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Growing internet use may help explain the rise in prescription drug abuse in the United States

Dana P. Goldman, PhD and

Schaeffer Center for Health Policy and Economics, University of Southern California, 3335 S. Figueroa St., Unit A, Los Angeles, CA 90007

Anupam B. Jena, MD, PhD

Massachusetts General Hospital, 55 Fruit St., Boston, MA 02114

Abstract

The rise in availability of commonly abused prescription drugs through the internet has raised public health concerns. We examined whether U.S. prescription drug abuse growth may be explained by growth in internet use. We find that for every 10 percent increase in high-speed internet use at the state level, associated admissions for prescription drug abuse rose by 1 percent. Non-prescription drug related admissions bore no association with internet use. The results suggest that better surveillance of online prescription drug use is warranted, and aggressive efforts to curb illegitimate online pharmacies may be necessary.

Online pharmacies have grown tremendously in recent years. From 1999 to 2003 alone, U.S. online sales of prescription drugs increased from \$160 million to \$3.2 billion.¹ While the growth of legitimate pharmacies has benefited patients through lower costs and added convenience, important concerns have been raised about growth in illegitimate internet pharmacies that promote unfettered access to both ordinary prescription medications and controlled substances without any direct physician examination and sometimes approval.¹⁻⁷

Several studies have argued that the dramatic increase in U.S. substance abuse admissions for prescription drugs - e.g., nearly five-fold increase from 1997 to 2007 in substance abuse admissions for narcotic painkillers⁸ - may partially stem from wider online availability of these drugs.^{9, 10}

Although the majority of online pharmacies operate no differently than standard brick-and-mortar pharmacies that rely on prescriptions originating from actual doctor-patient interactions, a growing number of illegitimate pharmacies have emerged that do not abide by these safeguards.^{2, 6, 11} Illegitimate pharmacies have taken on two forms: "questionnaire pharmacies," which provide medication without an actual visit to a doctor, and "rogue pharmacies," which require neither a prescription nor a medical history.

In 2007, the National Center on Addiction and Substance Abuse at Columbia University estimated that 581 websites offered to sell controlled prescription drugs with only two of the pharmacies legitimately certified by the National Association of Boards of Pharmacy.¹² Nearly 85 percent of sites did not require a prescription and of the remaining sites, 57 percent required that only a prescription be faxed, therefore allowing customers to forge prescriptions or use the same prescription multiple times.¹²

Given concerns over rising availability of controlled prescription drugs on the Internet, the federal government enacted the Ryan Haight Online Pharmacy Consumer Protection Act in 2008. The law, which came into effect in April 2009, amended the existing Controlled Substances Act and prohibited the delivery, distribution, and dispensing of controlled prescription drugs over the internet without a prescription by a physician who conducted an in-person interview and examination of the patient.¹³ Months later, in November 2009, the U.S. Food and Drug Administration issued warnings to more than one hundred online pharmacies for prescribing violations that included the sale of controlled substances without prescriptions and in some instances, the sale of medications not yet approved for distribution in the U.S. (e.g., the anti-obesity medication, Acomplia).¹⁴

Despite their growing presence on the internet and federal regulations seeking to curb them, relatively little is known about rates of prescription drug abuse originating from illegitimate online pharmacy sites and more importantly, whether the observed increase in overall prescription drug abuse may partially stem from wider online availability. Survey evidence from small, locally conducted samples as well as national samples of prescription drug abusers place estimated use of controlled prescription drugs purchased online between 1-11 percent of users, with most surveys attributing approximately 3 percent of use to online purchases.^{15, 16}

Aside from pure underreporting, the modest rates of prescription drug abuse attributed to internet purchasing in some of these surveys may underestimate the impact of internet availability of these drugs for several reasons. First, people most likely to purchase controlled prescription drugs online may not have been included in surveys because of where those surveys were conducted. For example, surveys of patients at methadone clinics may yield a downward-biased estimate of online prescription drug purchasing since Schedule II drugs such as methadone are more difficult to acquire online than drugs in Schedules III and IV which traditionally have lower potential for abuse.¹⁶ Second, surveys will naturally not include those involved in the distribution of controlled prescription drugs.

