Amanda R. Haddock A Bibliometric Analysis of Opioid Publications at the University of North Carolina – Chapel Hill. A Master's Paper for the M.S. in I.S degree. April, 2019. 52 pages. Advisor: Dr. Fei Yu

Introduction: With the increasing severity of the opioid epidemic in America, there has been an increase in publications addressing this urgent issue. However, no systematic analysis has been performed to identify who the main researchers are, where these studies are the published, and what topics are they publishing on.
Objectives: This study conducted a bibliometric analysis on opioid-related research publications produced at the University of North Carolina-Chapel Hill (UNC-CH).
Methods: Bibliometric methods were used to reveal the research productivity within opioid research at UNC-CH. Organizational and country collaboration networks were generated to show the collaborated working with UNC-CH researchers. The topic analysis illustrated the range in topics over the past 20 years.
Results: The results demonstrate that there has been a shift in topics over the past 20 years as well as the increase in collaboration with other academic research institutions.

Headings:

      Bibliometrics

      Bibliometrics -- Citation Analysis

      Opioids

      Opioid Epidemic

A BIBLIOMETRIC ANALYSIS OF OPIOID PUBLICATIONS AT THE UNIVERSITY
OF NORTH CAROLINA – CHAPEL HILL

by
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A Master's paper submitted to the faculty
of the School of Information and Library Science
of the University of North Carolina at Chapel Hill
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Approved by

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Dr. Fei Yu

Acknowledgements

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I. Introduction

The opioid epidemic has been declared a national emergency in the United States. The US Centers for Disease Control and Prevention statistics report that between 1999 and 2017, over 700,000 people have died from a drug overdose, approximately 400,000 of these deaths being due to prescription and illegally obtained opioids[1]. According to Morbidity and Mortality Weekly Report published by the CDC, in 2017 alone, there were 63,632 deaths due to drug overdoses, two-thirds of these were due to opioids (Scholl, et. al., 2018). The CDC has identified 3 "waves" that have contributed to the increase in opioid abuse since the 1990s. The first wave was an increase in the prescription of opioids in the 90s; the second wave was increase in heroin use and related deaths beginning in 2010; the third wave was the increase in the use of the synthetic opioid fentanyl in 2013, which continues to be a significant issue to this day. In an article in Frontline, published by PBS, the authors cited statistics from the National Institute on Drug Abuse that the amount of opioids prescribed by doctors tripled between 1991 and 2011. At the same time heroin production and supply into the United State increased from 8 to 50 metric tons in just four years from 2005 to 2009 (Nolan, 2016).

The opioid epidemic in America has become so extreme that educators are being trained to handle an overdosing student. Educators in Alabama are being preemptively

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[1] Opioid Overdose. (2018, December 19). Retrieved March 13, 2019, from https://www.cdc.gov/drugoverdose/epidemic/index.html

shown how to use overdose reversing drugs like Narcan, and how to tell if one of their

students is overdosing. According to an article by the BBC, Florida is also considering

adopting a similar project to combat opioid overdoses in their students[2].

Pharmaceutical companies in the United States are now facing legal action for

their roles in the deaths that have occurred due to opioid overdose. An article by NPR

journalist Brian Mann details how companies such as Janssen Pharmaceuticals, Purdue

Pharmaceuticals, and CVS are facing numerous lawsuits from people who want to see

them held accountable for pushing opioids into the hands of those who have suffered and

died from addiction. According to the same NPR article:

*"One reason for the shift is that cities and states filing these suits are moving more
aggressively to pull back the curtain on the drug industry's practices, urging courts to
make internal memos, marketing strategies and reams of other documents public."*

Some internal documentation from companies such as Purdue Pharmaceuticals have

given indication that these companies knew the serious addictive side effects of these

drugs and did not make the medical community aware of this before prescribing. Internal

documentation from Purdue show that they were not only aware of the danger addiction

from drugs like OxyContin but specifically pushed it so that they could profit from

people becoming addicted to it. These lawsuits against Purdue have led the CEO to

announce that the company is considering bankruptcy as the lawsuits could cost the

company tens of billions of dollars, according to an article from the Washington Post.

In 2017, the United States Department of Health and Human services declared a

public health emergency in regards to opiate abuse in the US[3]. They introduced the "5-

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[2] Baker, Vicky. "Opioid Crisis: US Schools Prepare for Student Overdoses." *BBC News*, BBC, 11 Mar. 2019, www.bbc.com/news/amp/world-us-canada-47447603.

[3] U.S. Dept. of Health and Human Services. (2018, March 6). What is the U.S. Opioid Epidemic? Retrieved September 12, 2018, from https://www.hhs.gov/opioids/about-the-epidemic/index.html

Point Strategy to Combat the Opioid Crisis" which outlines five main strategies in

fighting the opioid epidemic. These include: 1) Improve access to treatment and recovery

services; 2) Promoting use of overdose-reversing drugs; 3) Strengthening our

understanding of the epidemic through better public health surveillance; 4) Providing

support for cutting edge research on pain and addiction; and 5) Advancing better

practices for pain management[4]. While many of these goals focus on immediate

treatment of opioid addiction and overdosing, points 3 and 5 address the wider public

health goal of research and development of better treatments and practices in regards to

opioid addiction and prescription. Currently there is a lack of systematic survey and

analysis of the research effort regarding the opioid epidemic. This study aims to fill this

gap by taking a bibliometrics approach to identify and summarize the research output in

the field of opioid addiction treatment and prevention.

Specifically, the purpose of this paper is to focus on the research contributions by

researchers at UNC-Chapel Hill's to this nationally recognized public health issue. This

will be achieved through identifying published research articles that originate from UNC.

This also includes identifying key stakeholders in this research, i.e. the practitioners,

medical researchers, and pharmaceutical companies, who are focusing on finding

improvements to current opioid addiction treatments, alternative pain management drugs

and treatments, and addiction presentation and sustainment measures. The reason this is

essential to further progress in this field is to create a type of social network between

stakeholders to create open collaboration and sharing of research and ideas.

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[4] U.S. Dept. of Health and Human Services. (2017, April 19). Secretary Price Announces HHS Strategy for Fighting Opioid Crisis. Retrieved September 12, 2018, from https://www.hhs.gov/about/leadership/secretary/speeches/2017-speeches/secretary-price-announces-hhs-strategy-for-fighting-opioid-crisis/index.html

II. Literature Review

A. Bibliometrics within the Biomedical and Health Sciences

Bibliometrics is the statistical analysis of a corpus of published work. Bibliometric analysis can be used to predict trends in publications in a specific domain and is often used to advise researchers and grant funding agencies. Generally, bibliometrics is often used as an approach to analyze published works to determine their research impact. White et al (1989) describes bibliometrics as

" [the] task … to provide evolutionary models of science, technology, and scholarship".

Little to no analysis has been conducted into the scope of opioid related research in the United States. However, there have been many papers written on bibliometric analysis in a variety of other medical related fields, aimed at tracking progress and demonstrating research impact in a certain field. Bibliometric analyses have been done to study the impact of publications in pediatrics, hematology, and global and public health topics, such as alcohol abuse, diabetes, and migrant health.

A study of air pollution and respiratory diseases created a research landscape for this field using co-authorship, journal, country, organizational, and topic keyword analysis (Sweileh et al. 2018). Through bibliometric analysis they determined the most popular keywords (air pollution, asthma, particulate matter), the most active organization in the publications set (Harvard), and the countries from which the most active authors are from (the Netherlands, Italy, UK). Similar to this bibliometric analysis, they used VOSviewer to visualize networks. They concluded that air pollution research is rapidly

increasing and how increase research in this air correlates to an international response to air pollution and respiratory issues. McDowell et al. (2017) used bibliometric analysis techniques to gauge the research output of the pediatric liver transplantation community and identify the most influential articles on this topic. They used co-citation and journal analysis to answer these questions. Like Sweileh et al. (2018), McDowell et al. (2017) used VOSviewer to visualize these results. Gonzalez-Alcaide et al. (2016) used Web of Science Journal Citation Reports to identify articles from journals that were categorized under "substance abuse". They created a "citation matrix" to show how many times an article cited another article in the publication set. They used this data to create a co-citation network, visually showing connections between publications, and clustering based on type of substance abused being studied. This type of analysis is similar to a topic analysis and helps to show where developments are happening in the field, in this case the field of substance abuse. It can also help inform where future research should focus, by revealing areas where research has been minimal. Liu et al. (2018) also used citations about human fatigue from Web of Science to show publication trends since 1975, global publication distribution, what disciplines are publishing on this topic, keyword distributions, and the top rank countries in terms of human fatigue publications.

B. Visualization Techniques and Analytics

Visualization is an important tool for the analyst to represent their results and findings. Frequently, visualizations are used in end of year fiscal reports to show research output. Specifically, visualizations are helpful in showing collaboration

networks among a group of authors. In creating visualizations, it is important to remember who the audience is and to communicate the data in the clearest and succinct way possible.

VOSviewer is a very prominent tool in visualizing the networks created by bibliometric analysis; two of the articles noted above used this tool to report their findings in network visualizations. Liao et al. (2018) utilizes the tool VOSviewer to show keyword co-occurrences in their analysis of medical related big data. The visualization they created shows how keywords, which are assigned by the author or the publisher, are related to one another, and which keywords have the most publications related to them. These types of visualizations are helpful in discovering areas where there has been a lack of research and also to show the breadth of research topics in a publication set.

