The Opioid Analgesic Epidemic: Who is to Blame?
An analysis of the physician prescribing trends of opioid analgesics.

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Abstract

The use of opioid analgesics to treat acute and chronic pain is routine in the medical world. Beginning in the 1990s a steep rise in opioid analgesic abuse sparked major public health concern. Today, opioid abuse is so severe that it is now the second leading cause of death in the United States (Okie, 2010). Although over the past decades, this topic has been widely studied using large nationally representative pharmaceutical and emergency department data sets, there is a lack of current studies using recent data and comparing it to different geographical trends. This research paper analyzes the most recent opioid prescription trends using a large and nationally representative pharmacy claims data set containing data from approximately 80% of all pharmacies in the nation. The overarching aim of this study is to understand whether the national trend during recent years also shows an increase in the prescriptions for opioid analgesics. It also examines whether trends differ by certain area characteristics such as age, unemployment rate, poverty rate, education level, and primary care physician availability. I do this by aggregating the number of prescriptions at the MSA level. By examining recent population characteristic trends and comparing them to the national opioid trend, factors associated with high opioid use can be established and used to explain the level of opioid misprescribing, misuse, abuse and death in the United States. Furthermore, the data results will provide information about the current severity of the opioid problem, and identify characteristics of the population most likely to consume opioids. This will enrich the knowledge of the public health community and increase the success rate of future public health initiatives.
Introduction

The use of opioid analgesics to medically treat chronic and acute pain is standard practice in the United States, and the most effective pain treatment to date. Food and Drug Administration (FDA) experts note that extended release and long-acting opioids such as OxyContin are severely misprescribed, misused, and abused (FDA, 2011). Improper opioid use has resulted in overdose, addiction, and death. The late 1990’s marked a spike in opioid analgesic abuse and has created an ongoing public health concern in the United States. The FDA estimates that over 33 million Americans age 12 and above misused extended release and long-acting opioids in 2007. The 2003 data marked opioid misuse at 29 million Americans----an increase of 4 million over a 5 year period. Research has shown a sizeable increase in opioid medications with an even greater increase in adverse health effects related to opioid use (Compton and Volkow, 2005). Opioid misuse has become so severe that it is now the second leading cause of accidental death in the United States (Tavernise, 2013). The number of deaths caused by opioid overdose has quadrupled since 1999, pushing the Center for Disease Control and Prevention (CDC) to declare pharmaceutical opioid overdose a national epidemic.

The federal government has played an important role in combatting the opioid drug abuse epidemic. The White House initiative introduced in April 2011 detailed a multi-agency collaboration aimed to reduce prescription drug abuse (FDA, 2011). The FDA developed an education program targeting the misuse and misprescribing of opioids. The program, “Risk Evaluation and Mitigation Strategy (REMS)” narrows in on educating physicians about proper pain management. Specifically, the REMS plan educates doctors about proper pain management, patient selection, and enhancing patient drug safety awareness. The new initiative calls for
companies to give patients education materials, including a patient friendly medication guide explaining safe use and proper disposal.

Studying physician prescribing trends of opioid analgesics is important to the development of public health and the laws and regulations surrounding pain management. Thus far the rise in opioid use has only been confirmed nationally through year 2009. This study’s contribution is to examine the recent physician prescribing trends of opioid analgesics for year 2007- quarter one 2013. In addition, this study answers a new question—is there a different pattern of opioid use over time in communities that have different levels of age distribution, income level, education, and, physician availability? The answers to these questions help us understand determinants of potential misprescribing, misuse, abuse, and eventually death associated with opioid analgesics.

**Background**

Opioids are the synthetic version of opium, and the most frequently used pain inhibitor in the United States (Volkow and McLellan, 2011). The clinical side-effects associated with opioid ingestion include: respiratory depression, cough suppression, nausea, vomiting, constipation, and urinary retention (Duthie and Nimmo, 1987). Nevertheless, prescription opioids are able to produce a “euphoric” feeling throughout the body, making them highly susceptible to abuse (CAMH, 2010). Opioids such as morphine and oxycodone are primarily used to treat moderate to severe pain. However, over the past several decades pharmaceutical companies developed and manufactured long-lasting opioid medications to better treat chronic pain conditions. Drugs that are classified as opioid analgesics are fentanyl, hydrocodone, hydromorphone, morphine, and oxycodone (WebMD). This class of drugs has an unparalleled ability to subdue the perception
and emotional response to pain through decreasing the pain signals sent by the nervous system to the brain.