The National Drug Intelligence Center at the Department of Justice reports large amounts of Schedule III and IV medications purchased through the internet by local dealers of these drugs, as well as increasing involvement of street and motorcycle gangs in the distribution of controlled prescription drugs acquired through the internet.^{16,17} Wider availability of controlled prescription drugs on the Internet may therefore affect rates of abuse not only through individual purchasing of drugs but also through organized purchasing and local distribution.

In addition to the limited survey evidence on abuse of controlled prescription drugs acquired through Internet pharmacies, other studies of illegitimate online pharmacies have examined the ease at which prescription drugs may be obtained without valid prescriptions or doctor-patient interactions. In each of these studies, including a 2004 study by the U.S. General Accounting Office⁴, research investigators directly attempted to purchase controlled prescription drugs online and demonstrated readily available access to commonly abused prescription drugs such as narcotic pain killers, stimulants, sedative hypnotics, and anxiolytics.^{17, 18}

The extensive availability of commonly abused prescription drugs on the internet raises the possibility that widespread internet growth may itself have contributed to the observed trend in prescription drug abuse. From 2000 to 2007, non-heroin narcotic (e.g., oxycodone) admissions to U.S. substance abuse facilities increased 374 percent, while admissions for alcohol abuse actually declined by 5 percent,⁸ suggesting that general trends in drug

trafficking and substance abuse behavior may not explain the growth in narcotic painkiller abuse.

During this same period, U.S. internet use grew from 18 percent of households in 1997 having internet at home to 61 percent in 2007,¹⁹ with nearly half of those using the web doing so for purposes that included health care.²⁰ Nearly all of this growth in overall internet use stemmed from growth in high-speed internet access with only 4 percent of households in 2008 using dial-up modems.²¹

We explored whether overall growth in internet use may partly explain observed prescription drug abuse growth in the U.S. To gauge this, we used state-level data on high-speed internet penetration and admissions to substance abuse facilities for treatment of controlled prescription drug abuse. Internet-based dispensing of general prescription drugs increased nearly 15-fold from 1999-2003 due in large part to wider internet use by consumers¹; by this same mechanism, growth in internet use may have plausibly led to the purchase and abuse of controlled prescription drugs also available online.

METHODS

Overview

To test the hypothesis that increases in internet use have been partially responsible for recent increases in prescription drug abuse rates, we obtained annual state-level data on high-speed internet penetration and prescription drug admissions to U.S. substance abuse facilities between 2000 and 2007. For each of four classes of prescription drugs - narcotic painkillers, stimulants, anxiolytics, and sedative-hypnotics - we estimated longitudinal linear regression models in which the key explanatory variable was high-speed internet penetration within a state and the dependent variables included one of two measures of prescription drug abuse.

To account for varying trends in prescription drug abuse within states, we accounted for fixed state characteristics and state-specific trends through state indicators and state-year trends, respectively. We conducted additional “falsification tests” in which we repeated the analysis with either the substance abuse admission rate for alcohol, cocaine, or heroin. We assumed that internet growth could more plausibly be linked to prescription drug abuse growth if it were also unassociated with substance abuse growth among substances not readily purchasable online.

Internet use

We measured internet penetration across states using publicly available data from the Federal Communication Commission (FCC) high-speed internet deployment database. In 2000, the agency instituted a formal data collection program to gather information about state-level subscriptions to high-speed internet services.²² Among other information, internet service providers were required to report the number of high-speed internet lines (defined as carrying > 200 kbps in one direction) to residential customers in each state. Combining this information with intercensal state population estimates from the U.S. census, we calculated the number of residential internet lines per capita for each state and year from 2000 to 2007 and used this as our estimate of state internet use. Broadband internet deployment is a reasonable measure of internet penetration within states given that nearly all of the last decade’s growth in overall internet use was due to growth in high-speed internet access, with only 4 percent of households in 2008 using dial-up modems.²¹ State-level internet use has also been argued to be important in other major online markets as well, including growth in online dating and internet pornography.^{23, 24}

Rates of prescription drug abuse

Annual, state-level estimates of prescription drug abuse are generally difficult to obtain. As a baseline measure of prescription drug abuse, we used data on treatment admissions to substance abuse programs in the U.S. publicly available from the Treatment Episode Data Set maintained by the U.S. Substance Abuse and Mental Health Administration.⁸ The data set consists of treatment admissions to public and private substance abuse programs receiving public funding; the unit of observation is treatment admission to a substance abuse facility.