Palmblad and van Eck (2018) used VOSviewer to visualize co-authorship networks for publications by members of the American Society for Mass Spectrometry. Nees Jan van Eck, one of the co-creators of VOSviewer, has published several articles demonstrating the functionality of the software. In this 2018 publication, in addition to the co-authorship analysis, Palmblad and van Eck used topic, organizational, and country analysis to demonstrate the breadth of publications made by the members of the American Society for Mass Spectrometry. The authors claimed that this was the first bibliometric analysis of a scientific organization with international coverage. They came to the conclusion that collaboration tends to happen when authors are in close geographic proximity to each other but this may be due to the fact that this community in particular is very small and might differ in larger research communities.

In addition to VOSviewer for visual reporting of bibliometric analysis results, Tableau is used to report the quantitative results to support the visual map of collaboration or topic words. Yu et al. (2018) used Tableau in an analysis of the research impact of the Cancer Cell Biology Program at UNC-Chapel Hill. Here they used Tableau to visualize the publication year distribution in the citation set. A similar technique was used in this study to show the increase in publication volume from 1999 to 2019.

III. Methods

This study adopted bibliometrics to conduct organizational collaboration analysis and topic analysis. These analyses help to give us an overview of the landscape of research effort, such as who is doing research, who are they working with, and what topics are they publishing on. By visualizing these collaboration and keyword co-occurrence networks, we can see where key collaboration is happening, where there are potentials for future collaboration, and identify popular topics and where research gaps need to be filled.

To facilitate this bibliometric analysis, collaboration with UNC-CH Health Sciences Library's Impact Measurement and Visualization (IMV) team, of which the author is a member, was necessary. The IMV team provides analysis and visualization services to the UNC-CH research community through bibliometrics and visualization, analysis of publication trends and collaborations, and publication impact[5]. Members of

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[5] https://hsl.lib.unc.edu/impact

the IMV team have already worked on projects using bibliometric analysis and validated visualization methods.

This study employed these bibliometric analysis methods to illustrate the research effort that researchers at UNC-Chapel Hill have dedicated to opioids, opioid addiction treatment, and other opioid related topics from 1999 to 2019. This date range was chosen to encompass the beginning of the opioid addiction crisis as well as the shift toward research regarding addiction treatment. These dates were recommended by members of NC TraCS who are familiar with the trends in opioid research. Research effort was measured by the scope of internal collaborations which exist within UNC-Chapel Hill and the number of external collaborators, the countries UNC has collaborated with, and the range of topics within this citation set.

A. Search Strategies and Data Collection

Before beginning the data gathering process, a discussion was had with members of North Carolina Translational and Clinical Sciences Institute at UNC-Chapel Hill (NC TraCS) and the UNC Injury Prevention Research Center (IPRC) who are interested in tracking UNC-CH research related to opioids. The purpose of this meeting was to get practitioners' opinions on how to search for relevant research articles. After this discussion, it was decided to keep the searches broad in order to gather as many relevant articles as possible. Initially it had been planned to only search the PubMed database but this was expanded to include Scopus and Web of Science Core Collection, as limiting searching to PubMed resulted in too few citations.

Once the scope of the search was determined, librarians at the Health Sciences

Library were consulted to help build the search string to be used in each of these three

databases. See Table 1 below for the search string documentation.

Database	Search String	Number of Results	Date Range
Pubmed	((opioid* OR opiate*) AND (unc[ad] OR "university of north carolina"[ad] OR "chapel hill"[ad] OR "unc ch"[ad] OR uncch[ad]))	553	1999-2019
Scopus	(TITLE-ABS-KEY (opioid*) OR TITLE-ABS-KEY (opiate*)) AND (AFFIL (unc) OR AFFIL ("university of north carolina") OR AFFIL ("chapel hill") OR AFFIL ("unc ch") OR AFFIL ("uncch")) AND (LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2007) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2005) OR LIMIT-TO (PUBYEAR , 2004) OR LIMIT-TO (PUBYEAR , 2003) OR LIMIT-TO (PUBYEAR , 2002) OR LIMIT-TO (PUBYEAR , 2001) OR LIMIT-TO (PUBYEAR , 2000) OR LIMIT-TO (PUBYEAR , 1999))	953	1999-2019
WoS	(TS=(opioid* OR opiate*)) AND (OG= (unc OR university of north carolina OR unc ch OR uncch) AND (AD=chapel hill)) TS=(opioid* OR opiate*) AND OO= (unc OR "university of north carolina" OR "chapel hill" OR "unc ch" OR uncch)	812 Total citations generated from both search strings	1999-2019

Table 1
Search strategy documentation for opioid citations used in bibliometric analysis

All search strings across databases are equivalent, changing the format of the string to fit

the databases parameters. Note that these searches were limited to only those articles on

which UNC-Chapel Hill researchers/authors were included. Citations from Scopus and

WoS were downloaded in csv format and included all information needed by the

visualization software. PubMed citations were downloaded in XML format and

converted to an Excel spreadsheet using a tool called PubMed2XL, developed by Roman

V. Kiseliov[6].

B. Deduping and Title Abstract Screening

Due to overlap between the databases used, this citation set included duplicates

that needed to be removed before cleaning, normalization, and analysis could take place.

All datasets from the three databases were also downloaded in RIS format and imported

into a library in EndNote X8 citation management software. The deduplication process

required citations to be in RIS format and used EndNote as a repository for the citations

which were classified as unique and duplicates. This process was facilitated by a tool

called Deduper which was developed by ICF (Magnuson et al. 2019). The process

consisted of two phases by which duplicates were identified. Phase 1 is an executable

program which runs within an Excel GUI. The user points the executable to the RIS files

within the GUI, which is prioritized by database source (see Figure 1).

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[6] Copyright 2013 Nitin Arora. Licensed under the MIT license. Downloaded from
http://blog.humaneguitarist.org/projects/pubmed2xl/

Argument Index	Variable	Value	Remarks
1	Input Filename of PubMed RIS File, if any	Scopus.ris	Input file name of PubMed RIS file. Leave blank if none.
2	Input Filename of WoS RIS File, if any	Pubmed.ris	Input file name of PubMed RIS file. Leave blank if none.
3	Input Filename of Other Sources RIS File, if any	WoS.ris	Input file name of PubMed RIS file. Leave blank if none.
4	Desired Output Filename	Opioid.ris	Output filename. Will be suffixed with _Keep and _Dups.

PURPOSE: To combine and perform Phase 1 deduplication on RIS files from PubMed, Web of Science, and Other Sources.

RUN

DETAILS: Identifies records with identical title, publication year, first author, and starting page as duplicates.

New fields added to RIS are A4 containing first author last name and SE containing first page

In duplicate clusters, PubMed records are prioritized for keeping, followed by Web of Science, followed by Other Sources.

INPUT: RIS file containing standard fields.

OUTPUT: 2 RIS files: _Keep and _Dups

Figure 1
Screenshot of DeDuper Phase 1 GUI

Duplicates are determined by comparing author first and last name, starting page number, article title, and publication year. If two or more articles match on all 4 of these fields they are identified as duplicates in Phase 1. Phase 1 was designed to avoid any false positives so that manual review of duplicates would not be needed. The output of this phase is two new RIS files, Keeps and Dups. These were loaded into EndNote and organized. Phase 2 uses the dedupe package in Python, which uses machine learning to predict likely duplicates. This package is publicly available. This phase contains false positives which necessitates manual review, but high recall of potential duplicates. The Phase 1 executable file are not publicly available and use of this tool was coordinated through Michelle Cawley, Head of Clinical Academic and Research Engagement at HSL.

After deduplication, the data set consisted of 1182 citations. Priority was given to citations pulled from Scopus. These citations were then uploaded to Covidence to go through a title abstract screening to ensure they were relevant to the topic and that each citation included authors from UNC-Chapel Hill. Covidence[7] is a tool freely available to

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[7] Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org

UNC-Chapel Hill affiliates and is used by groups to make decisions as to whether or not

citations are relevant to the topic they are working on, most commonly used for

systematic reviews. Becky Naumann of the UNC Injury Prevention Research Center,

who has worked in opioid research previously, was asked to do a title abstract screen of

these citations and weed out those she thought were irrelevant. After screening the final
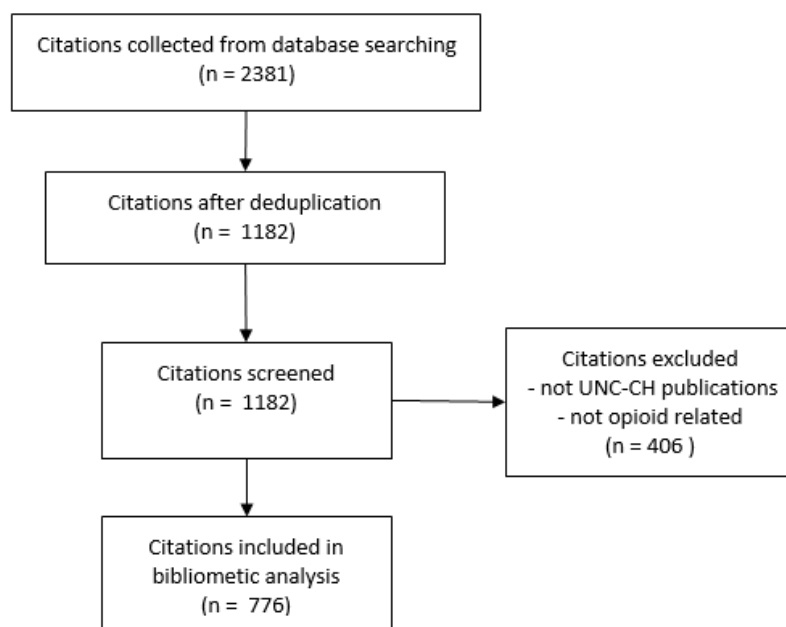
data set consisted of 776 citations.