The use of opioids to manage pain has had positive outcomes, but the steep rise in opioid related deaths and abuse has put physicians under scrutiny. The CDC’s November 4, 2012 issue of the *Morbidity and Mortality Weekly Report* indicated that in 2008, opioid prescriptions attributed to 14,800 overdose deaths, compared to 4,000 deaths in 1999 (AMA, 2013). In addition, Emergency Department admittance rates totaled approximately 340,000 visits a year. The rise in opioid related deaths and emergency department visits from 1999-2008 was analogous to the increase in opioid sales and non-medical opioid use (MMWR, 2011). The CDC’s *Healthy People 2010* midcourse review showed opioid analgesic related deaths were among the fastest growing drug related deaths in the United States. The escalation of opioid overdose increased 10-fold since 1990, which is in part attributed to the aggressive marketing tactics for extended-release OxyContin (Okie, 2010). The introduction of extended-release OxyContin in 1995 put pressure on physicians to take a greater initiative in diagnosing and treating pain. Methadone saw a similar spike in popularity for the treatment of chronic pain management. Insurers and Medicaid pushed physicians to prescribe the drug because of its inexpensive cost and reputation for being a less “abusable” long-acting opioid. The push for better pain treatment from manufacturers and insurers quadrupled the sale of oxycodone and methadone from 1997-2002.

While the costs of opioid prescriptions are covered to some extent by most private health insurance companies and government programs, stringent regulations are being adopted to reduce the amount of unnecessary prescription claims. Strategies to identify opioid abusers and decrease the level of inappropriate prescribing include claims reviews, claims matching and
formulary controls (Tufts Healthcare Institute, 2010). For example, claims review procedures could include notifying insurance providers when primary care physicians prescribe an opioid medication versus a licensed specialist. The process decreases the likelihood inappropriate prescriptions are given to individuals, and enables insurance providers to keep track of potential opioid abusers.

Compton and Volkow, (2005) place prescription opioids into two distinct categories: acute pain treatment accompanied with brief opioid use and chronic pain treatment paired with long term opioid consumption. According to research conducted by Porter and Jick in 1980, treatment of acute pain is rarely associated with abuse or addiction due to the short duration of the prescription. Conversely, long term opioid exposure has attributed to abuse or addiction in 2.8-18.9% of patients. The potential reason for the increase in opioid misuse is three-fold. First, pharmacy data analyzed by Zacny et al. (2003) shows a significant increase in the number of opioid prescriptions being written, which can be explained by the increasing availability of the drug through manufacturers. Second, the National Center on Addiction and Substance Abuse (2004) identified the internet as a new channel for prescription transactions, ultimately increasing consumer access to prescription opioids; and third, according to the United States General Accounting Office (2003), alternations in drug formulation and an emphasis on primary care physicians to treat pain conditions rather than pain specialists.

Additionally, it is important to note the acceleration of opioid related deaths has fluctuated in different parts of the country. Rural areas such as West Virginia, New Mexico, Utah, Louisiana, Oklahoma, Nevada, Kentucky, and Tennessee produce the highest rates of fatal overdoses (Okie, 2010). Leonard Paulozzi of the CDC attributes the heightened prevalence to the surge in opioid prescribing trends in the 1990s. The influx of opioids into the rural market
increased the availability of “abusable” drugs. This was a significant factor because rural locations had accessible pharmacies, but lacked established underground drug markets. A 2006 study of accidental drug overdose in West Virginia showed that drug abuse or substance abuse was apparent in almost all cases. In 93% of those cases opioids were present, methadone being the most common. The study attributed the low level of education and socioeconomic status to be the major risk factors. In addition, national prescription-tracking data indicated that about 40% of opioid prescriptions are given to patients by general or family practitioners, osteopaths, or internists.

Currently, approximately 3% of adults receive long-term opioid treatment for chronic non-cancer pain, placing this particular population at a higher risk of overdose. The reduction of opioid related deaths and abuse has been challenging for various reasons. Improper prescribing as well as insufficient counseling and observation are contributing factors (FDA, 2011). Additionally, patient misuse and abuse, sharing of pills, and “doctor shopping” attribute to opioid mortality rates. Consequently, many risk factors contribute to opioid related deaths, but the extensive rate of misprescribed, misused, and abused opioid medications contributes to this public health issue.