Each observation contains information on the substance abused, including alcohol, cocaine, heroin, prescription opiates (including synthetic opiates), benzodiazepines and other anxiolytics (drugs used to treat anxiety), barbiturates and other sedative hypnotics, and amphetamines and other stimulants. We computed rates of substance abuse admissions for each state and drug category by dividing the total number of admissions within a state by that state's population.

Although the Treatment Episode Data Set does not contain all substance abuse admissions within a state, available inclusion rates suggest that facilities in the data set account for nearly 70 percent of total known admissions.⁸ While comparisons across states are limited by differences in the extent to which substance abuse admissions are recorded in the data set, comparisons within states over time are less subject to this measurement error.

It is possible that changing treatment environments in substance abuse facilities over time may lead to spurious associations between state-level growth in internet use and measured prescription drug abuse. For example, if treatment facilities located in states with large growth in internet use preferentially admitted more patients with prescription drug abuse over time for unobserved reasons, we would falsely attribute changes in substance abuse admissions for prescription drugs to internet growth. While the inclusion of separate state-year trends in our regression model would presumably account for these unobserved factors, changing treatment patterns that remain correlated with state-level internet growth are possible.

In addition to our baseline measure of prescription drug abuse, we therefore explored other options for measuring prescription drug abuse at the state level. The Drug Abuse Warning Network (DAWN) collects data on emergency department visits for a number of prescription drug classes but continually collected information for only thirteen cities between 2000 and 2007²⁵; although a time-series of internet use at the city-level was not readily available to us, DAWN cities were also large metropolitan centers that likely varied little in internet growth.

We also explored the possibility of computing state-level inpatient hospital admission rates for abuse of prescription drugs using the National Inpatient Sample, an approximately 20 percent sample of all U.S. hospital admissions.²⁶ Administrative coding of hospital discharge data did not allow us, however, to specifically identify admissions for prescription drug abuse.

As a second measure of state-level prescription drug abuse, we ultimately relied on state estimates of narcotic painkiller and cocaine abuse self-reported by respondents of the National Survey of Drug Use and Health. The annual, cross-sectional survey gathers information on rates of substance abuse among the U.S. non-institutionalized population aged 12 and above.¹⁵ We focused on reported state-level estimates of narcotic painkiller and cocaine abuse as only these drugs had annual data available for each state from 2002-2005

(but not the full 2000-2007 period for which substance abuse treatment admission data was available).

Statistical analysis

In our baseline model, we estimated longitudinal linear regressions of the association between high-speed internet use and substance abuse admissions for each of several prescription drug abuse categories: non-heroin opioids (including synthetics), benzodiazepines, sedative hypnotics, and stimulants (including amphetamine).

For each drug in question, the dependent variable was the natural log of the substance abuse rate in state s in year t , and the key explanatory variable was the natural log of high-speed internet lines per capita in state s in year t . In order to account for unobserved fixed state characteristics and trends over time, we included both state-level fixed effects and state-specific year trends. To validate our model, we also conducted separate “falsification tests” in which we replaced the dependent variable with substance abuse admission rates for alcohol, heroin, and cocaine separately.

Since none of these substances are known to be readily purchasable online, the absence of any relationship between internet use and abuse rates of these substances would further suggest that any observed relationship between internet use and prescription drug abuse might be causal. To account for changing demographics not captured in state-year trends, all models included controls for the percent population in each state and year that was male and the percent less than thirty years old.