Figure 2
PRISMA Diagram for citation screening

C. Data cleaning

Due to these citations originating from three different databases, it was necessary

to pull them together in one consistent format. The visualization software used,

VOSviewer, described below, requires a specific format in order to read the data

correctly. Since the majority of the citations came from Scopus, it was decided to format

the PubMed and WoS citations in Scopus .csv format and use this in VOSviewer. The

required fields were Author(s), Title, Source Title, Author Affiliation, and Publication

Year. Data cleaning and formatting was done manually in Excel.

Data Source	Data Fields	Data Measure	Metric	Tools
Publications	Journal Name, Title, Abstract Author Affiliation, Topic Keywords	Bibliometrics, Network Analysis	# of publications per year, top publishing journals, organizational collaboration, topic keyword analysis	VOSviewer, Tableau, MS Excel

Table 2
Details of data types, methodology, and tools used.

D. Analysis and Visualization

The visualizations in this paper were created using VOSviewer visualization

software version 1.6.10 and Tableau Desktop Professional Edition 2018.3.3. VOSviewer

was used to create network maps for the organizational, country and topic analyses.

Tableau was used to generate bar graphs showing top 14 countries and top 30 external

collaborating organizations represented in the data set. A bar graph of the 32 journals

which most frequently appeared to publish articles in this data set. These 32 journal

represent those which published articles contained in this data set 5 or more times.

i. VOSviewer

VOSviewer is a bibliometric visualization software developed by Nees Jan van

Eck and Ludo Waltman at the Centre for Science and Technology Studies at Leiden

University in the Netherlands. This software is freely available to use. As stated above,

this study utilized Scopus csv formatted citations for convenience of data manipulation, but VOSviewer also takes PubMed Medline format, WoS, Dimensions, RIS, and CrossRef bibliographic data. VOSviewer has multiple analysis options for this type of data: co-authorship linkage, including authors, organization, and country items; co-occurrence linkage for keywords which can be extracted from PubMed MeSH terms, author or index keywords, or title and abstract key words; bibliographic coupling, which is when two or more papers cite one or more of the same papers, authors, organizations, etc., the strength of which increases with more mutually cited papers; and co-citation, which measures how often two or more papers, authors, etc. are cited together. For this analysis, co-authorship analyses using organizations and countries and key term co-occurrence/topic analysis using the title and abstract fields were created.

1. Workflow

Once the data set was uploaded to VOSviewer and the type of analysis was chosen, VOSviewer generates a list of items that it extracts from the data set and identifies individual nodes in the visualization. Due to messy data in the original data set, this list may include multiple occurrences of the same entity with syntax variations. In order to map all the different instances to the same node, a thesaurus was created. The thesauri for each organization and country analyses were manually done using Microsoft Excel. The thesauri consist of two columns, Label and Replace By. Label represents the original list of organizations or countries generated by VOSviewer and Replace By represents how they will be shown in the visualization. See Figures 3 and 4 for example of thesaurus building.
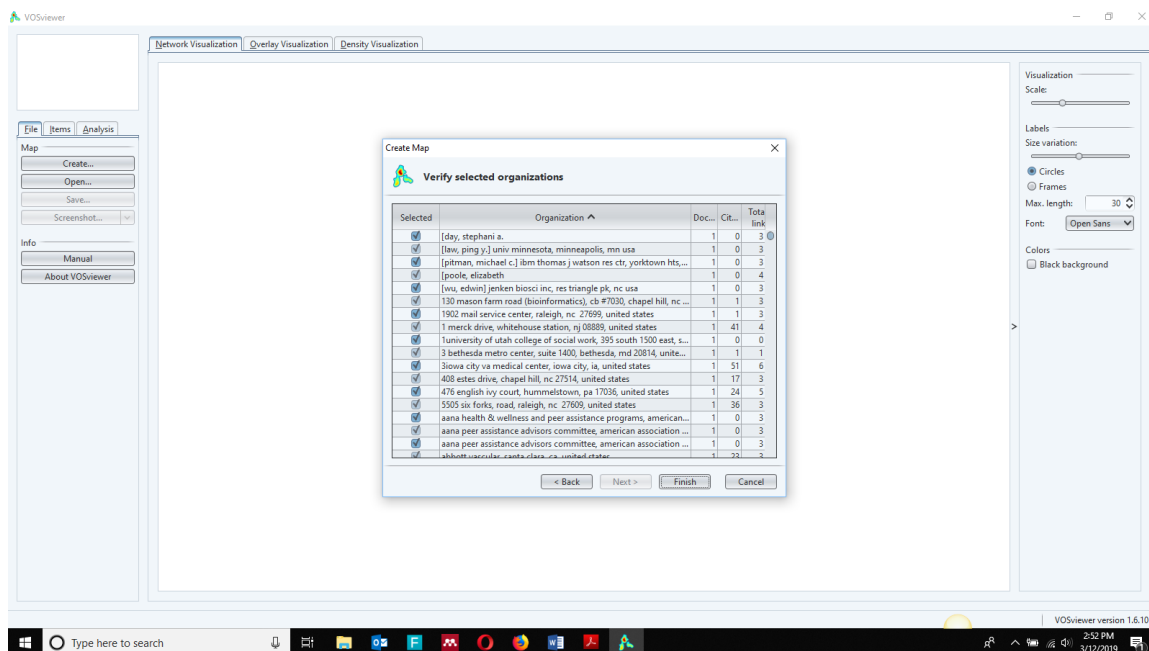
Figure 3
Screenshot of VOSviewer Organization list.
Note that it is the same for country and topic list, but list contains countries or topic words, respectively.

Figure 4
Screenshot of Organization Thesaurus created for Organization Analysis
Note that there are multiple instances of Ajou University and Albert Einstein College of Medicine which
VOSviewer sees as 6 and 9 different entities respectively. They have been mapped to one entity in the final visualization.

Once a thesaurus has been created it is uploaded into VOSviewer with the original citation set, the type of analysis is chosen and the network map for the analysis is generated.

VOSviewer allows for different types of analysis and manipulation to be done one the visualizations generated. In all of the visualizations created in this project, a time overlay was used, in which the color of the node represents the time in which the collaboration took place, or when a topic word was being used most frequently, as will be seen in the results section. VOSviewer also is capable of creating visualizations where the color can be assigned manually to represent association between nodes, such as departments in the same institution or authors affiliated with the same university. In addition, VOSviewer will generate density maps in which words are represented by a heat map, representing how often they appear in the data set. It also allows for manipulation of the attraction and repulsion between nodes, and the size of the nodes relative to each other. The parameters used for the visualizations in this paper are explained in the Results for each of the visualizations.

These visualizations were then saved as high resolution screenshots and map and network files. The map files are either text or csv files which contain details on the nodes in the visualization, which include node ID, the label which appears in the visualization (organization name or topic key word), x and y coordinates of the node, the cluster that VOSviewer has assigned the node to based on the algorithm it uses to calculate similarity, weight, and binary counting of occurrence in all documents. The color of the node can be changed according to what the user wants color to convey in the visualization. The network files are also either text or csv files. These files contain

information about which nodes are linked together and how strong that linkage is. These two files are used together to generate the visualization after the original visualization created with the bibliographic data has been saved. For this project, the map file was used to generate bar graphs for top publishing countries, organizations, and journals in Tableau.

ii. Tableau

Tableau Desktop is a visualization and data graphing tool, which is available free for students at UNC-Chapel Hill. While Tableau is capable of creating graphs in a variety of visual formats based on the imported data, only bar graphs were selected for the purposes of this project. These graphs were used together with the VOSviewer network visualizations to explain collaboration within the publication set.

Three bar graphs were generated for this project: top 30 publishing organizations, top 14 publishing countries, and top 32 publishing journals. To create the organization bar graph, the original data set was split into two sets, one containing citations published 1999-2009 and one containing all those published 2010 and after. The 10 year split was used to show the research output before and after the beginning of the opioid epidemic. These two sets were imported into VOSviewer to create two map files. Note that VOSviewer averages the dates associated with the papers published by an organization. These map files were imported into Tableau to create a stacked bar graph.

Similarly, the map file was used to create the top publishing journals bar graph. The network map generated by this was not used in this analysis, only the map file exported by this visualization. Since journal names are not represented the same across

bibliographic databases, it was necessary to normalize the names before importing into Tableau. The journals contained in this citation set were ranked based on how many citations were published by them. The purpose of this ranking is to show what journals are publishing the most opioid related research and inform researchers which journals are most receptive to opioid research publications.

Finally, the country bar graph was created by copying and pasting the country column in the original dataset into a new Excel sheet. Country names were normalized and associated with a count number for each of the instances of the country in the data set. This Excel sheet was uploaded into Tableau to create the most publishing countries graph.