**Literature Review**

Previous studies on opioid analgesics focused on the rising trends of opioid related misuse, abuse, and death, although no studies have used data past year 2009. The surge in opioid related health issues beginning in the 1990s has challenged researchers to identify the risk factors responsible for the rising trend. This section will discuss previous studies related to the rise in
opioid analgesic misuse, abuse, and death, as well as the correlates that may explain the increasing opioid problem in the United States to put my study into context.

Using data collected from the 2002 National Survey on Drug Use and Health, Compton and Volcow (2005) analyze the level of opioid abuse in the United States. The epidemiological data surveying a population size in the thousands, revealed that 4.7% of U.S. household residents over the age of 12 abused an opioid prescription in 2002 (Compton & Volcow, 2005). The study defines opioid abuse as, “any intentional use of opioids outside of a physician’s prescription for a bona fide medical condition, excluding accidental misuse (p. 103).” The authors point out that their use of the word “abuse” is not synonymous with the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM IV) abuse definition.

Moreover, of the 4.7% who abused an opioid medication, 13.7% identified with the DSM-IV symptoms for opioid use disorder. Opioid related drug mentions from medical examiner cases, obtained from the Drug Abuse Warning Network (2002), revealed a steep rise in opioid related deaths in 28 of 31 reporting localities from 1998-2002. The increasing relationship between mortality rates and opioid prescriptions explains why opioid use is of high concern. Compton and Volcow (2005) further highlight the extent of the opioid prescription problem through analyzing emergency department data. This was carried out by examining the U.S.’s annual number of opioid related mentions which increased 135% from 1995-2002 and a drastic 18.5% from 2001-2002. The alarming data sparked a major public health concern, especially within adolescent and elderly populations.

Early literature about the rise in opioid abuse as a result of pain treatment has been contradicted over the past decades. Jorason et al.’s (2000) descriptive study analyzing a sample size in the thousands, determined there was a steady rate of opioid abuse despite the spike in
opioid medications from 1990-1996. Further studies and increased media coverage of the opioid analgesic public health epidemic lead Zacny et al. (2003) to refute Jorason and colleagues’ initial determination that prescription opioids were not directly related to opioid abuse. Zacny et al. indicated the rate of increase in opioid analgesic emergency department mentions (which are a measure of adverse opioid related outcomes), does not fully explain the increase in opioid prescriptions. The study found that adverse events related to opioids, was in some cases equivalent to the rate of prescriptions, and in other cases exceeded it. Zacny’s contradiction of the previous literature led Jorason and colleagues’ to revisit the topic in order to determine the extent to which opioids as a drug class contribute to opioid abuse.

After analyzing the use of five different opioids (Fentanyl, Hydromorphone, Meperidine, Morphine, and Oxycodone) from 1997-2002 against the Automation Reports and Consolidated Orders System (ARCOS) (used as an indicator for medical use), and the Drug Abuse Warning Network (DAWN) (used as an indicator for abuse) Gilson and colleagues found four of the five drugs to correlate with medical use and abuse. Fentanyl and Oxycodone prescriptions increased significantly from 1997-2002, and Meperidine prescriptions decreased by 6% over the same time period (Gilson et al, 2004). The study attributes the decrease to the drug’s short duration and long-living metabolite.

Although there were limitations to both the DAWN and ARCOS data, the extent to which opioid analgesics contribute to abuse was 9.85% of the total DAWN emergency department mentions. Non-opioid analgesics accounted for 5.93% while illegal drug and alcohol combinations represented more than half of the total DAWN mentions. The opioid analgesic abuse levels had a significant turning point in 2002, with opioid analgesic mentions increasing by 120.24% over the six year study period.
The DAWN system does not explain the causes of drug abuse, but the literature aims to determine possible explanations. The number of multi-drug incidents increased by 28% from 1997-2002. Thus, one particular episode may contribute multiple opioids to the total number of DAWN mentions. Also, the rise in pharmacy theft, especially OxyContin which doubled from 218,339 dosages in 2000 to 506,711 dosages in 2002, could be a contributing factor in prescription opioid abuse.

As these studies above illustrate, there has been a substantial amount of attention given in prior research to opioid abuse concerns. The studies contemplate the contributing factors to opioid analgesic abuse, yet the researchers validate the importance of their use in the medical field. The chemical structure of opioid medications inevitably increases the probability of addiction, especially in long term pain treatment. Each study recognizes the effectiveness of opioid analgesic prescriptions; however, public health initiatives aimed to decrease the risk of abuse and educate stakeholders about proper prescribing, use, and identification of addiction is necessary going into the future.

