for adults are slightly smaller in magnitude than those for adolescents. For adolescents, NMPD use is associated with 8.2 percentage points increase in the probability of an ER visit in the past year and with 3.6 percentage points increase in the probability of staying overnight in the hospital in the past year. For adults, NMPD use is associated with 6.0 percentage points increase in the probability of an ER visit in the past year and with 2.2 percentage points increase in the probability of staying overnight in the hospital in the past year.

Some studies exploring the association between illicit drug use and health services utilization find that heavy illicit drug users are about 25-50 percent more likely to be hospitalized or to visit the ER than non-drug users [30]. Other studies report that chronic illicit drug use increases the probability of using an ER by 30 percent [39]. While according to these studies the magnitude of the association between illicit drug use and health services utilization seems to be larger than our estimates for NMPD use, this was expected as the negative health consequences of both chronic and heavy illicit drug use are already established in the literature. Nevertheless, we argue that the

magnitude of our findings is very problematic given our conservative measure of NMPD use which considers any NMPD use during the past 12 months.

Understanding the negative consequences associated with NMPD use has critical public policy implications. The results of this study suggest that NMPD is linked to increased health care costs for the society. Although numerous studies have shown both the efficacy [40] and cost-efficiency [41-43] of substance abuse treatment, prescription drug abuse remains untreated relative to alcohol and illicit drugs. Moreover, although studies on the impact of Prescription Drug Monitoring Programs (PDMPs) are still scarce, limited data suggests that PDMPs have the potential to reduce abuse practices. Although they have been used for many years, PDMPs are still undergoing re-evaluation and restructuring and studies like the current one are needed in order to evaluate whether these economic efforts are justifiable on efficiency grounds.

The problem of NMPD drugs is particularly complex because the benefits and the risks of prescription drugs are so closely intertwined. Thus, it is critical that we learn how to strike the right balance between ensuring the availability of these substances and preventing their associated risks and adverse effects. Government authorities, parents, medical doctors, pharmacists, pharmaceutical companies have all important roles to play.

## Conclusion

These results have important policy implications as the burden imposed on society by NMPD use might be greater than initially assumed. Efforts to curb NMPD use such as expansion of Prescription Drug Monitoring Programs (PDMPs), prevention interventions, and increased funds allocated to treat prescription drug abuse might be economically justified.

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