IV. Results

The analyses performed on this citation set were organizational collaboration, both internal to UNC-CH and external, topic analysis, and country collaboration. The top countries and external collaborators were ranked in order of who had the most research publications represented in this citation set, as well as the top publishing journals.

The original citation set consisted of 2,318 citations. After deduping and screening 776 citations were included in the analyses. These citations span a 20-year period (1999-2019). See Figure 5 for publications per year distribution graph. 2018 was the most active year for opioid publications, with 122 articles being published.

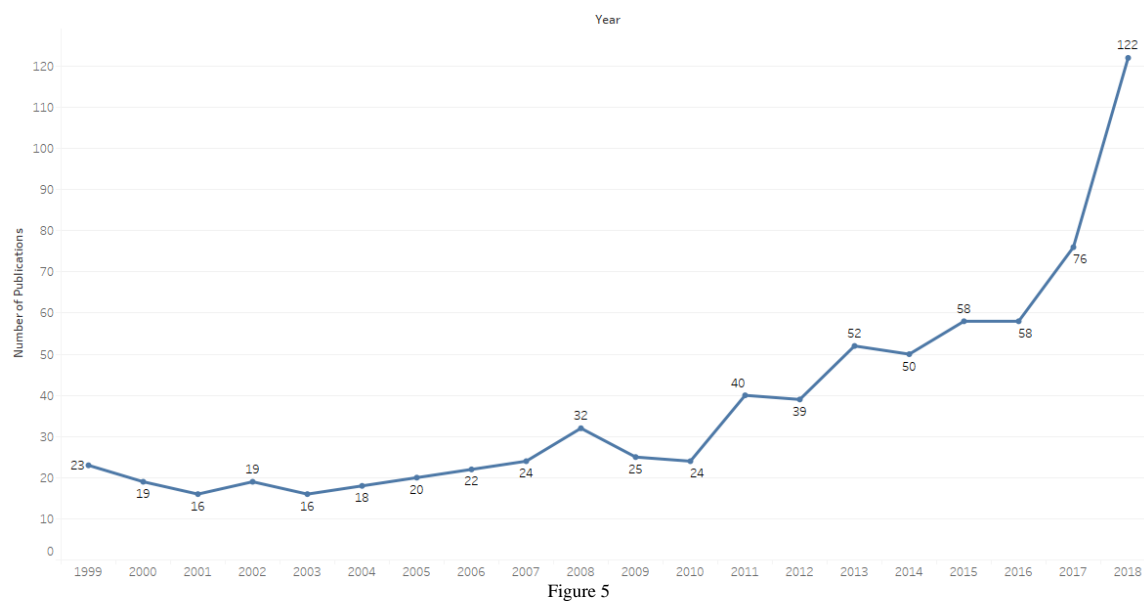Sheet 1

Figure 5
Distribution of Publications per year. Grand total: 776 publications.

A. Top Publishing Journals

In Figure 6, the top 30 journals that most frequently published articles in this citation set are ranked. The journals shown are those which have published 5 or more articles in this set; Psychopharmacology is the journal which has published the most journals in this set.

Top Publishing Journals

Journal Name	Number of Records
Psychopharmacology	30
Drug and Alcohol Dependence	28
Alcoholism: Clinical and Experimental Research	18
Journal of Pharmacology and Experimental Therapeutics	18
Journal of Pain	14
Pain Medicine	14
Pharmacoepidemiology and Drug Safety	14
Addiction	12
Addictive Behaviors	10
Pain	10
American Journal of Obstetrics and Gynecology	9
American Journal on Addictions	9
Brain, Behavior, and Immunity	9
North Carolina Medical Journal	8
PLoS ONE	8
Headache	7
Journal of Addiction Medicine	7
Neuropsychopharmacology	7
Academic Emergency Medicine	6
American Journal of Drug and Alcohol Abuse	6
Clinical Obstetrics and Gynecology	6
Journal of Neuroimmunology	6
Journal of Pain and Symptom Management	6
Journal of the American Medical Association	6
Obstetrics and Gynecology	6
American Family Physician	5
Critical Care Medicine	5
FASEB Journal	5
Journal of Acquired Immune Deficiency Syndromes	5
Journal of General Internal Medicine	5
Pharmaceutical Research	5
Pharmacology Biochemistry and Behavior	5

Figure 6

Bar graph showing the top 30 journals which most frequently published articles in this citation set.

B. Organization Analysis

The organization analysis was broken up into two parts, internal UNC-Chapel Hill collaborators and all external organizations with had collaborated with UNC-CH. These organizations represent the institutes the authors of the papers in this citations set are affiliated with. Each node in the collaboration maps shown below represents a single institution that has published an article in the citation set used in this project. Figure 7 shows all UNC-Chapel Hill affiliated schools and departments which have published opioid related publications in this citation set. Note that only institutions which have collaborated with other UNC-Chapel Hill institutions are represented in this image. Those nodes representing institutions which were not connected to other nodes, meaning they had not directly collaborated with those intuitions, were eliminated from this

visualization. These nodes may have been connected with other nodes, specifically the

external organizations which were not shown in this visualization, but do not have direct

collaboration connections with the nodes that are shown here.

Those institutions that were not shown are:

- Center for Developmental Science
- Measure Evaluation
- Department of Geology
- Institute for Global Health and Infectious Diseases
- Department of English and Comparative Literature
- Project China
- Department of Psychology and Neuroscience
- Health Sciences Library
- School of Information and Library Science
- Carolina Center for Genome Sciences

The decision was made to exclude these from the final visualization so that it would be

easy to see the network between collaborating schools and institutes at UNC-CH. It was

also decided to exclude UNC Rex Health Care, UNC Health Care, and UNC-Wake

Medical Center as they are hospitals and are separate entities from UNC-Chapel Hill as a

university. The organizations represented here have all published at least one article in

the citation set, i.e. the publication threshold was set to 1.

The School of Medicine is the most productive unit within UNC-Chapel Hill with

330 publications in this citation set. The Gillings School of Global Public Health and the

Department of Psychology are second and third with 102 and 83 publications

respectively.
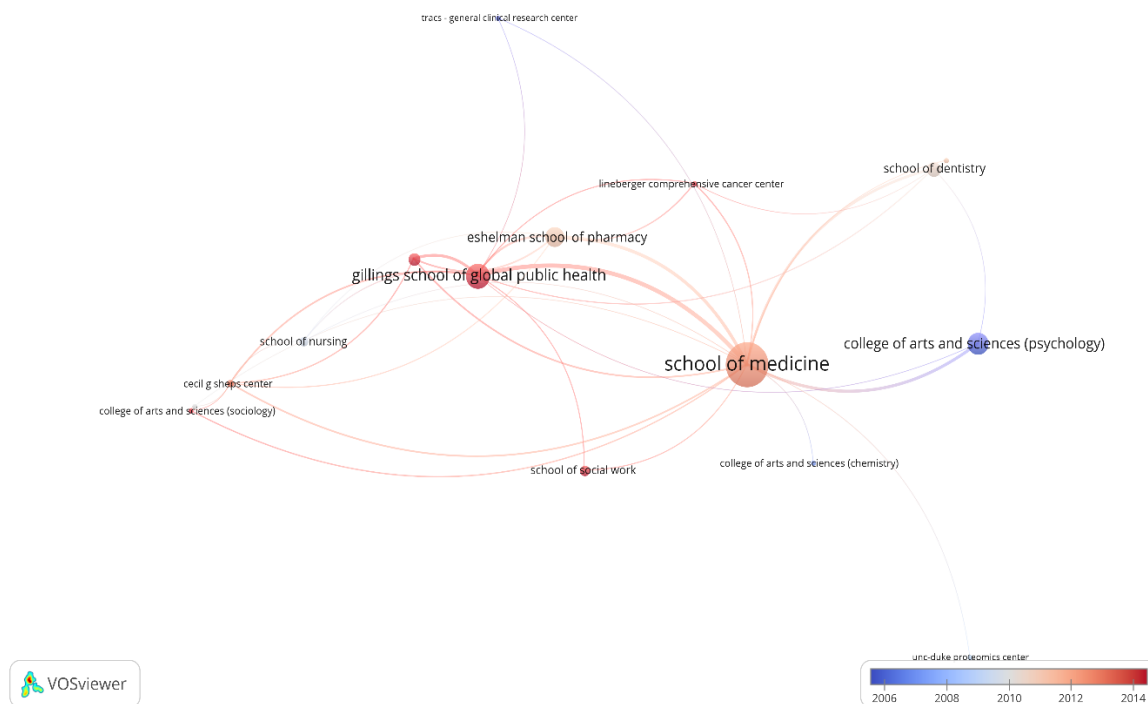
Figure 7
Internal UNC-CH Organization Collaboration Visualization

In this visualization, the color scheme represents the average publication year of an institutions publications in the citation set. Nodes in blue represent an average publication year of 1999 to 2011 and nodes in red represent an average publication year of 2012 to 2019.