This background is helpful as the context for studying the most recent opioid analgesic prescription data to determine the national trends as well as different trends by area characteristics, with a view to better understanding risk factors associated with opioid analgesic misprescribing, misuse, abuse, and death. The national rate of increase for prescription opioid analgesics, and the level of opioid prescriptions associated with each variable characteristic are expected to decline as a result of various public health initiatives and stringent regulations. Although county level analysis is expected to reveal patterns that differ by characteristics such as income level and physician availability, the contributing factors to the opioid analgesic epidemic may be difficult to determine given the data limitations.
Data

In order to examine the rate of increase or decrease in opioid analgesics, a nationally represented pharmacy claims database was used. The Symphony Health Solutions’ data-rich source provides pharmaceutical data collected from over eighty percent of all pharmacies in the United States. The database provides opioid analgesic prescription data by quarter from year 2007 to quarter one of 2013. I use data on the number of prescriptions of Fentanyl, Hydromorphone HCL, Hydrocodone with Acetaminophen, Morphine Sulfate, Meperidine HCL, Oxycodone HCL. The opioid prescription data extracted from the pharmaceutical database allows this study to examine the most recent trends in opioid prescriptions, which is important to determine the current level of opioid use, and perhaps the level of opioid misprescribing, misuse, abuse, and death in the United States.

Another data source, the Area Resource File (ARF), publically provides information on a vast array of characteristics for each county in the United States. This data set is produced by the Health Resources and Services Administration (HRSA). Eight interesting variables were chosen from the ARF to analyze in this study: Age, Per Capita Income, Persons in Poverty, Employed and Unemployed in Civil Labor Force, Persons with less than High School Diploma, Persons with 4+ Years of College, and Primary Care Physicians. The analysis of the above listed variables expands the depth of this study by comparing the characteristics of communities with opioid analgesic trends. Comparing the two datasets together provides a more holistic analysis of the opioid analgesic problem, and allows for more informed assumptions and conclusions to be made about trends in opioid analgesic use in the United States.
Methods

Since this study aims to understand prescription trends of the opioid analgesic class, and attempts to explain the trends by variations in particular county characteristics, this requires the pharmaceutical data set to be merged with the Area Resource File.

The pharmaceutical data are available nationally and also by geographical area. The data are available quarterly. The smallest geographical unit available is the Core Based Statistical Areas (CBSA) level. CBSA’s are geographic regions that encompass all metropolitan and micropolitan statistical areas. I chose six different opioids to represent the opioid analgesic class in this study. Ideally, each product within the database’s opioid analgesic class would be used for analysis, however due to time constraints, and computing power limitation, six highly utilized opioids were chosen to represent the opioid class. The opioids used in the report were: Fentanyl, Hydromorphone HCL, Hydrocodone with Acetaminophen, Morphine Sulfate, Meperidine HCL, Oxycodone HCL, which were added together to represent opioids for this study.

In order to be able to merge the ARF variables with the pharmaceutical data, and compare on a geographic level, ideally one would use a CBSA to FIPS county crosswalk. However, the crosswalk only represents Metropolitan Statistical Areas (MSAs), so I instead converted the pharmaceutical data with a CBSA variable to the MSA level, and the ARF variables containing the FIPS county variable to the MSA level. This method created a data set with both prescription data and area characteristics at the MSA level by quarter. We also aggregated these data to the national level to analyze national trends.

First, ratios for each variable were calculated by dividing each area characteristic by the total population. Three new variables were generated to categorize age into three different
classifications: Ratio of Population 15-29 (Ratio_Pop15_29), Ratio of Population 30-44 (Ratio_Pop30-44), and Ratio of Population 45-59 (Ratio_Pop45-59). The ratios were calculated by dividing each population age range by the total population. The age variable was grouped into three categories in order to determine if the trends for young, middle age, and older populations varied widely, and if so, determine if it has significance to the hypothesis of this study.

After defining the age variables, the mean of each remaining variable was computed by summarizing the distribution using Stata. Then, each variable was split into a high range (designated by being greater than or equal to the mean) and a low range (designated by being less than the mean). For example, if the variable “Ratio_Pop15_29” had MSAs with an age ratio above the mean, it was labeled “highpop15_29”, and if the variable had MSAs with an age ratio below the mean the label “lowpop15_29” was given. This procedure was used in order to compare if variable characteristics above the mean and below the mean seemed to display similar or different trends.