Sensitivity analyses

As an additional sensitivity analysis to our baseline model, we accounted for other factors that may be associated with changes in prescription drug abuse rates over time. Because states with greater high-speed internet growth may also have experienced greater legal prescriptions for commonly abused substances, we accounted for the overall prescribing environment in a given state and year by including as a covariate the number of prescriptions per Medicaid beneficiary of each drug we considered.²⁷ In addition to changes in legal prescribing behavior, coincident increases in criminal enforcement towards heroin and cocaine may have occurred in states that experienced high-speed internet growth. We therefore included as a covariate drug arrest rates (as a percentage of total arrests in a given state and year) obtained from the National Consortium for Violence Research, which itself computed rates from Federal Bureau of Investigation Uniform Crime Reports.²⁸

As a final sensitivity analysis, in addition to our baseline model which used state treatment facility admission rates as a measure of substance abuse, we also estimated the association between self-reported state cocaine and narcotic painkiller abuse rates and high speed internet use. Because our data spanned only four years (2002-2005), our longitudinal linear regression model used state fixed effects (rather than state-year trends) as well as controlled for state Medicaid prescription rates for narcotic painkillers and state drug arrest rates.

RESULTS

Exhibit 1 displays per-capita rates of high-speed internet access and substance abuse admissions in the U.S. between 2000 and 2007.

From 2000 to 2007, high-speed internet access in the U.S. increased 13.5-fold from 1,816 residential lines per 100,000 people to 24,674 lines per 100,000. There was significant variation in growth across states, with the bottom five states (MA, NE, NH, CA, RI)

growing substantially more slowly over the seven-year period than the top-five states (MT, MD, IN, KY, DE) (734% vs. 5,232%, $p < 0.001$).

Substance abuse admissions for prescription drugs grew dramatically during this period as well. Substance abuse admissions for non-heroin opioids grew 184 percent, followed by benzodiazepines (62 percent), stimulants (49 percent), and sedative hypnotics (16 percent). Importantly, substances of abuse not readily purchasable online - alcohol, heroin, and cocaine - all witnessed either negative or minimal growth during this same period.

Exhibit 2 illustrates how growth in prescribed narcotic and alcohol abuse varied with growth in state internet use. The figure arrays states in order of increasing internet growth between 2000 and 2007 and plots state-level growth in substance abuse admissions for narcotics and alcohol during that same period. This provides the conceptual basis of our estimation model, which examines other substance abuse categories as well.

Exhibit 2 demonstrates that states with larger high-speed internet growth from 2000 to 2007 also experienced greater growth in substance abuse admissions for prescribed narcotics. For each 10 percent increase in high-speed internet use within a state between 2000 and 2007, there was an associated 0.3% increase in prescribed narcotic abuse admissions ($p = 0.04$). During the same period, for each 10 percent increase in internet use within a state, there was virtually no change in alcohol abuse admissions (0.01%, $p = 0.74$).

Exhibit 3 refines this descriptive analysis and presents estimated coefficients from our baseline substance-specific longitudinal regression models. For each substance-specific model, we accounted for state-fixed effects and state-specific trends.

Growth in internet use across states was neither practically nor statistically significantly correlated with growth in abuse of substances not readily purchasable online: alcohol, cocaine, or heroin. For example, our estimates suggest that a 10 percent increase in internet use was associated with only a 0.18 percent increase in admissions for cocaine abuse ($p = 0.51$). At the same time, growth in internet use across states was significantly correlated with growth in three out of four substances known to be readily purchasable online, namely prescription opioids, sedative hypnotics, and stimulants. Estimated associations were similar in magnitude: a given 10 percent increase in internet use was associated with a roughly 1 percent increase in prescription drug admission rates for these three drugs.

Sensitivity analyses

We explored how accounting for legal prescription rates of commonly abused prescription drugs and drug arrests within a state affected the estimated association between state high-speed internet use and admissions to U.S. treatment facilities (Exhibit 4, column 1). After we controlled for both of these factors as well as state fixed effects and state-specific time trends, growth in internet use across states was still significantly correlated with growth in prescription narcotics, sedative hypnotics, and stimulants. For each 10 percent increase in internet use, treatment facility admission rates for these three drugs continued to rise by roughly 1 percent.

We found similar results when focusing on self-reported cocaine and prescription narcotic use as opposed to treatment facility admission rates (Exhibit 4, column 2). Accounting for state fixed effects, legal prescription rates of narcotics, and drug arrests within a state, a 10 percent increase in state high-speed internet use was associated with a 0.06 percent change in self-reported cocaine use ($p = 0.43$) and a 0.43 percent increase in prescription narcotic use ($p = 0.02$).

DISCUSSION

The growth in illegitimate online pharmacies has raised concerns about inappropriate access to commonly abused prescription medications. Despite studies documenting the availability of controlled substances without prescription on the internet, little is known about how prevalent such purchasing is and whether the observed increase in prescription drug abuse in the U.S. could in part be linked to internet-based purchasing. Anecdotally, at one of our institutions, one of us (AJ) was involved for the first time in a case of tramadol (Ultram) toxicity from extensive and prolonged internet purchasing of this synthetic opioid medication.

We hypothesized that given the availability of commonly abused prescription drugs on the internet, growth in overall internet use might explain some of the growth in prescription drug abuse in the U.S. Utilizing the facts that high-speed internet growth has accounted for nearly all of the recent growth in internet use and that non-prescription drugs should not have been affected by this growth, we demonstrated that states with greater high-speed internet growth had more growth in prescription drug abuse but no detectable change in abuse of drugs not readily purchasable online.

Our results were robust to adjustments for state-specific factors that trended linearly over time, legal prescription rates of commonly abused prescription drugs, and drug enforcement environments. Our results suggest that for every 10 percent increase in state high-speed internet use, associated admissions for prescription drug abuse rose by roughly 1 percent.

Our work is hypothesis generating: it raises the possibility that the observed growth in U.S. prescription drug abuse may partially stem from wider internet availability through online pharmacies that sell prescription drugs illegally. There are, however, important limitations of our analysis. First, although we employed falsification tests with substances not readily purchasable online, our results ultimately reflect an association that might more convincingly be causal if there were natural experiments to exploit, e.g. variations in state laws or law enforcement policies to shut down illegitimate online pharmacies.

More generally, although we accounted for factors such as drug arrests, legal prescription rates, and unobserved state-specific factors that varied linearly over time, unobserved state factors may still confound our association. Second, using administrative data such as substance abuse treatment facility admissions has its own limitations. Changes in how data are collected over time may lead us to spurious associations simply because specific substance abuse classes such as prescription drugs may have better data recording over time.

Third, prescription drug abuse and access to internet are hard to define. Increases in treatment rates may not necessarily reflect increases in the prevalence of substance abuse, though we do find such associations for the single case of self-reported prescription drugs that we consider, namely narcotics. Access to high-speed internet use within a state may be a poor proxy for access to illegal online pharmacies, yet nearly all of recent growth in internet use has been driven by expansion of high-speed internet services and access to such sites by definition requires access to internet.

Despite these important limitations, our results suggest that better surveillance is warranted to understand the extent to which prescription drug abuse occurs due to drugs purchased online, either by individuals or by organized dealers who then distribute drugs locally. Our findings provide a first glimpse that growing internet use may partly explain why U.S. prescription drug abuse rates have risen dramatically while other substance abuse rates have not.

Based on our findings, recent efforts by the Food and Drug Administration to shut down illegitimate pharmacies seem not only warranted but may also lead to substantial reductions in prescription drug abuse. The success of these efforts will, of course, depend not only on the ability of the FDA to serially monitor the emergence of new, rogue internet pharmacies but also on its ability to promptly shut down pharmacies by coordinating with internet service providers. And while coordinated efforts may be feasible with U.S. internet service providers, it is unclear how FDA efforts will deal with foreign based pharmacies that ship medications into the U.S. An important question that remains to be answered is whether actions taken by the FDA to curb the growth of illegitimate pharmacies can have a meaningful impact on access to prescription drugs of abuse.

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Exhibit 1.

Relationship between high-speed internet growth and growth in alcohol and narcotic admissions to U.S. substance abuse treatment facilities, 2000 - 2007

Source: Authors analysis of data from Federal Communications Commission (data on internet growth) and U.S. Dept of Health Substance Abuse Mental Health Services Administration Treatment Episode Data Set (data on substance abuse growth)

Notes: Figure plots the percentage growth in alcohol and prescription narcotic admissions to U.S. substance abuse treatment facilities against states in increasing order of percentage internet growth from 2000-2007. Fitted lines for alcohol and prescription narcotics are included.

EXHIBIT 2

High-speed internet use and substance abuse admissions to U.S. treatment facilities, 2000 and 2007

	Year		Growth (%)
	2000	2007	
Internet lines (per 100,000 pop.)	1,816	24,674	1,259
Admissions to U.S. substance abuse treatment facilities (No.)			
<i>Substances not Purchasable on Internet</i>			
Alcohol	1,194,443	1,100,712	-8
Cocaine	546,769	552,070	1
Heroin	323,054	294,606	-9
<i>Substances purchasable on Internet</i>			
Benzodiazepines	32,791	52,972	62
Opioids	58,097	164,708	184
Sedative hypnotics	14,406	16,686	16
Stimulants	148,786	221,897	49

Source: Authors analysis of data from Federal Communications Commission (data on internet growth) and U.S. Dept of Health Substance Abuse Mental Health Services Administration Treatment Episode Data Set (data on substance abuse growth)

Notes: High speed state-level internet use is measured by number of residential internet lines per 100,000 people.

EXHIBIT 3

Estimated relationship between state high-speed internet use and admissions to U.S. treatment facilities, 2000 - 2007

Substance	Percentage impact on substance abuse admission rates of 10% increase in internet use	p-value
<i>Substances not purchasable on Internet</i>		
Alcohol	0.23	0.34
Cocaine	0.18	0.51
Heroin	0.31	0.40
<i>Substances purchasable on Internet</i>		
Benzodiazepines	-0.10	0.82
Opioids	1.09	<0.01
Sedative hypnotics	0.97	0.05
Stimulants	1.18	<0.01

Source: Authors analysis of data from Federal Communications Commission (data on internet growth) and U.S. Dept of Health Substance Abuse Mental Health Services Administration Treatment Episode Data Set (data on substance abuse growth)

Notes: Estimates are from longitudinal linear regression models including state fixed effects and state-specific year trends. Each estimate reflects the percentage effect of a 10 percent increase in state per-capita high-speed internet lines on admission to a substance abuse facility. For example, a 10 percent increase in per-capita high-speed internet lines is estimated to raise prescription opioid admission rates by 1.09 percent.

EXHIBIT 4

Sensitivity analysis of estimated relationship between state high-speed internet use and prescription drug abuse, 2000 - 2007

Substance	Percentage impact on prescription drug abuse admission rates of 10% increase in internet use	p-value	Percentage impact on self-reported use of 10% increase in internet use	p-value
<i>Substances purchasable on Internet</i>				
Benzodiazepines	-0.14	0.75	-	-
Opioids	1.04	<0.01	0.43	0.02
Sedative hypnotics	0.98	0.05	-	-
		<		
Stimulants	1.70	0.001	-	-
<i>Substances not purchasable on Internet</i>				
Cocaine			0.06	0.43

Source: Authors analysis of data from Federal Communications Commission (data on internet growth) and U.S. Dept of Health Substance Abuse Mental Health Services Administration Treatment Episode Data Set (data on substance abuse growth)

Notes: Reported estimates reflect the percentage effect of a 10 percent increase in state per-capita high-speed internet lines on admission to a substance abuse facility (Column 1) or self-reported drug use (Column 2), adjusting for state fixed effects, state-specific year trends, and additional covariates that may be correlated with treatment admissions (legal prescription rates for a given prescription drug and overall drug arrest rates within a state).