The second organization analysis generated was external collaborators (see Figure 8). This visualization represented how UNC-Chapel Hill has collaborated as a whole with outside organizations. All UNC-Chapel Hill entities have been consolidated to one node labeled "unc-chapel hill". As can be expected, UNC-Chapel Hill is the largest node as it is the common collaborator on all the papers in this citation set. The top 3 collaborators in the data set are Johns Hopkins University (55 documents), Duke University (55), and Harvard University (39). Again, nodes in blue represent an average

publication year of 1999 to 2011 and nodes in red represent an average publication year

of 2012 to 2019.
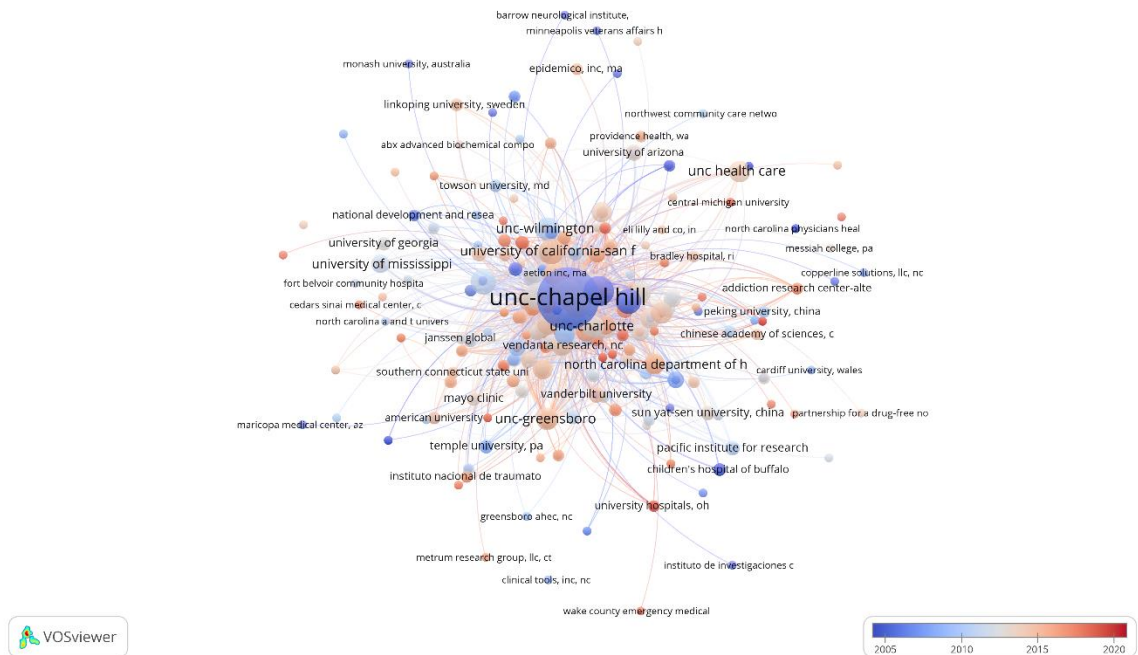
Figure 8
UNC-CH consolidated and external collaborators.
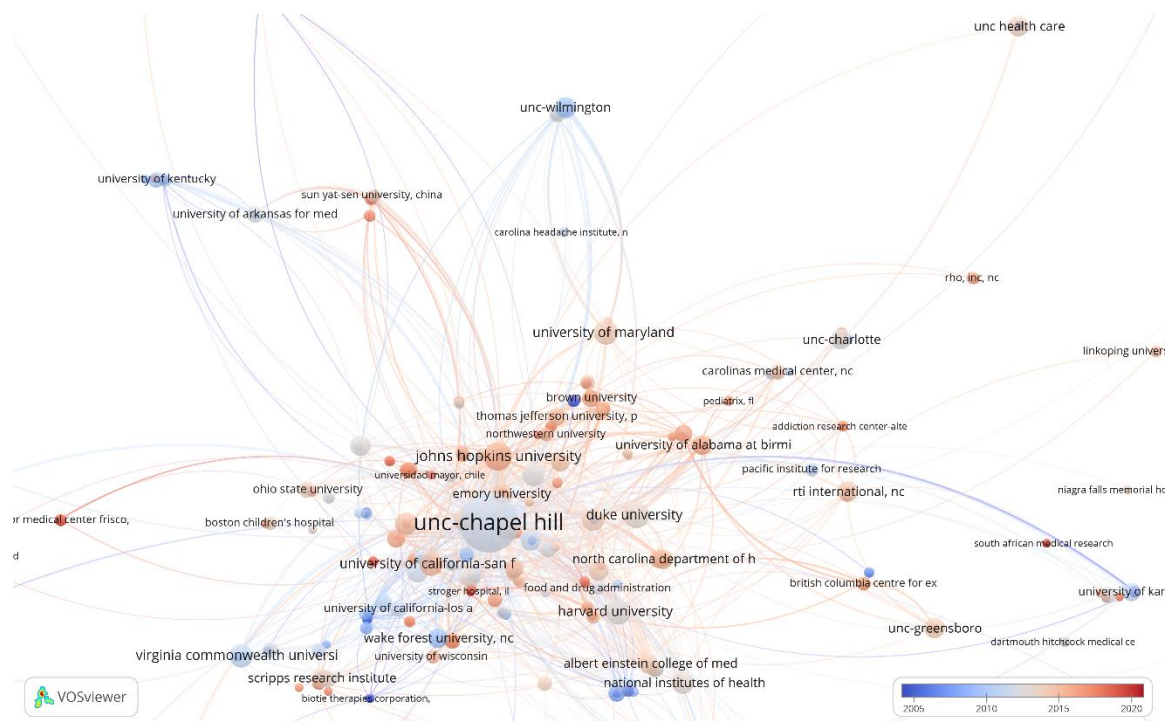
Figure 9
UNC-CH consolidated and external collaborators – central node zoomed in.

Top 30 Collaborating Institutions

		Year Ranges
		■ 1999-2019
		■ 2010-2019
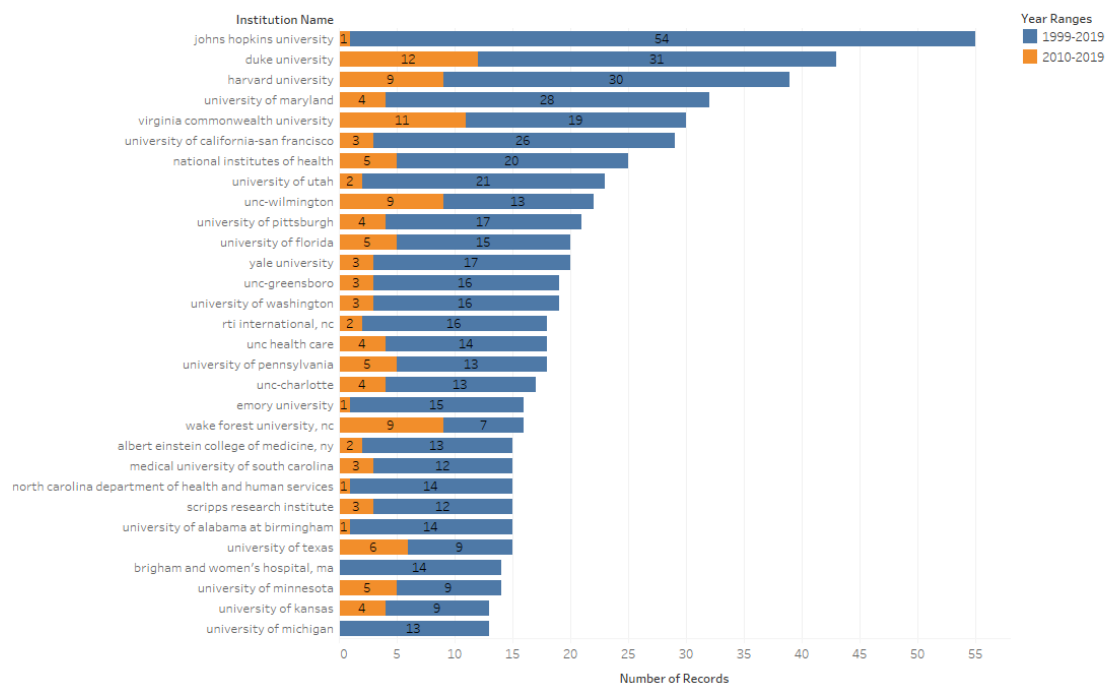
Figure 10
Top 30 External Organizations. UNC-CH is not included in this list.
The orange bar represents publications made by the organization before 2010 and the blue is post 2010. Together they are the total number of publications from the organization in the citation set.

The top 30 external collaborators were visualized in a bar chart using Tableau (see Figure 10). This figure shows how many publications each of these institutions have produced. A total of 558 external collaborating institutions were represented in this data set.