Once the mean number of opioid prescriptions by quarter was generated for each variable, the graphical representation was developed, so visual trends could be analyzed. After examining the graphical trends for the mean number of opioids on the national level, and the trends for the mean number of opioids per ARF variable, statistical analysis was performed to determine whether or not the trends were statistically different from one another.

Results

First, I present each data set’s trend in usage of opioid analgesic prescriptions from quarter one 2007 to quarter four 2012, and describe its significance to the analysis of the current
The graphical representation shown in Figure 1 of the national opioid trend from 2007-2012 seems to show a decrease from Q1 2007 to Q4 2008, and then a stable increase. A t-test analysis comparing the mean number of opioids in the year 2007 to year 2012 proves the data is statistically significant. When comparing Figure 1 to opioid trends in the 1990’s, it is not surprising to see a decline in the rate of increase, especially considering the amount of attention given to the opioid drug problem by the public health community, government, and society. However, it is still concerning the level of opioid use has been on an upward trend since Q1 2009.

*Figure 1: National Mean Number of Opioid Prescriptions by Quarter*

Notes: t-test statistic = -3.52 shows that the mean in 2007 is statistically significantly different from the mean in 2012.
Primary care physicians (PCP) are a particularly important variable in this study, as experts Compton and Volcow have identified the shift from pain specialists to primary care physicians (for treatment of pain conditions) as a contributing factor to the opioid epidemic. This expert assumption leads me to expect MSAs with a high ratio of PCPs (highPCP) to account for a greater level of opioids than areas with a low ratio of PCPs (lowPCP). The visual analysis displayed in Figure 2 validates the above assumption; additionally, the highPCP trend line seems to be comparable to the national opioid trend. However, it is important to note the level of opioid prescriptions for the high PCP trend line is greater than the national opioid trend line.

*Figure 2: Mean Number of Opioid Prescriptions by Primary Care Physicians*

![Figure 2](image)

Notes: t-test statistic = 12.47 shows that the highPCP mean is statistically significantly different from the lowPCP mean.

Figures 3, 4, and 5 represent the three different age variables, and have quite an interesting trend. Because young individuals are less likely to suffer from chronic pain conditions, I assume their level of opioid consumption will be less than the other age groups, and
therefore areas with a low ratio of young adults to account for less opioid prescriptions. Consequently, Figure 2 shows areas with a low ratio of young adults accounting for a greater amount of opioid prescriptions. Again, the low ratio trend seems to look visually similar to that of the national opioid trend, and the high ratio trend appears to be rather flat over the five year period. Additionally, the level of opioid prescriptions for the low ratio trend line in Q4 2010 is the highest out of all the age categories. The implications of the trend results are challenging to define, but the t-test statistic proves the data is significantly different.

Figure 3: Mean Number of Opioid Prescriptions by Population 15-29

![Graph showing mean number of opioid prescriptions by population 15-29 over quarters from 2007Q1 to 2012Q4.]

Notes: t-test statistic = -12.35 shows that the highpop15_29 mean is statistically significantly different from the lowpop15_29 mean.

The next age category, MSAs with a population ratio 30-44 years is shown in Figure 4. One would assume the need for pain treatment increases at this age, especially compared to the young adult population. I expect MSAs with a high population ratio of 30-44 year olds to account for a greater number of opioid prescriptions than MSAs with a low population ratio. The
trend pictured in Figure 4 seems to prove the above assumption, however the marginal difference between the high and low trend seems to be small. The t-test calculations between the high and low ratios are statistically different from one another.

*Figure 4: Mean Number of Opioid Prescriptions by Population 30-44*

![Graph showing mean number of opioid prescriptions by population 30-44.](image)

Notes: t-test statistic = 4.09 shows that the highpop30_44 mean is statistically significantly different from the lowpop30_44 mean.

The age bracket 45-59 is displayed in Figure 5. Because this is the highest age category, I presume the population would have a greater amount of medical needs that require pain treatment, and thus the greatest amount of opioid prescriptions out of the three different age categories. Furthermore, I anticipate geographic areas with a high ratio of 45-59 year olds to account for a greater amount of opioid prescriptions. Also, I assume the high ratio population trend line to increase at a faster rate than the low ratio trend line. Figure 5 seems to reject the above assumption, and in fact, MSAs with a low ratio of 45-59 year olds account for a greater amount of opioid prescriptions, and also seems display a steeper trend. Additionally, the level of
opioid prescriptions does not appear to be significantly higher than the other age groups. The statistical calculation is significantly different, though the implications of this trend are difficult to understand without more extensive population information.

*Figure 5: Mean Number of Opioid Prescriptions by Population 45-59*

![Graph showing mean number of opioid prescriptions by population 45-59.](image)

Notes: t-test statistic = 19.30 shows that the highpop45_59 mean is statistically significantly different from the lowpop45_59 mean.

The next ARF variable, poverty level is shown in Figure 6. It is reasonable to predict that MSAs with a high ratio of the population in poverty to account for a low level of opioid prescriptions. Typically, individuals in poverty do not hold health insurance, and are unable to pay the high cost for an opioid prescription. It is not surprising the graph shows areas with a low ratio of people in poverty accounting for a greater amount of opioid prescriptions than MSAs with a high ratio. Both the high ratio trend line and low ratio trend line follow a similar trend, and the shape appears to be comparable to the national opioid trend. The t-test analysis yields a
statistically significant result. Moreover, it is worthwhile to compare the poverty graph with per capita income, as both variables relate to financial stability.

*Figure 6: Mean Number of Opioid Prescriptions by Persons in Poverty*

![Graph showing mean number of opioid prescriptions by persons in poverty over time. The graph compares high poverty (highPov) and low poverty (lowPov) areas. The t-test statistic is -11.96, indicating a statistically significant difference.]

Notes: t-test statistic = -11.96 shows that the highPov mean is statistically significantly different from the lowPov mean.

I expect areas with a per capita income above the mean to account for a greater amount of opioids, than areas below the per capita income mean. This assumption stems from the knowledge that people with higher incomes often are employed, insured, and can afford prescription costs. The graph shown in Figure 7 reveals MSAs with a high per capita income account for a significantly greater level of opioid consumption. Both line graphs are statistically different from each other, and when comparing the per capita income graph (Figure 7) to the poverty graph (Figure 6), it is noticeable the number of opioids for areas with a high ratio of poverty are slightly greater than areas with a low ratio of per capita income. However, the opposite occurs when comparing the high per capita income trend line to the low poverty trend.
line. Therefore, personal wealth rather than areas with a low poverty population account for the greatest amount of opioid prescriptions.

*Figure 7: Mean Number of Opioid Prescriptions by Per Capita Income*

![Graph showing mean number of opioid prescriptions by per capita income](image)

Notes: t-test statistic = 17.87 shows that the highPerCapInc mean is statistically significantly different from the lowPerCapInc mean.

Employment is another unique factor that may help explain the level of misprescribing, misuse, abuse, and death related to opioid prescriptions. The graphical expectation is that areas with high employment and thus low unemployment would account for a greater amount of prescriptions, and therefore, Figures 8 and 9 would depict the inverse of one another. However, this is not the case; areas with a high level of employment and unemployment account for the greatest number of opioid prescriptions. Though the marginal difference in the unemployment graph is significantly smaller than the employment graph, both trends are significantly different, making it difficult to understand why this trend is occurring.
Figure 8: Mean Number of Opioid Prescriptions by Employed Persons

![Graph showing mean number of opioid prescriptions by employed persons over time, with statistical significance noted.]

Notes: t-test statistic = 14.54 shows that the highEmp mean is statistically significantly different from the lowEmp mean.

Figure 9: Mean Number of Opioid Prescriptions by Unemployed Persons

![Graph showing mean number of opioid prescriptions by unemployed persons over time, with statistical significance noted.]

Notes: t-test statistic = 2.96 shows that the highUnemp mean is statistically significantly different from the lowUnemp mean.
Lastly, education level is an important variable to analyze as it is a common predictor of future income level and employment status. Similar to the assumptions related to income and employment, it is expected areas with a high level of education account for a greater number of opioids than areas with a low level. Figure 10 shows the trend for MSAs with a high and low ratio of the population with less than a high school degree. Again, it is anticipated areas with four or more years of college, shown in Figure 11, display the inverse of Figure 10 (as was seen with the employment and unemployment variables). Looking at the graphs, the assumption is proven correct, and it is obvious MSAs with a high ratio of college educated individuals account for the highest level of opioid prescriptions; yet, it is interesting the low ratio trend line appears to remain rather flat from 2007-2012. Statistical examination for both the collegiate graph and less than high school degree graph yields a significantly different result.