C. Topic Analysis

The topic map shown in Figure 11 uses title and abstract keywords extracted from the articles in the citation set. Abstracts of citations from the Web of Science database are not included in this visualization as they were not available for download from the database at this time. Color again denotes the average year of publication of the articles

in which key terms appear the most; the color gradient represents the same as in the previous visualization. Note the clear distinction between the blue nodes and red nodes. This means that the terms in blue are terms that were being published on before 2011; terms in red are those which have been published on more recently.
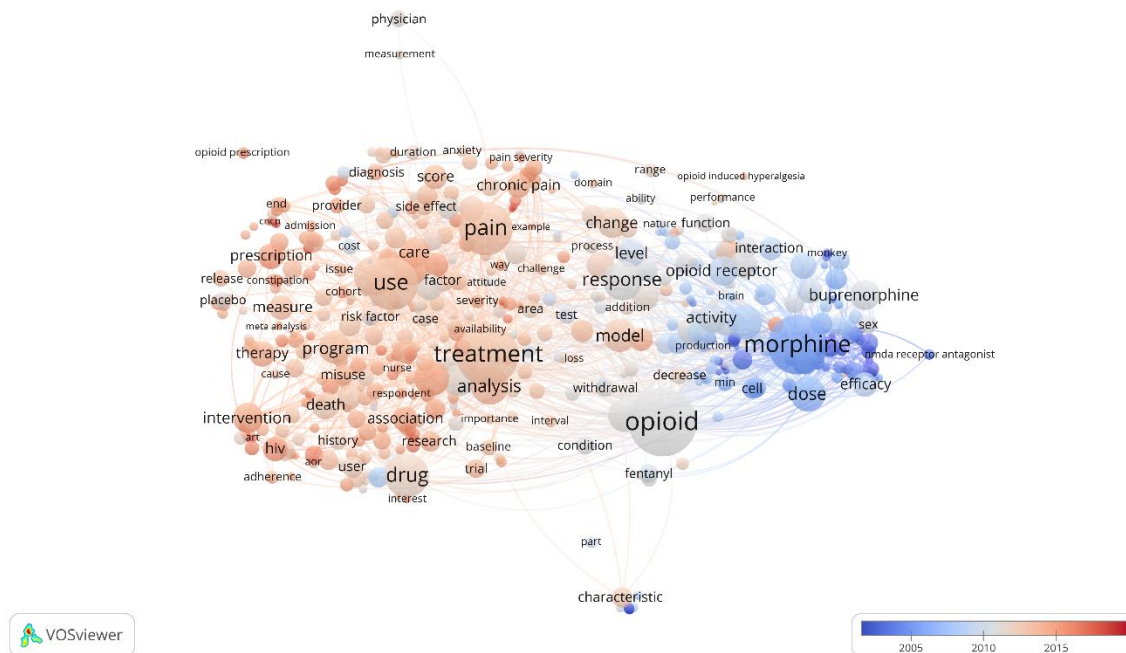
Figure 11
Title and abstract keyword topic map.

Term	Number of Occurrences
opioid	586
treatment	500
morphine	463
pain	387
use	379
drug	276
response	225
medication	223
analysis	26
dose	188

Table 3
Top 10 most commonly occurring terms.

D. Country Analysis

The country analysis shows what countries have collaborated together, which countries are the top contributors, and what the average year was that these countries were the most active in producing publications. Figure 12 shows a geolocation map of collaboration between countries represented in the citation set. The placement of the nodes represents the location of the country on the map. Since this data set focused on UNC-Chapel Hill publication, the node representing the largest country publishing opioid research is the United States. UNC-CH has collaborated with a total of 38 countries. The United States has the highest number of publications, with a total of 764 publications. The United Kingdom comes second with 23 publications and Canada is third with 22 publications. Figure 13 shows the ranking of the top 14 countries with the most publications in this citation set.
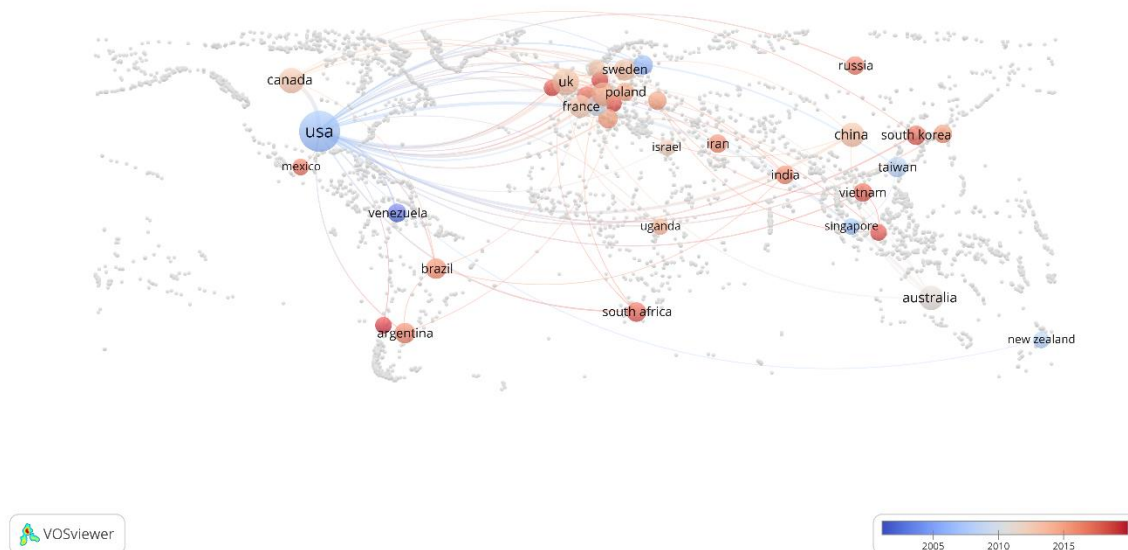
Figure 12
Geolocation Country Collaboration Map.

Top 14 Countries

Country

usa	764
uk	23
canada	22
australia	16
china	16
germany	10
france	7
sweden	6
argentina	4
brazil	4
switzerland	4
taiwan	4

0   200   400   600   800

Number of Documents
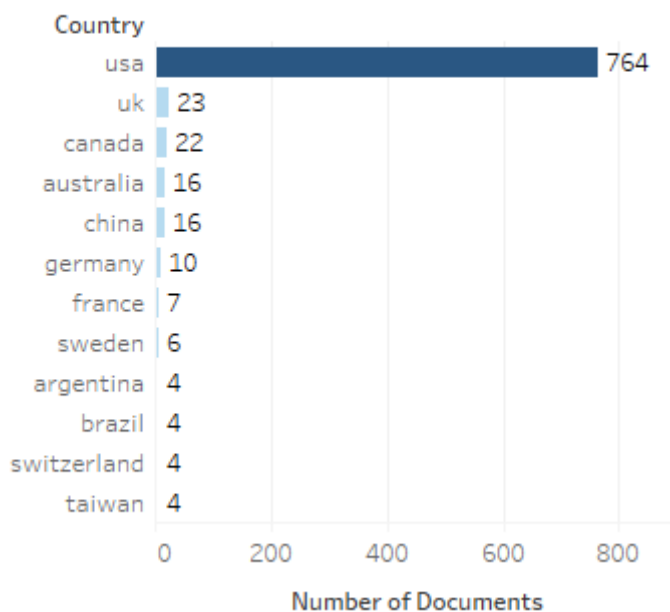
Figure 13
Bar graph showing top 14 country ranking based on amount of publications. Shows countries with 4 or more publications.

VI. Discussion

From the analysis and visualizations created here, we can see what the research landscape looks like for opioid publications produced by researchers at UNC-Chapel Hill. These visualizations are important in identifying what institutions UNC-Chapel Hill has the strongest relationships with. They also are important in providing patterns of key topics are being published on and how the topic landscape has changed over the years.

From the publications per year graph, we see that publications on opioids began to increase in 2010 with a rapid increase beginning around 2016. This sharp increase in research correlates to the 2017 state of emergency declaration by the US HHS regarding the opioid crisis. It is also interesting to note the clear distinction in the topic analysis network map between topics being published on before 2010 and those being published

on currently. Before 2010, topic keywords are focused mostly pharmaceutical research

and development, the topic words containing words such as production, morphine, dose,

and interaction, which deal mostly with prescribing opioids in a medical setting. Post

2010, a shift is seen in the topic words, focusing more on addiction treatment, with words

such as use, treatment, therapy, HIV, and misuse dominating the more current topic

words. This suggests that that the focus has shifted toward treatment for opioid addiction

and away from development and prescription of opioids.

We see from the organizational analysis that the majority of collaboration UNC-

CH has done with the top collaborators in this data set has taken place post 2010. Most

of the top 40 collaborators have been with other academic medical institutions, such as

Johns Hopkins, Harvard, Duke, and UC-San Francisco. Non-academic collaborators in

this data set included RTI International, the CDC, and the FDA. In addition to the non-

academic research institutions and hospitals UNC-Chapel Hill as collaborated with,

representatives from the pharmaceutical industry were also included in this publication

set, most notably Purdue Pharmaceuticals, Merck, and GlaxoSmithKlein. As stated in the

introduction Purdue has recently come under fire for knowingly marketing opiate

medications that were harmful and addictive. However, they were not main collaborators

in this dataset, with Merck and GSK having 4 publications each and Purdue only having

2 publications. Although it is unknown how researchers at UNC-CH collaborated with

researchers in the pharmaceutical industry, the finding from this study show the research

collaboration between the pharmaceutical industry and UNC-CH has been very small and

unsatisfactory considering their huge role in the current opioid epidemic. This implies

that most of the research being done is on the shoulders of academic universities. It also

shows that the research that UNC-Chapel Hill has been involved with is mainly treatment and not focused on drug development.

The country analysis shows that while the United States is the top player in opioid research there are many other countries who contributing to this topic. The US is the main research publication producer due to the urgency of the opioid epidemic, but the spread of publications shows that the opioid epidemic is a global concern. Other western countries such as the UK, Canada, and Australia are represented here as well. In addition, eastern countries, such as China and Taiwan are represented as well, showing that while opioid addiction may not be at a local epidemic level yet, globally, many other countries are preparing to fight this problem.

In the future the IMV team hopes to expand the scope of this project, using this as a proof of concept for a larger research project. The IMV team plans to collaborate with NC TraCS to discover more opioid affiliated researchers at UNC-CH and their collaborators. This is to create a social network of researchers at UNC-CH and allow researchers to find new collaborators in other departments they may not have known about previously. In addition to a complete list of departments and researchers involved in opioid research at UNC-CH, we would also like to expand the bibliometric analysis to include other research institutions in North Carolina, and eventually all the United States.

Originally it was planned to use the Bibliometrix R package to run statistics on the citation set. Due to inconsistent data formatting, it was decided that using this tool would be too time consuming for the current project. In the future, we hope to be able to work around this and include the statistics that this package can provide.

Finally, we hope to include grant and patent data into the larger opioid bibliometric analysis. The IMV team has been researching using grant and patent data in conjunction with our already established bibliometric practices to show the trajectory of research process. This type of analysis will also help researchers learn what kind of grants are available for opioid research, which funding agencies have the most interest in funding this type of research, and the potential commercialization opportunities disclosed by patent activity.

V. Limitations

There were some limitations to this project which may have affected the results detailed previously. The main limitation was the amount of citations that were able to be identified. Even though very broad search terms were used, there are still citations from UNC-CH regarding opioids that were not collected through the initial data gathering. The reason for these citations not being captured in this data set include authors not reporting their UNC-CH affiliation or the affiliation that was included was not in a format accounted for in the search strings used. Some of the UNC-CH publications that were captured in the data gathering did not include specific school or department affiliation (i.e. the author only reported their affiliation as UNC-CH, not School of Medicine, Gillings School, etc.). Since this does not tell us much about how internal units are collaborating, these affiliations were excluded from the internal organization analysis.

As mentioned in the results section for the topic analysis, abstracts for citations pulled from Web of Science were excluded from this analysis. At the time of

exportation, the abstracts for these citations were not available. Web of Science support was contacted, and they promised to make these abstracts available, but at the time of writing of this paper the abstracts were still not available.

VIII. Conclusions

This study used bibliometric analysis and network visualization to show the opioid research output at the University of North Carolina – Chapel Hill in the past twenty years. Collaboration and topic networks along with quantitative analysis reveal the research productivity of researchers at UNC-Chapel Hill, the major journal sources, and the research collaborations taking place within UNC-CH units and between UNC-CH external institutions. The bibliometric analysis helps us to understand the landscape of the opioid research effort of UNC-CH researchers and demonstrates the transitions of both internal/external partners and topic areas in the past 20 years.

We see that there has been an increase in publications in the past 4 years, which correlates with the U.S governments focus on the opioid crisis and the national emergency declaration. Due to the continuing danger of opioid addiction in the United States, it is important to continue the research effort of tracking the progress of publications on this topic. As this project continues, we expect to illustrate how the state of North Carolina and the United States as a whole are working against this epidemic and identify potential gaps for improvement.

Appendix I

Terms excluded from Topic analysis
These terms were excluded as they were not related to opioids. These terms are related to population, type of study, or publication terms. These were excluded to reduce noise in the visualization.

patient	month	class
effect	age	female
study	increase	article
data	number	north carolina
group	system	older adult
day	visit	nbs
participant	week	hospital
rat	population	reason
year	relationship	total
time	male	subject
woman	person	adult
mouse	type	
mg kg	state	
individual	present study	

Appendix II

Full List of Non-UNC External Organizations

aalborg university hospital, denmark
abbott vascular, ca
abx advanced biochemical compounds, germany
academia sinica, taiwan
acelrx pharmaceuticals, ca
acs heritage, inc, va
addiction research center-alternative georgia, georgia
aetion inc, ma
african palliative care association, uganda
ajou university, south korea
albany college of pharmacy and health sciences, ny
albany medical center, ny
albert einstein college of medicine, ny
alkermes, inc, ma
allergan, inc, ca
american academy of pediatrics
american association for the treatment of opioid dependence, ny
american association of nurse anesthetists
american chronic pain association, ca
american institutes for research, md
american pain society, il
american university
amgen corporation, ca
amgen, ma
anhui medical university, china
anthem blue cross blue shield, va
appalachian psychiatric healthcare system, oh
appalachian state university, nc
arizona state university
arkansas children's hospital
armstrong atlantic state university, ga
astrazeneca pharmaceuticals
astrid lindgren's children's hospital, sweden
atlanta veterans affairs health care system, ga
auburn university, al
autonomic technologies, inc, ca
azienda ospedaliera universitaria integrata, italy
barrow neurological institute, az
baylor college of medicine, tx

baylor medical center frisco, tx
baylor university, tx
baystate medical center, ma
behavioral health system, md
beijing center for disease control and prevention, china
bekhterev research psychoneurological institute, russia
beth israel deaconess medical center, ma
beth israel medical center, ny
binghamton university, ny
biomedical systems, mi
biostatistics, rho, inc, nc
biotie therapies corporation, finland
bioventus, llc, nc
birmingham veterans affairs medical center, al
boehringer-ingelheim pharmaceuticals, inc, ct
boston children's hospital
boston medical center
boston university
bradley hospital, ri
brigham and women's hospital, ma
bristol-myers squibb, nj
british columbia centre for excellence in hiv/aids, canada
brogan, inc, canada
brown university
cabernet pharmaceuticals, nc
canadaigua veterans affairs medical center, ny
cardiff university, wales
carolina headache institute, nc
carolinas medical center, nc
carolinas pain institute, nc
case western reserve university, oh
catsink, canada
cedars sinai medical center, ca
celgene corporation, ca
center for drug use and hiv research, ny
center for free electron laser science, germany
center for health research, pa
centers for disease control and prevention
centers for medicare and medicaid services, md
central institute for mental health, germany
central michigan university
centre for preventive medicine of thai nguyen, vietnam
centre for trauma and neuroscience, uk

centro de ciencias, brazil
chang gung university, taiwan
chapel hill orthopedics surgery and sports medicine, nc
charleston county school district, sc
children's and adolescent's hospital, germany
children's healthcare of atlanta
children's hospital of buffalo, ny
children's hospital of philadelphia
children's hospital of pittsburgh
children's hospitals and clinics of minnesota
children's mercy hospital, mo
children's oncology group, ca
china medical university
chinese academy of sciences, china
chinese center for disease control and prevention, china
chonnam national university, south korea
christiana care health system, de
cincinatti children's hospital medical center
cincinatti veteran's affairs medical center
city of hope national medical center, ca
clemson university, sc
cleveland clinic, oh
clincal research institute of montreal, canada
clinical tools, inc, nc
cns drug consulting, va
collegium pharmaceutical, inc, ma
columbia university
comprehensive cancer centers of nevada
cone health system, nc
cooper university hospital, nj
copperline solutions, llc, nc
cork university hospital, ireland
cornell university
corporal michael j. crescenz veterans affairs medical center, pa
coulter pharmaceuticals, inc, ca
council of state and territorial epidemiologists, ga
covance laboratories, pa
creighton university, ne
cvs caremark
dana farber cancer institute, ma
darmouth medical school, nh
dartmouth college, nh
dartmouth hitchcock medical center, nh

data solutions, llc, ny

dean foundation for health research and education, wi

dominican university of california

drossman gastroenterology, nc

duke university

durham veterans affairs healthcare system, nc

east carolina university

eastern virginia medical school

einstein healthcare network, pa

elaine boyal university of leicester, uk

eli lilly and co, in

emory university

endo pharmaceuticals, pa

endpoint outcomes, ma

epidemico, inc, ma

eth zurich, switzerland

ethknoworks, llc, nm

european x-ray free-election laser facility, germany

evandro chagas institute, brazil

evm internam medicine, va

exelixis, inc, ca

farnam companies, inc, az

fhi 360, nc

first pavlov state medical university of st. petersburg, russia

florida international university

florida state university

food and drug administration

forensic testing, inc, tn

fort belvoir community hospital, va

fort walton beach medical center, fl

fred hutchinson cancer research center, wa

freiburg university medical center, germany

friedrich-alexander-universitat erlangen-nurnberg, germany

friends research institute, inc, md

furman university, sc

george mason university

george washington university

georgetown university

georgia regents university

georgia southern university

georgia state univeristy

glaxo wellcome, inc, nc

glaxosmithkline

glycomimetics, inc, md
grady memorial hospital. ga
grant medical center, oh
greensboro ahec, nc
hackensack university, nj
hadassah-hebrew university medical center, israel
haight ashburg free clinics, ca
harbor-ucla medical center, ca
harborview medical center, wa
harlem hospital center, ny
harm reduction coalition, ny
harry and jeannette weinberg cancer center
hartford hospital, ct
harvard university
heartland alliance, il
henry ford health system, mi
honghe prefecture center for disease control and prevention,
china
hopital de poissy saint germain, france
hoseo university, south korea
ibm thomas j waston research center, ny
icahn school of medicine at mount sinai, ny
ilia state university, georgia
indiana university
inova fairfax hospital, va
institut de genomique fonctionnelle, france
instituto de investigaciones clinicas, venezuela
instituto nacional de traumatologia e ortopedia, brazil
international clinical research institute, ks
intrabiotics pharmaceuticals, inc, ca
iowa city veterans affairs health care system
iowa pharmacy association
iowa state university
janssen global
jbs international, inc, md
jenken biosciences, nc
john a. burns school of medicine, hi
john h. stroger jr. hospital of cook county, il
johns hopkins university
kaiser permanente
kaiyuan city center for disease control and prevention, china
kaplan university
keele university, uk

kentucky regional poison center
kerman university of medical sciences, iran
king's college london, uk
kings college london, uk
lancaster general hospital, pa
lehigh valley health network, pa
lenox hill hospital, ny
lifetree clinical research
lilly research laboratories, in
linkoping university, sweden
london school of hygiene and tropical medicine, uk
louis stokes cleveland veterans affairs medical center, oh
louisiana state university
loyola university, il
maekay memorial hospital, taiwan
makerere university, uganda
manchester royal infirmary, uk
map pharmaceuticals, inc, ca
maria fareri children's hospital, ny
maricopa county department of public health, az
maricopa medical center, az
marshal university, wv
maryland medical research institute, md
marymount university hospital and hospice, ireland
massachusetts general hospital
maval hospital jacksonville, fl
mayo clinic
mcgill university, canada
mcking consulting corporation, va
mclean hospital, ma
md anderson cancer center, tx
medical college of georgia
medical university of lodz, poland
medical university of south carolina
medical university vienna, austria
memorial sloan kettering cancer center, ny
merck
mercy medical center, md
messiah college, pa
metrum research group, llc, ct
millennium research institute, ca
minneapolis veterans affairs health care system, mn
miriam hospital, ri

mission health, nc
monash university, australia
moncrief army community hospital, sc
montefiore medical center, ny
mountain area health education center, nc
nama recovery, tx
nanjing medical university, china
nantong university, china
nassau university, ny
national cancer center, japan
national cheng-kung university, taiwan
national defense medical center, taiwan
national development and research institutes
national institutes of health
national pain foundation, co
national science foundation
national taiwan university
national university of cordoba, argentina
national university of singapore
nema research, inc, fl
network for public health law
new england research institutes, ma
new york medical college
new york state psychiatric institute
new york university
newham university hospital, uk
niagra falls memorial hospital, ny
north carolina a and t university
north carolina department of health and human services
north carolina harm reduction coalition, nc
north carolina office of the chief medical examiner, nc
north carolina physicians health program
north carolina state center for health statistics
north carolina state university
north china coal medicine university, china
north florida/south georgia veterans health system
north shore medical center, ma
north shore university hospital, il
north shore university hospital, ny
northeastern university
northwest community care network, nc
northwestern university
nova southeastern university, fl

ohio state university
ohio valley hospital, pa
oklahoma state university
olmsted medical center, mn
open society foundations
orange county migraine and headace center, ca
oregon health and science university
oregon research institute
ors paca, france
orthocarolina hip and knee center, nc
oxford university hospitals, uk
pacific institute for research and evalution
palmetto health richland hospital, sc
paracelsus medical university, germany
partnership for a drug-free north carolina
pediatrix, fl
peking university, china
pennsylvania state university
pfeiffer university, nc
pfizer
pinnacle oncology hematology, az
pinnacle orthopedics, ga
pinney associates, md
polish academy of sciences, poland
portland state university, or
pra health sciences, az
project lazarus, nc
providence health, wa
providence veterans affairs medical center,ri
purdue university
qualitas biosciences, llc, az
queen mary university of london, uk
queen's university, canada
queensland institute of medical research, australia
quest diagnostics, inc, nj
ralph h. johnson veterans affairs medical center, sc
rand corporation, ca
rho, inc, nc
roche diagnostics, in
rocky mountain blood and marrow transplant program, co
rocky mountain poison and drug center, co
roswell park cancer institute, ny
rouebush veterans affairs medical center, in

royal marsden hospital, uk
royal north shore hospital, australia
royal perth hospital, australia
royal surrey county hospital, uk
rti international, nc
rush university medical center, il
rutgers university
saint louis university, mo
san francisco veterans affairs medical center, ca
save our kids coalition
scripps research institute
seattle cancer care alliance
seattle children's research institute
second military medical university, china
sentara norfolk hospital
shaw university, nc
shenzhen port hospital, china
shriners hospitals for children
simon fraser university, canada
smith college, ma
social relations and tourism, ukraine
south african medical research council, south africa
southeast anethesiology consultants, nc
southern connecticut state university
southwest university of political science and law, china
southwestern institute of forensic sciences, tx
spectrum health-butterworth campus
st. john's university, ny
st. joseph mercy health system, nc
st. joseph mercy hospital, mi
st. joseph's regional medical center, nj
st. jude children's research hospital, tn
st. vincent's hospital, australia
stanford university
state university of new york
stollery children's hospital, canada
stroger hospital, il
sucampo ag, switzerland
sucampo pharma americas, llc, md
sun yat-sen university, china
suny downstate medical center, ny
swansea university, uk
swedish medical center, wa

taipei medical university, taiwan

takeda pharmaceuticals, ma

talbot recovery campus, nc

tehran university of medical sciences, iran

telesage, inc, nc

temple university, pa

tennessee department of health

texas a and m university

texas christian university

texas scottish rite hospital for children, tx

the bonoi academy of science and education, nc

the healing place of wake county, nc

the lite center, fl

the metrohealth system, oh

the miriam hospital, ri

the network for public health law

the pain treatment center of the bluegrass, ky

thomas jefferson university, pa

tiffin university, oh

tioga pharmaceuticals, ca

towson university, md

tsinghua university, china

tufts university

tulane university

ucb biosciences, nc

ukrainian institute on public health policy, ukraine

unc - wake medical center

unc health care

unc rex health care

unc-asheville

unc-charlotte

unc-duke proteomics center

unc-greensboro

unc-wilmington

unidad de tecnologia farmaceutica, argentina

uniformed services university, md

univeristiy of hawaii

universidad central del caribe, puerto rico

universidad mayor, chile

universidad nacional autonoma de mexico

universidad nacional de cordoba, argentina

universidade federal de juiz de fora, brazil

universita degli studi di bari, italy

universite aix marseille, france
universite de bordeauz, france
universite de toulouse, france
university college london, uk
university hospital zurich, switzerland
university hospitals, oh
university medical center freiburg, germany
university of adelaide, australia
university of alabama at birmingham
university of arizona
university of arkansas for medical sciences
university of auckland, new zealand
university of bath, uk
university of british columbia, canada
university of buffalo, ny
university of calgary, canada
university of california-berkeley
university of california-davis
university of california-los angeles
university of california-san diego
university of california-san francisco
university of california-santa cruz
university of cambridge, uk
university of cape town, south africa
university of chicago
university of cincinnati
university of colorado
university of connecticut
university of delaware
university of denver
university of edinburgh, uk
university of ferrara, italy
university of florida
university of georgia
university of gothenburg, sweden
university of hamburg, germany
university of heidelberg, germany
university of helsinki, finland
university of illinois
university of illinois at urbana-champaign
university of indonesia
university of iowa
university of kansas

university of kentucky
university of kwazulu-natal, south africa
university of leuven, belgium
university of lodz, poland
university of louisville
university of macau, china
university of maine
university of maryland
university of massachusetts
university of medicine and dentistry of new jersey
university of melbourne, australia
university of miami
university of michigan
university of minnesota
university of mississippi
university of missouri
university of montreal, canada
university of new mexico
university of new south wales, australia
university of north florida
university of oklahoma
university of oslo, norway
university of oxford, uk
university of pennsylvania
university of pittsburgh
university of rochester, ny
university of rouen, france
university of south alabama
university of south australia
university of south carolina
university of south florida
university of southern california
university of sydney, australia
university of tennessee
university of texas
university of texas southwestern medical center
university of toronto, canada
university of tsukuba, japan
university of turku, finland
university of utah
university of vermont
university of virginia
university of washington

university of wisconsin
university of wurzburg, germany
university of zulia, venezuela
uppsala university, sweden
us department of health and human services
utah department of health
valley pretinatal services, az
vanderbilt university
vendanta research, nc
venebio group, llc, va
vera institute of justice, ny
veterans affairs ann arbor healthcare system, mi
veterans affairs connecticut healthcare system
veterans affairs healthcare system, mi
veterans affairs long beach healthcare syste, ca
veterans affairs medical center, mn
veterans affairs pittsburg healthcare system, pa
veterans affairs san deigo healthcare system, ca
veterans health adminstration, washington, dc
veterans health care system of the ozarks, ar
veterinary information network, ca
vib-vub center for structural biology, belgium
vietnam adminstration of hiv/aids control, vietnam
virginia commonwealth university
vrije universiteit brussel, belgium
wake county emergency medical services, nc
wake forest baptist medical center, nc
wake forest university, nc
walter reed national military medical center, md
wannan medical college, china
washington and lee university, va
washington state university
washington university, mo
wayne state university, mi
west virginia department of health and human resources
west virginia university
white river junction veterans affairs medical center, vt
wilkes county health department, nc
william beaumont hospital, mi
winnie palmer hospital for women and babies, fl
women and infants hospital, providenc, ri
women's hospital of greensboro, nc
world health organization

wright state university, oh
wythenshawe hospital, uk
y.r. gaitonde center for aids research and education, india
yale university

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