**Figure 10: Mean Number of Opioid Prescriptions by Persons with Less than a High School Degree**

Notes: t-test statistic = -9.07 shows that the highHS_less mean is statistically significantly different from the lowHS_less mean.
**Discussion and Conclusion**

This study’s thorough analysis of the opioid analgesic trend from 2007- quarter one 2013 has brought important insight to the current opioid prescription problem in the United States. The data gathered and examined from both the Symphony Health Solutions pharmaceutical claims database and the HRSA Area Resource File provide extensive detail about the current level of opioid activity on the national and area characteristic level.

Using Stata for statistical analysis enabled the large data sets to be merged and programmed to quantify the desired outputs. Computing the mean number of opioid prescriptions by quarter, and the mean number of opioid prescriptions per area characteristic by
quarter generated interesting visual trends. Each variable was found to be significantly different in change over the time period, validating the initial visual analysis.

The variables examined throughout the study revealed many interesting trends. However, the reason for the increase in the national number of opioid prescriptions beginning in quarter one of 2009-quarter four 2012 is inconclusive. Perhaps the lack of a multi-agency federal initiative to combat the level of opioid misprescribing and misuse until 2011 is a contributing factor to the upward trend. Analysis in the future will need to be done to conclude whether or not the Risk Evaluation and Mitigation Strategy deployed by the Food and Drug Administration (FDA) reduced the level of opioid prescriptions on the national level. Also, comparing medical procedure data with the level of opioid prescriptions would show if the increase was related to an influx in clinical procedures and treatment.

Although the age variables produced noteworthy graphs, their significance to the opioid analgesic problem is inconclusive. Further analysis should be conducted in order to establish the significance of age to the rate of opioid prescriptions. The next variable trend, primary care physicians, showed that areas with a high ratio of PCPs accounted for a greater number of opioid prescriptions. It is uncertain if this trend was caused by a shift from pain specialists to PCPs, or if higher availability increased access to treatment in the population.

Moreover, poverty and per capita income seem to provide results that can help explain the current opioid situation. Areas and individuals with a greater amount of financial stability account for a larger number of opioid prescriptions for many potential reasons. First, financial stability is usually associated with employment, and therefore insinuates a higher level of academic achievement. Since employment and health insurance are in many instances linked to
one another, it is appropriate to assume the population with an above average ratio of per capita income and a low ratio of poverty has increased access to health services and opioid prescriptions. The question then moves to whether or not this population is in greater need of pain treatment, or if the non-financially stable are unable to enter the healthcare market, and therefore unable to obtain treatment for their medical conditions.

Education level is an important variable to consider because it has a direct correlation to future financial stability as well as employment. The graphs shown in Figures 10 and 11 solidify the notion that populations with a higher level of education are likely to utilize a greater amount of opioid prescriptions. I assume the trend exists for the same reasons as the financial variables discussed above. Also, I find it important to note that the greatest amount of opioid prescription utilization stems from the areas with the most highly educated population (four or more years of college). Further data must be analyzed to understand if this trend exists because barriers to access pain treatment have kept the less educated population from obtaining opioids, or if certain factors have made the educated population more susceptible to chronic pain and in need of opioid treatment.

Additionally, employment seems to be correlated with a higher level of opioid use, and the trend can be explained through the assumption that employment is associated with a higher level of education, financial stability, and therefore access to health services and prescription drugs. On the other hand, the unemployment graph shows a surprising trend. Areas with a higher level of unemployment account for a greater amount of prescriptions than areas with a low level of unemployment. Perhaps the unemployed population is receiving unemployment health benefits, which is enabling them to access the healthcare system. Although this assumption does not provide insight into the current level of misprescribing, misuse, abuse and death related to
opioid prescriptions, further research must be conducted to understand why a high level of employment is not inversely related to the unemployment level of opioid prescriptions.

In closing, the ARF variables explored in this study do not provide enough evidence to prove whether or not particular area characteristics are directly related to the level of misprescribing, misuse, abuse and death related to opioid analgesic prescriptions. The variables analyzed in this study provided insight to the characteristics of the population at risk, but did not describe how this population was using prescription opioids. Examining emergency department and mortality data related to opioid use, and comparing it with the ARF variables would deliver a more accurate picture of the level of misprescribing, misuse, abuse, and death in the United States. Also, analysis of clinical operations and treatment should be conducted in order to understand if the increase in opioid prescriptions is the outcome of an increase in pain related treatment. Although this study was unable to prove the specific factors causing the current opioid analgesic trend, medical professionals must be aware that there is still a steady incline in opioid use, and to exercise caution when prescribing pain medications to patients.
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**Appendix**

*rename variables from Area Resource File to use in ratio calculations;*

. rename f1467510 PCP;
. rename f1390609 Tot_M;
. rename f1390709 Tot_F;
. rename f0671000 M15_19;
. rename f0671100 F15_19;
. rename f0671200 M20_24;
. rename f0671300 F20_24;
. rename f0671400 M25_29;
. rename f0671500 F25_29;
. rename f0671600 M30_34;
. rename f0671700 F30_34;
. rename f0671800 M35_44;
. rename f0671900 F35_44;
. rename f0672000 M45_54;
. rename f0672100 F45_54;
. rename f0672200 M55_59;
. rename f0672300 F55_59;
. rename f0978108 PerCapInc;
. rename f1322309 Pov;
. rename f1445005 HS_less;
. rename f1445205 Coll;
. rename f1451105 Emp;
. rename f1451205 Unemp;
. rename f00002 FIPS;
. rename f04437 County;

*create opioid class variable using pharmaceutical data;*

. egen opioids = rsum(fentanyl hydrocodone hydromorphone meperidine morphine oxycodone);

*create ratios for each variable using the renamed ARF variables*

. gen Pop30_44=M30_34+F30_34+M35_44+F35_44;
. gen Pop45_59=M45_54+F45_54+M55_59+F55_59;
. gen Ratio_Pop15_29=Pop15_29/(Tot_M+Tot_F);
. gen Ratio_Pop30_44=Pop30_44/(Tot_M+Tot_F);
. gen Ratio_Pop45_59=Pop45_59/(Tot_M+Tot_F);
. gen Ratio_HS_less=HS_less/(Tot_M+Tot_F);
. gen Ratio_Coll=Coll/(Tot_M+Tot_F);
. gen Ratio_PCP=PCP/(Tot_M+Tot_F);
. gen Ratio_Pov=Pov/(Tot_M+Tot_F);
. gen Ratio_Emp=Emp/(Tot_M+Tot_F);
. gen Ratio_Unemp=Unemp/(Tot_M+Tot_F);

*Summarize the distribution to obtain the mean for the opioid class variable and each ARF variable.

sum opioids,d;
sum Ratio_Pop15_29,d;
sum Ratio_Pop30_44,d;
sum Ratio_Pop45_59,d;
sum Ratio_PCP,d;
sum Ratio_HS_less,d;
sum Ratio_Coll,d;
sum Ratio_Pov,d;
sum Ratio_Emp,d;
sum Ratio_Unemp,d;
sum Ratio_Coll,d;

*obtain trend for all MSAs using opioid class variable and ratio for each ARF variable;

. collapse (mean) mnopioids= opioids, by(Qtr);
. collapse (mean) highpop15_29= opioids if Ratio_Pop15_29>.200, by(Qtr);
. collapse (mean) lowpop15_29= opioids if Ratio_Pop15_29<.200, by(Qtr);
. collapse (mean) highpop30_44= opioids if Ratio_Pop30_44>.204, by(Qtr);
. collapse (mean) lowpop30_44= opioids if Ratio_Pop30_44<.204, by(Qtr);
. collapse (mean) highpop45_59= opioids if Ratio_Pop45_59>.166, by(Qtr);
. collapse (mean) lowpop45_59= opioids if Ratio_Pop45_59<.166, by(Qtr);
. collapse (mean) highHS_less= opioids if Ratio_HS_less>.09, by(Qtr);
. collapse (mean) lowHS_less= opioids if Ratio_HS_less<=.09, by(Qtr);
. collapse (mean) high_Coll= opioids if Ratio_Coll>.148, by(Qtr);
. collapse (mean) low_Coll= opioids if Ratio_Coll<=.148, by(Qtr);
. collapse (mean) highEmp= opioids if Ratio_Emp>.453, by(Qtr);
. collapse (mean) lowEmp= opioids if Ratio_Emp<=.453, by(Qtr);
. collapse (mean) highUnemp= opioids if Ratio_Unemp>.035, by(Qtr);
. collapse (mean) lowUnemp= opioids if Ratio_Unemp<=.035, by(Qtr);
. collapse (mean) highPerCapInc= opioids if PerCapInc>33220.73, by(Qtr);
. collapse (mean) lowPerCapInc= opioids if PerCapInc<=33220.73, by(Qtr);
. collapse (mean) highPCP= opioids if Ratio_PCP>.0007269, by(Qtr);
. collapse (mean) lowPCP= opioids if Ratio_PCP<=.0007269, by(Qtr);

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References:


