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QUANTIFYING COMMUNITY LEVEL BEHAVIORAL HEALTH
PROFESSIONAL CAPACITY TO PREVENT AND TREAT
SUBSTANCE USE DISORDER IN COLORADO

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ABSTRACT

COMMUNITY LEVEL BEHAVIORAL HEALTH
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By Stephen Holloway

The United States is experiencing an epidemic of substance use disorder, which has resulted in substantial avoidable health care costs, suppressed workforce participation, lowered quality of life, and extraordinary rates of preventable mortality. In response, effective public health intervention requires improving access to secondary and tertiary prevention services provided by behavioral health professionals.

This thesis proposes a model to conduct quantitative assessment of community level needs by predicting the demand for substance use disorder treatment at small geographies and comparing that predicted demand with the estimated supply of treatment services. By evaluating the ratio of need to supply in a two-step floating catchment area framework, this model enables discrete, localized spatial evaluation of substance use disorder workforce capacity in a way not previously attempted. The resulting continuous surface output map analysis reveals localized and variant detail across a gradient of relative treatment capacity in Colorado.

When applied to public health practice, this assessment model will facilitate greater understanding of substance use disorder treatment needs in Colorado, more efficient targeting of workforce resources, and support for longitudinal evaluation of public health interventions that promote increased supply of secondary and tertiary treatment services in underserved communities. If this model improves public health decision making regarding workforce investments, morbidity and mortality attributable to substance use disorder may decrease in Colorado.

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LIST OF ABBREVIATIONS, ACRONYMS AND INITIALISMS

2SFCA	Two-step Floating Catchment Area
ACA	Patient Protection and Affordable Care Act
ACE	Adverse Childhood Experiences
AHRQ	Agency for Healthcare Research and Quality
APA	American Psychiatric Association
CAC	Certified Addiction Counselor
CDC	Centers for Disease Control and Prevention
CHMSA	Critical Health Manpower Shortage Area
CHSC	Colorado Health Service Corps
CMS	Centers for Medicare Medicaid Services
DAWN	Drug Abuse Warning Network
DEA	Drug Enforcement Agency
DOJ	Department of Justice
GDP	Gross Domestic Product
GIS	Geographic Information System
HHS	Health and Human Services
HIV	Human Immunodeficiency Virus
HPSA	Health Professional Shortage Area
HRSA	Health Resources and Services Administration
HSR	Health Statistics Region
IRB	Emory University Institutional Review Board for Protection of Human Subjects
LAC	Licensed Addiction Counselor
LCSW	Licensed Clinical Social Worker
LMFT	Licensed Marriage and Family Therapist
LPC	Licensed Professional Counselor
MAT	Medication Assisted Treatment
NCS-R	National Comorbidity Survey - Replication
NPI	National Provider Identifier
NPPES	National Plan and Provider Enumeration System
NSDUH	National Survey on Drug Use and Health
OECD	Organization for Economic Cooperation and Development
PA	Physician Assistant
PII	Personally Identifiable Information
PNP	Psychiatric Nurse Practitioner
SAMHSA	Substance Abuse and Mental Health Services Administration
SUD	Substance Use Disorder
TEDS	Treatment Episode Data Set
USPHS	United States Public Health Service
US	United States
VA	Department of Veterans Affairs
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

Introduction and Rationale

An estimated 28.6 million Americans twelve and older have consumed an illicit drug in the last 30 days according to the most recent data available from the Center for Behavioral Health Statistics and Quality (Center for Behavioral Health Statistics and Quality, 2017). An important and growing subset of those who misuse drugs are individuals who consume opioids for nonmedical purposes. This group is now estimated at 3.6 million individuals (Center for Behavioral Health Statistics and Quality, 2017). The problem of opioid misuse has been declared a national public health emergency (U.S. Department of Health and Human Services, 2017) typified by a 30 percent increase in hospital admissions resulting from overdose between July 2016 and September 2017 (National Center for Injury Prevention and Control, 2018). Furthermore, mortality attributable to acute drug intoxication (overdose) has been steadily climbing for two decades (Kaiser Family Foundation, State Health Facts, 2018) and now claims 64,000 lives annually in the United States (National Center for Health Statistics, 2017). The social, economic, and health consequences of the current epidemic of substance use disorder (SUD) in the United States is profound and by some measures unprecedented (Woolf & Laudan, 2018).

The burden of SUD in Colorado is higher than the nation as a whole, where approximately 796,000 residents disclose that they have used an illicit drug in the last month (National Survey on Drug Use and Health, 2017). State trends in illicit substance use have consistently paralleled national trends since at least 1999. Colorado's experience with the epidemic indicates that risk of fatal overdose for all illicit drugs is highest among those between the ages of 35 and 54. In the current decade, drug overdose mortality characterized by age has broadened to the younger age band of 25 to 34 and to the older age band of 55 to 64 (Rosenthal, Bol, & Gabella, 2016). Between 2000 and 2015, overdose mortality in these two age groups in

Colorado has increased by 170 percent and 300 percent, respectively. Counter to commonly held assumptions, rates of drug use are similar among racial and ethnic groups and are in fact highest in non-Hispanic whites (Rosenthal, Bol, & Gabella, 2016). Colorado findings on racial variation in illicit drug use are consistent with national analysis (Johnson, O'Malley, Bachman, Schulenberg, & Miech, 2016). Opioid use is higher in men in Colorado, as it is nationally, and men are far more likely than women to die from heroin overdose in Colorado (Rosenthal, Bol, & Gabella, 2016). Overdose rates in women have annually increased faster than with men at 125 percent versus 88 percent, respectively (Rosenthal, Bol, & Gabella, 2016).

Figure 1: Comparison of age-adjusted mortality associated with all substance use overdose and opioid overdose, U.S. and Colorado, 1999-2016, death rate per 100,000 (Kaiser Family Foundation, 2018)
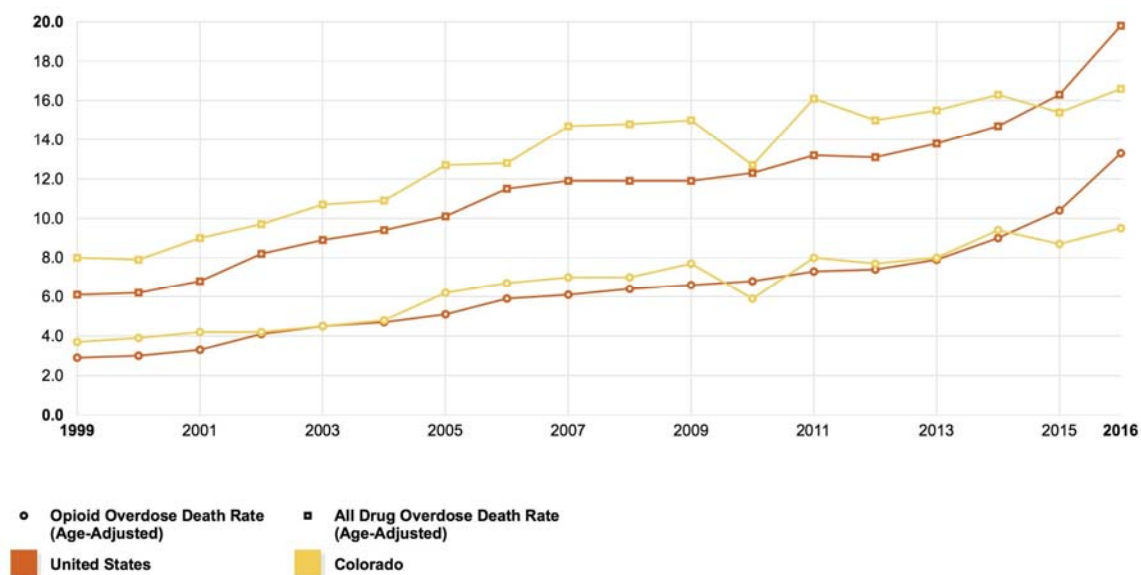
Colorado was among the first states to legalize marijuana for medical indications in 2000 (Colorado Department of Revenue, 2018). Colorado was also first along with Washington state to allow the sale and consumption of marijuana and its derivatives for recreational purposes in 2012 (Colorado Department of Revenue, 2018). Though these state policy changes regarding marijuana coincide with the national rise in SUD, early evidence does not suggest a significant effect of

marijuana legalization on the proportion of youth who have ever tried or regularly use marijuana in states where it has been legalized (Hasin, *et al.*, 2015). Youth rates of marijuana use in Colorado were statistically unchanged between 2011 (the year prior to recreational legalization) and 2015 (Center for Behavioral Health Statistics and Quality, 2017), though state rates of marijuana use remain above the national average for youth. Less is known about the related effects of marijuana legalization on the abuse of other illicit substances, though some evidence suggests there is little or no correlation to use or overdose of non-cannabinoids in states that have liberalized marijuana laws (National Bureau of Economic Research, 2017). Some evidence suggests a slight depressive effect on use of cocaine and heroin in states that have legalized marijuana (National Bureau of Economic Research, 2017). Related research suggests that rates of opioid prescribing are lower in states that have legalized medical marijuana (Wen & Hockenberry, 2018).

Characteristics of Nonmedical Drug Use in the United States

The National Survey on Drug Use and Health (NSDUH) indicates that 10.6 percent of U.S. residents aged 12 and older are active illicit drug users (Center for Behavioral Health Statistics and Quality, 2017). This proportion of the population has steadily increased since 2002. A primary driver of the observed increase has been the non-medical use of prescription opioids (Center for Behavioral Health Statistics and Quality, 2017). Pharmaceutical opioids such as Codeine, Oxycodone, and Vicodin are the most misused illicit drug category after marijuana (Center for Behavioral Health Statistics and Quality, 2017). In contrast to the rate of misused opioids, the use for all non-opioid pharmaceutical categories has remained relatively constant in the United States since 2011 (Center for Behavioral Health Statistics and Quality, 2017). This suggests that the increase in SUD during the current decade is driven by the sharp increase in the misuse of pharmaceutical and illicit opioids rather than other forms of abusable substances.

Between 21 and 29 percent of patients who receive a prescribed pharmaceutical opioid to treat pain eventually misuse them (Center for Behavioral Health Statistics and Quality, 2017). Approximately one in ten patients who receive a prescribed opioid during the course of treatment will later develop a SUD. Of those who misuse pharmaceutical opioids, four to six percent will transition to heroin. Approximately 80 percent of current injection opioid users began their addiction through the consumption of pharmaceutical opioids (Vowles, McEntee, Julnes, Frohe, Ney, van der Goes, 2017); however, a strict causal association of prior pharmaceutical opioid use and later heroin use initiation is less clear (Muhuri, Gfroerer, & Davis 2013).

Burden of Disease

Illicit drug use and SUD are associated with underachievement in academic and professional domains, suppressed work productivity, social dysfunction, criminal behavior, increased risk of infectious disease, neuropsychological impairment, overall poor health, poverty and homelessness (O'Brien, *et al.*, 2004). The economic costs of illicit drug use were $193 billion in 2007 (National Drug Intelligence Center, 2011). Remarkably, more recent comprehensive data on the national costs and economic impact of SUD is not available because the National Drug Intelligence Center (where the research was previously conducted) was discontinued in 2012 following budget cuts at the Department of Justice (DOJ) (Department of Justice, 2018). At least one non-peer reviewed source suggests that total annual spending on the SUD epidemic in the United States now approaches $1 trillion (Cidambi, 2017), a number that is at least plausible given the acceleration of the SUD epidemic and rising health care costs over the intervening ten years since the last available federal data.

Indirect economic costs are also a significant problem associated with illicit drug use. A recent study published by the Brookings Institution reports that the labor force participation rate[1]

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[1] The labor force participation rate is the percent of the civilian noninstitutionalized population ages 16 to 64 that is employed.

has declined since 2007 and is now at a 40-year low of 62.4 percent (Krueger, 2017). Only one other Organization for Economic Cooperation and Development[2] (OECD) nation has a labor force participation rate that is lower than the United States. The study notes that nearly half of working age men who are not in the labor force consume a pharmaceutical opioid on a given day. Furthermore, labor force participation has fallen most in counties where more opioid pain medication is prescribed. The author concludes that 20 percent of the observed decline in labor participation in men and 25 percent of the observed decline in labor participation in women is associated with prescription opioid consumption, though the author makes no assertion about the directionality of the effect. Given the close relationship of Gross Domestic Product (GDP) to labor force participation (Martin, 2014), one can infer substantial and persistent economic effects of the current SUD epidemic especially as it relates to opioid misuse.

Illicit drug use also has substantial public health implications. Significant domains of public health concern include: the increased risk of infection by bloodborne pathogens, including Human Immunodeficiency Virus (HIV); the increased risk of intentional and unintentional injury, including suicide, homicide, and traffic accidents; the teratogenic risk to fetal development resulting from prenatal exposures; and the increased risk that children in proximity to those with SUD will have more adverse childhood experiences (ACE) exposure leading to lifelong negative health and social consequences (National Institutes of Medicine, 1996).

Perhaps the most significant public health concern is that of preventable mortality associated with SUD. Opioid overdose has been a primary contributor to the recent decline in life expectancy in the United States (Woolf & Laudan, 2018), a trend not observed since the 1963 influenza pandemic. Some researchers have come to include fatal drug overdose within a category of preventable deaths in midlife referred to collectively as "deaths of despair" (Case &

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[2] The OECD is an intergovernmental economic organization of 35 member countries with high incomes and a similar commitment to democratic institutions and market based economies.

Deaton, 2015). Other causes of preventable mortality in this category include suicide, homicide, and cirrhosis.

Origins of the Epidemic

The social, political, and cultural antecedents of the SUD epidemic are complex, varied, and continue to be elucidated through criminal justice, social, and public health research. Primary domains of population research into illicit drug use include federal drug control laws, changes in the marketing practices of pharmaceutical opioid producers, and effects of changes in social and economic conditions.

Drug Control Law

Throughout U.S. history, there has been a philosophical and strategic disconnection between various governmental efforts to control nonmedical drug use (Brown, 1981). Criminal justice policy has focused on interdiction and enforcement strategies. In contrast, public health policy has focused on prevention, harm reduction, and access to treatment. With respect to the former, illicit drug users must avoid involvement with public services to evade criminal justice involvement whereas, with the latter, illicit drug users must seek out and maintain engagement with public services to receive harm reduction support and recovery treatment. These two public sector approaches to drug control have generally been uncoordinated, if not plainly contradictory (Friedman, Mateu-Gelabert, & Rossi, 2012).

Nearly 70 major pieces of illicit drug control legislation have passed since the Harrison Act in 1914[3] (Food and Drug Administration, 2018 and Congressional Research Service, 2014). Though the rate and nature of illicit drug use has increased and decreased over this period, implementation of more expansive and punitive criminal standards tend

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[3] The first major federal legislation criminalizing illicit drug use in the United States.

to occur after drug use rates have peaked (Musto, 2002). Therefore, changes in federal and state criminal policy could not have been primarily causal in episodic declines in illicit drug use in the population over time. According to Musto, extreme criminal punishments may help limit the peak of epidemic drug use, but there is little evidence that rates of illicit drug use fall coincident with major drug control legislation or that these legislative initiatives reduce overall illicit drug use in the long term.

Some researchers have posited that criminal and legal mechanisms intended to control illicit drugs have exacerbated the SUD epidemic rather than mitigated it (Miron & Zwiebel, 1995). Increasing criminal penalties create incentives for illegal markets to avoid detection by reducing the volume of drugs needed to respond to per capita demand. This reduction in volume can be achieved by producing and distributing more potent and addictive drug forms and diversification into unscheduled[4] and dangerous synthetic drugs (*e.g.*, synthetic cathinon "bath salts" or synthetic cannabinoid "spice") (Rowe 2013). Evidence of this effect in illegal markets can be found in the transition from the consumption of beer and wine to distilled spirits during prohibition in the 1920s and the transition from the consumption of marijuana into hashish[5] following the Marijuana Control Act of 1937. The primary contemporary example of this effect can be observed in the increasing use of the opioid fentanyl to cut[6] heroin and cocaine (Gladden, *et al.*, 2016). The transition of illicit markets to the distribution of highly potent and addictive drug variants has been a primary contributor to increased overdose hospitalizations observed through the end of 2017 (Centers for Disease Control and Prevention, 2018).

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[4] Scheduling is a two-component process of the Drug Enforcement Administration (DEA) that classifies drugs according to potential for abuse and for identified medical applications.
[5] A concentrated and purified resin derivative of cannabis (marijuana).
[6] A compound of two or more substances that are mixed to increase or decrease drug potency or volume.

Marketing Practices of Pharmaceutical Opioid Producers

A second possible factor in the current epidemic of opioid misuse in the United States is the change in marketing practices of pharmaceutical companies that produce opioid based pain relievers (National Institutes of Health, 2018). In the late 1990s, opioid manufacturers began citing a one-paragraph letter to the editor in the New England Journal of Medicine published in 1980. The letter suggested that the risk of addiction in patients who were prescribed opioids for chronic pain management was insignificant (Zhang, 2017). Coinciding with this marketing strategy, clinicians were encouraged to begin thinking of pain as "the 5th vital sign." Clinical quality measures in Medicare and many private health plans began including patient perception of effective pain management as an important clinical performance metric of prescribers (Morone & Weiner, 2013 and Quinones, 2015).

These events together likely resulted in both lowered caution and heightened motivation among clinicians to prescribe powerful opioids to chronic pain patients. Between 1999 and 2010, the Centers for Disease Control and Prevention (CDC) reported a substantial increase in the per capita consumption of prescribed opioids in the United States (Guy, *et al.*, 2017). As a result, United States residents consume eight times the international per capita median for prescription opioids (International Narcotics Control Board, 2016). The changes in opioid-prescribing behaviors of physicians coincide with the origins of the current epidemic of misuse and the widespread diversion of pharmaceutical opioids into non-medical purposes (Morone & Weiner, 2013).

Social and Economic Conditions

A third possible factor in the current epidemic of SUD in the United States involves changes in social and economic conditions. The SUD epidemic has steadily worsened since the stock market crash and recession that began in 2008. The unemployment rate

reached a peak of ten percent in October 2009 (Bureau of Labor Statistics, 2018), a rate exceeded in only one period since 1947 when record keeping began. A review of literature conducted by Dieter Henkel (2011) considered the findings of more than 130 papers analyzing the relationship of employment and substance use. Among the key findings of the review were that problem users of illicit substances are more likely to be unemployed and less likely to maintain employment. Unemployment itself is a significant risk factor for substance use and the later development of SUD, and the experience of unemployment reduces the chances for lasting recovery from dependence once treatment is initiated.

The employment, income, and wealth experiences of individuals that are formed by macro-economic conditions are formative in the de facto assignment of social position within society. The World Health Organization (WHO) has recognized that health status and access to health care varies along social gradients. In the report, "Closing the Gap in a Generation: Health Equity through Action," the WHO stated that "children have dramatically different life chances depending on where they were born" and that "at all levels of income, health and illness follow a social gradient: the lower the socioeconomic position, the worse the health" (World Health Organization, 2008).

The United States has experienced economic changes that have widened income and wealth distribution within society. Nations with more unequal income distributions, as measured by the Gini Coefficient,[7] experience higher rates of drug use (Wilkinson, Pickett, 2010).

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[7] The Gini Coefficient measures inequality among values across a frequency distribution of income where higher values indicate greater distributional inequality.

Figure 2:   Drug use is more common in more unequal countries (Wilkinson, Pickett, 2010)

Income disparities have increased in the United States since at least 1980, with a sustained Gini Coefficient measure above 40 since 1995 (World Bank, 2018). The current Gini Coefficient places the United States as fifth most unequal among OECD nations (Organization for Economic Development and Cooperation, 2018). Observed increases in overdose mortality could be an effect of greater adverse social differentiation in highly unequal societies (Wilkinson & Pickett, 2007). The increase in income inequality in the United States since the mid 1990s could have been a leading indicator of the emerging SUD disorder epidemic experienced at the beginning of the 21st century and continuing through the present.

Problem Statement

The United States is in the midst of an epidemic of SUD, which increases health care spending, decreases labor participation, lowers quality of life, and causes higher rates of preventable death. These public health issues can be addressed through better primary prevention but must also be addressed through improved access to secondary prevention in the form treatment for those currently experiencing SUD.

Access to SUD treatment is substantially modulated by the availability of behavioral health providers (Keeney & Manocchio, 2017) yet just ten percent of those requiring SUD treatment services actually receive needed care (Center for Behavioral Health Statistics and Quality, 2017). These two observations strongly suggest that public investments to increase access to SUD treatment must be focused on expanding the capacity of behavioral health systems to respond to the demand for care. In order to be effective, these public investments must be targeted to communities that are experiencing the greatest shortage of provider capacity.

Existing methodologies of workforce shortage assessment insufficiently evaluate the unique systems of care that are needed to respond to the epidemic of SUD. These methodologies also do not measure shortage at the community level where people are likely to seek out and acquire care. The assessment model proposed in this thesis will address shortcomings of existing behavioral health professional assessment methodologies and thus respond to urgent need for better targeted resources that expand access to treatment for SUD in Colorado.

Theoretical Framework

Access to behavioral health care services in proximity to one's home is an important requisite for access to SUD treatment. Numerous barriers to behavioral health care access exist and may include personal characteristics such as age, sex, race, income, education, insurance status, language, or geographic isolation. Characteristics such as age, sex, and education appear to have

inconsistent or weak association with poor behavioral health care access (Hser, Maglione, Polinsky, Anglin, 1998). However, difficulty transiting to treatment, distance to treatment, and long wait times for treatment are cited as common and consistent barriers to access (Rapp, Xu, Carr, Lane, Wang & Carlson, 2007).

Structural access barriers such as these are related to the local behavioral health system's capacity to supply SUD care to the level needed by the area population. An inherent feature of overall system capacity is the availability of SUD clinicians to provide treatment. Clinician capacity can be determined by an enumeration of practicing clinicians and an assessment of their respective clinical practice time. In other words, clinician capacity is a function of the aggregate clinical contact hours among all clinicians within a service area. Where the "supply" of SUD treatment clinical capacity falls short of "demand," a localized shortage can be determined and quantified.

When access to behavioral health care improves in an assessed shortage area, community level indicators of SUD treatment and recovery are also expected to improve. Moreover, when access to behavioral health care improves, morbidity and mortality attributable to or associated with SUD is expected to decrease.

Purpose Statement

The purpose of this thesis is to develop a novel method to determine behavioral health professional capacity needs at the service area level for those experiencing SUD. Behavioral health service needs, along with an assessment of behavioral health provider capacity, will then inform public policy decisions regarding the relative priority for public investment in improved behavioral health service access.

<u>Alternate Hypothesis</u>

A novel index of population level data can be constructed to more effectively determine behavioral health service area workforce capacity needs at the community level for those who are experiencing substance use disorder than existing models.

<u>Null Hypothesis</u>

A novel index of population level data cannot be constructed to more effectively determine behavioral health service area workforce capacity needs at the community level for those who are experiencing substance use disorder than existing models.

Research Objectives

1. To define discrete area SUD treatment needs for behavioral health care encounters according to standardized criteria.
2. To define discrete area SUD treatment capacity for behavioral health encounters according to standardized criteria.
3. To compute the ratio of SUD treatment encounter capacity to treatment encounter need in each service area.
4. To stratify all service areas in Colorado into deciles according to relative need for, or surplus of, SUD treatment capacity.
5. To compare the results of the assessment model proposed in this thesis to alternative models that measure behavioral health and physical health shortages.

Statement of Significance

The United States is experiencing an epidemic of illicit drug use and dependence, which has resulted in substantial avoidable health care costs, suppressed workforce participation, lowered

quality of life, and extraordinary rates of preventable mortality. It is in the interest of the public's health and society that those who experience SUD receive needed treatment in specialized behavioral health settings. The public health response to the SUD epidemic should be informed by the systematic assessment of behavioral health systems' capacity to provide secondary and tertiary prevention services. The methodology for assessing community needs for behavioral health professionals proposed in this thesis will perform a vital public policy function in Colorado, and perhaps nationally, by substantially improving the resolution of community level needs assessment for public investment in prevention, treatment and recovery from SUD. The application of this methodology will not be limited to the theoretical but will have present applications as policy makers and public systems respond to the SUD epidemic in Colorado.

Definition of Terms

The following definitions are created by the author for the purposes and goals of this thesis. Generally accepted definitions are used where available and when consistent with the communication objectives of this paper.

Barrier Free describes the assumption that the entire population of a given service area can receive needed health care services from within the service area without regard to individual access restrictions such as insurance status, ability to pay for health services, language or cultural needs, or transportation.

Behavioral Health Clinician includes professionals who are physicians boarded in psychiatry, child psychiatry, and addiction medicine, medical physician assistants (PA) with a psychiatric or behavioral health focus, psychiatric and mental health nurse practitioners (PNP), licensed addiction counselors (LAC), certified addiction counselors (CAC), clinical psychologists, licensed clinical social workers (LCSW), licensed professional counselors (LPC), and licensed marriage and family therapists (LMFT). In the context of this paper, this definition does not

include peer specialists, unlicensed psychotherapists, or pastoral counselors, though these professionals may provide valuable allied support services in many treatment contexts.

Behavioral Health Services

Community Based Behavioral Health Services include screening and assessment, diagnosis, treatment planning, case management, care coordination, therapeutic services (counseling, psychotherapy, group therapy), crisis services, and referral.

Medication Assisted Treatment Services (MAT) dispense naltrexone, methadone, and buprenorphine in an ambulatory[8] setting for the purpose of reducing symptoms of opiate withdrawal.

Complementary Behavioral Health Services include hypnotherapy, acupuncture, acupressure, therapeutic massage, manual therapy, and physical therapy.

Medically Monitored Detoxification Services are short term voluntary and involuntary medically supervised holds for those who are actively experiencing acute intoxication in order to safely facilitate the effects of drug and alcohol use withdrawal.

Acute Behavioral Health Services include emergency medical services, medical stabilization, medically directed evaluation, medically managed intensive inpatient detoxification, social model detoxification, and other inpatient hospitalization.

Residential Treatment is medium and long-term residential care that manages extended therapeutic and medical treatment of substance use disorder.

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[8] Care that is provided on an outpatient basis, including diagnosis, observation, consultation, treatment, intervention, and rehabilitation services.

Behavioral Health System is the constellation of behavioral health professionals, behavioral health service providers, health plans, and referral networks to and from primary care that deliver prevention, treatment and recovery services to those affected by substance use disorder.

Capacity is a description of health systems' ability to respond to the behavioral health service needs of the resident population of a specified service area.

Encounter is a unit of patient care interaction between patient and behavioral health clinician for the purpose of delivering a health care service or health assessment.

Harm Reduction is a public health strategy that aims to reduce adverse consequences resulting from nonprescribed use of intoxicating substances. Effectiveness is measured in terms of increased positive individual health, social and economic outcomes rather than the suppression or elimination of drug consumption.

Civilian Noninstitutionalized Population are all people who live and sleep most of the time within the boundaries of a geographic area but are not housed in a group quarter such as a correctional institution, juvenile facility, military installation, or dormitory.

Service area is a discrete geographic area where a preponderance of the civilian noninstitutionalized population within the service area could reasonably expect to access behavioral health services within the service area, when it is adequately resourced.

Social Determinants of Health are life-enhancing resources, such as food supply, housing, economic and social relationships, transportation, education and health care, whose distribution across populations effectively determines length and quality of life.

Substance Use Disorder is mild, moderate, or severe recurrent use of drugs and/or alcohol that causes clinically and functionally significant impairment of individuals. Impairment may include

health concerns, disability, risky behavior, social impairment, and failure to perform significant responsibilities at work, school, or with family. The diagnosis may be applied to the abuse of one or more of ten separate classes of drugs including alcohol, caffeine, cannabis, hallucinogens, inhalants, opioids, sedatives, stimulants, tobacco, and other substances. The dependent use of tobacco and caffeine, though important to public health policy, are not a primary focus of this paper.

Underserved describes a person or population group that possesses characteristics which are likely to create barriers to behavioral health care service access. Examples of barriers include: residence in an area where there are insufficient behavioral health providers; an inability to pay for needed health care, medical equipment or pharmaceuticals resulting from income and/or insurance status; limited transportation availability caused by either poor transit options or topographical barriers; being a member of a racial, ethnic, or linguistic minority; and having limited educational attainment.

CHAPTER 2: REVIEW OF LITERATURE

Introduction

This review of literature will abstract a brief history of public policy efforts to address localized health professional shortages through public investment and access to care resource allocation. The review will summarize current assessment methodologies used by the federal government to determine workforce shortage and related behavioral health care needs, and then describe how these assessment models will underperform in applications associated with the emergent epidemic of SUD. Finally, the review will analyze alternative workforce assessment models that either propose approaches to behavioral health needs assessment or elucidate technical elements of the proposed methodology described in this paper.

Federal Health Workforce Needs Assessment

Origins of Workforce Needs Assessment in Public Policy

The uneven geographic distribution of health professionals and health system resources has been a recognized problem in the United States since at least 1970 when Congress passed the Emergency Health Personnel Act. In the law, Congress establishes a role for the federal government whereby the Secretary of Health is to "improve the delivery of health services to persons living in communities and areas of the United States where health personnel and services are inadequate to meet the health needs of the residents of such communities and areas" (91-623, Section 329 (a)). The core purpose of the legislation, therefore, was to direct the systematic assessment and stratification of health professional workforce shortages in order to more efficiently allocate public resources to areas of the country determined to have the greatest needs (Health Resources and Services Administration, 2011).

The Emergency Health Personnel Act empowered state and local governments, as well as nonprofit health care organizations, to specifically request that the Secretary of Health declare

"Critical Health Manpower Shortage Areas" (CHMSA). In response to these requests, the Secretary was authorized to assign commissioned officers in the U.S. Public Health Service (USPHS) to provide health care services to persons residing in such areas.

This act also established that individuals who receive care from assigned USPHS personnel should be expected to pay for health care services at prevailing local rates but that charges could be reduced or waived if individuals are unable to pay for the care they need. This provision of the law is notable because it indicates that Congress contemplated affordability as an important barrier to health services access. This foresight in the design of federal access to care programs has become increasingly important given the divergence of health care cost inflation and core inflation since 1982.

Figure 3: Divergence of health care inflation from core inflation 1956 through 2016 (Federal Reserve Bank of Saint Louis 2016)
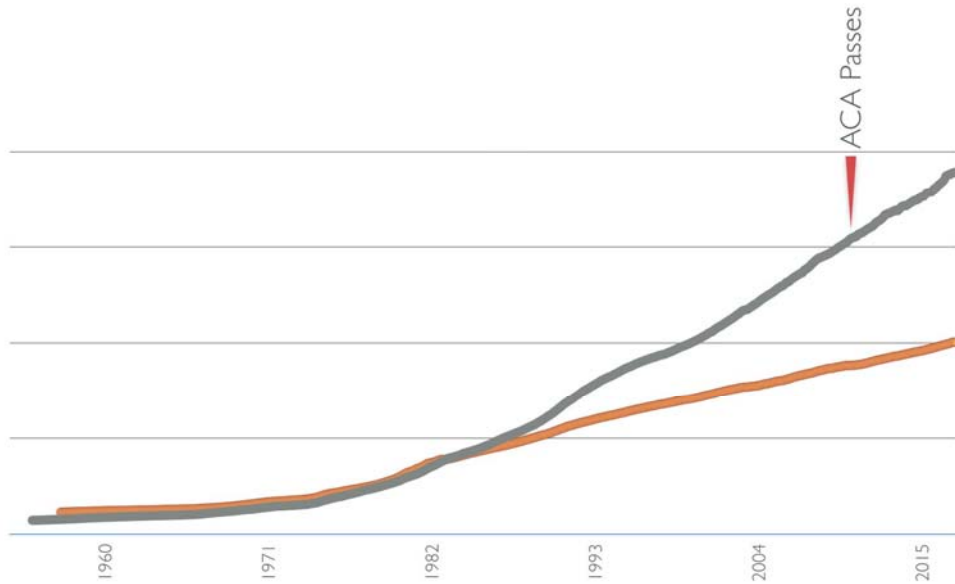
The Emergency Health Personnel Act is the first legislated example of a methodology to quantify health professional capacity necessary to respond to the health care needs of

communities in the United States. The criteria in the law "to determine which communities or areas may receive [workforce] assistance" included:

- The assessed needs of the health services area;

- The willingness of the health systems in the health service area to assist and cooperate with the placement of federal clinical personnel;

- The recommendations of a governmental agency or organization, which may be responsible for the development of the health professional shortage area application; and

- The recommendation and assent of the state medical, dental and other health professional societies.

These four elements of the shortage designation process, outlined in the Act, have persisted essentially intact throughout the nearly 50 years since the law's original enactment.

Current Workforce Needs Assessment in Public Policy

The designation of Health Professional Shortage Areas (HPSA) by the Secretary of Health and Human Services is the primary declaration of health services needs at a community level today (Health Resources and Services Administration, 2016). Shortage designation confers eligibility or priority for assistance in the supply, capacity, training, and distribution of health professionals in areas of the country that have an assessed shortage of clinical providers. Most federal programs that use HPSA designations apply additional program specific criteria and procedures to further refine the selection of communities to receive federal access to care assistance (Health Resources and Services Administration, 2011). In excess of 30 federal programs use shortage designation as an assessment or program eligibility requirement. These programs collectively cause the flow of billions of dollars in federal resources intended to improve the access needs of underserved populations (Health Resources and Services Administration, 2011).

Figure 4:   Select federal programs that apply HPSA designation to eligibility determination (Department of Health and Human Service, 2018).

Program	Agency	Use	Funding in millions
Certified Rural Health Clinic Program	Centers for Medicare Medicaid Services	1, 2	$818 (2010)
Community Health Center Program	Health Resources and Services Administration	2, 3	$5,089 (2018)
J1 Visa/National Interest Waiver for foreign medical graduates	Department of State	4	$0
Medicare Bonus for Physician Services	Centers for Medicare Medicaid Services	2	$215 (2010)
National Health Service Corps	Health Resources and Services Administration	4	$310 (2018)

1 - Certification eligibility
2 - Enhanced Medicare/Medicaid payment
3 - Development funding preference
4 - Provider placement

Current federal designation methodologies are not competitive among possible designatable service areas and simply require that an applicant (usually state government) demonstrate that an area meets minimum thresholds for designation eligibility. Designation can occur at any of three levels:

- *Geographic Area* designation indicates that all individuals in the area of designation have insufficient access to primary care, mental health, or dental health services.

- *Population Group* designation indicates that a subpopulation of individuals living in the area of designation has insufficient access to primary care, mental health, or dental health services. A subpopulation group might be defined by an elevated prevalence of low-income residents, higher rates of poverty, higher proportions of individuals receiving Medicaid, a cluster of migrant farm workers or the homeless, among others.

- *Facility* designation indicates that individuals served by a specific health facility have insufficient access to primary care, mental health, or dental health professionals. The

types of facilities that can be designated include federal and state correctional institutions, public and nonprofit healthcare facilities, and state and county mental hospitals.

There are four elements of the current federal methodology to determine designation as a HPSA.

- *Rational Service Area:* A description and rationale for the boundaries of the proposed shortage designation, including an explanation of why the residents of the service area are inadequately served for health care needs.

- *Population to Provider Ratio:* A ratio of the population or population group to the number of clinicians determined available to serve them.

- *Contiguous Area Analysis:* A statement of evidence that suggests adjacent service area capacity is not reasonably available to the population of the service area.

- *Nearest Source of Undesignated Care:* A measure of how remote a given service area is relatively to the nearest available alternative to care within the service area.

Attempts to Update Federal Methodologies

Critical Health Manpower Shortage Areas were retitled Health Professional Shortage Areas in a Federal Register notice published in July 1976 (Lee, 1977). This regulatory revision added "health status indicators" and "transportation, appointment and wait times, utilization rates, and other factors that impair access" to the federal methodology for determining workforce shortage.

Since 1976, there have been three additional attempts to modernize the federal shortage designation methodology. The first two attempts were initiated in 1998 and 2008. These attempts were proposed by the Health Resources and Services Administration (HRSA) and then later withdrawn because of substantial stakeholder opposition (Coburn, *et al.,* 2010).

A third attempt to modernize HPSA methods was initiated in 2010 as the result of the passage of the Patient Protection and Affordable Care Act (ACA). Section 5602 of the ACA directed the Secretary of Health and Human Services (HHS) to establish a negotiated rulemaking process to "reexamine the methodology for designating areas and populations that are

experiencing medical underservice and/or health professional shortages." This attempt also failed to achieve final rule status because the appointed rule negotiation committee did not reach a consensus.

Application of Current Federal Methodology to Behavioral Health Needs Assessment

Though components of the federal methodology to assess community level workforce capacity has application to the methods that are proposed in this thesis, the current policy and rules cannot be effectively applied to behavioral health care needs of communities impacted by SUD. The deficiencies of the current federal model for behavioral health needs assessment are as follows.

Current Methodologies do not Measure SUD Systems

Existing methodologies are designed to determine the delivery capacity of broad primary, oral and mental health services at the community level. They do not examine the unique systems of care needed to respond to SUD. Physical health care is typically provided in primary health care settings (Petterson, *et al.*, 2008) by generalist practitioners who are trained in first contact and continuous health care services for a diverse patient population. Alternatively, SUD is most often treated in separate specialized facilities using health professionals specifically trained in the care and treatment of individuals experiencing addiction (Cummings, Wen, Ko, & Druss, 2014 and Substance Abuse and Mental Health Services Administration, 2016). The differences in systems of care do not suggest that the assessed capacity of generalist providers can be effectively applied as proxy for SUD provider capacity.

Current Methodologies Do Not Assess Most Clinicians Involved in SUD Treatment

Existing methodologies only assess clinical services provided by physicians when determining clinical provider capacity. In the more than four decades since the current federal standard was established, there has been considerable growth in the use of non-

physician health care providers (*e.g.*, advanced practice nurses and physician assistants) in the delivery of health care services (Medical Group Management Association, 2014). Furthermore, the delivery of care for SUD is multidisciplinary and often not primarily lead by physicians.

Current Methodologies Do Not Consider Population Characteristics that SUD

Existing methodologies are do not attempt to differentiate high versus low predicted health services demands of the service area population according to indicators such as health status, income, or age. These characteristics, among others, are known to predict health service utilization for health care services (Phillips, *et al.*, 2016).

Current Methodologies Do Not Take Advantage of New Tools for Spatial Analysis

Existing methodologies require a service area construction that may or may not represent actual care patterns of populations and effectively assumes that boundaries are impermeable to transit of individuals who may select adjacent care centers for their health care needs. In other words, access to care across boundaries of service areas is neither accounted for or considered in the model (Government Accountability Office, 1995).

Alternative Behavioral Health Workforce Needs Assessment Models

The alternatives to HRSA health workforce assessment models, as described in the literature, are numerous and take varied approaches to understanding and measuring behavioral service area needs. Common approaches include enumeration of systems or providers, proxy indicators of risk, surveillance of health systems utilization, sampled surveys of drug use, and population level predictive risk measurement.

<u>Systems and Provider Enumeration</u>

The systems and provider enumeration approach to assessing community behavioral health workforce capacity considers the simple distribution of treatment facilities and/or clinicians within a defined geography.[9] This approach rests upon the assumption that clinicians available in the service area are providing patient care full time and that behavioral health service sites create "barrier free" access for the entire population of the service area. Access that is barrier free assumes that: all patients are accepted into care regardless of insurance status or ability to pay for services; patients experience no significant language or cultural obstacles to routine health service transactions; and service locations are physically accessible by all residents of the service area through private or public transit.

The variables being tested in the enumeration approach are the density of providers in a service area, or in more refined instances, the ratio of providers to the population of the service area. The technique often benefits from nationally uniform, contemporaneous data collection, simple and recognizable service areas for the purposes of policy making, and the ability to conduct longitudinal surveillance of the changes in provider density over time.

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[9] A description of the surface shape and characteristics of a land area proposed as a component of a service area.

Figure 5: Density of Substance Use Treatment Facilities in the U.S. by County (Jones, Honermann, Sharp and Millett, 2016)
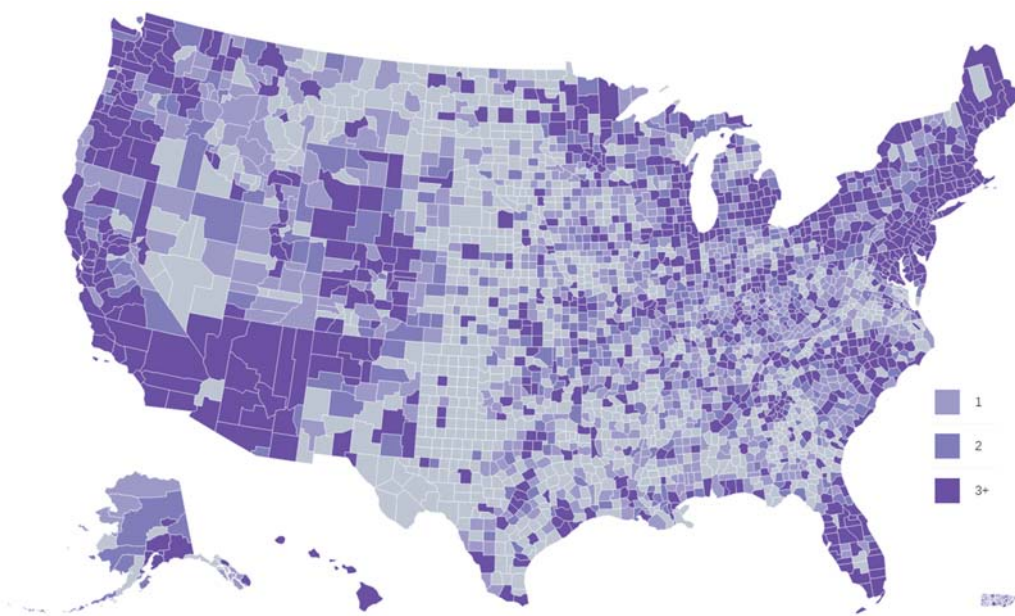
In this example, service areas are defined by existing civil boundaries (counties or parishes in the case of two states). Though counties provide a convenient service area model, they were created as administrative subdivisions of states well before the modern health service needs of populations were considered. The utility of county-based service areas is confounded by wide variation in the geographic size and resident population within them. In Colorado, twenty counties are geographically larger than the state of Delaware and resident populations range from 698 to more than 693,000 (Colorado Demography Office, 2018). In the above model, deep purple might imply a well-resourced community, yet three behavioral health sites will mean something quite different for a county population of 15,000 versus a county population of 500,000. For example, Arizona appears to have nearly statewide density of three or more treatment sites for SUD treatment; however, this representation is likely to be an artifact of geographically large counties rather than high treatment coverage or high treatment capacity.

Alternatively, provider enumeration approaches consider the density or ratio of behavioral health care professionals to the population in a given geographic area. The commonest

national data set applied to the provider enumeration strategy is the National Plan and Provider

Enumeration System (NPPES) maintained by the Centers for Medicare Medicaid Services

(CMS).

Figure 6:   Psychiatrists in rural U.S. counties per 100,000 population by Census Division (Andrilla, Patterson, Garberson, Coulthard, Larson, 2018)
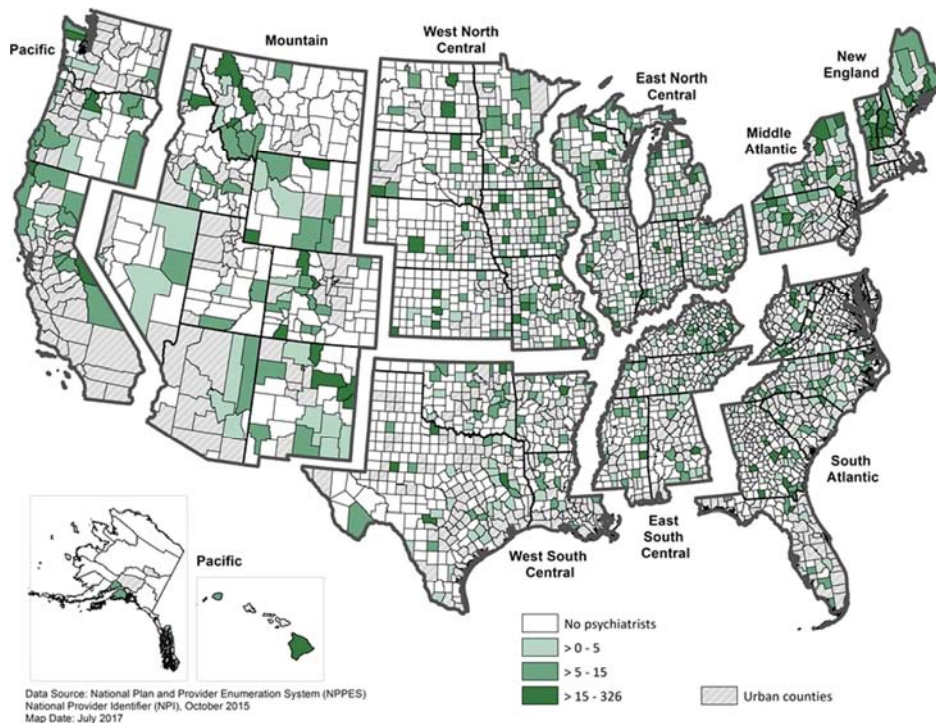
This approach can evaluate relative variation in the density of licensed behavioral health

professionals who maintain a National Provider Identifier (NPI) at larger geographies. However,

this method suffers from multiple limitations of the NPPES data set itself. Though any clinician is

eligible to receive an NPI, typically only those clinicians who have a direct billing relationship

with a health plan have cause to register in the system. This results in substantial

underrepresentation in the data of behavioral health professionals who are not physicians, clinical

psychologists, or advanced practice nurses.

Second, though providers are encouraged to maintain current practice location information, few do so in practice. In a review of the public use file for Colorado in 2017, nearly 85 percent of Colorado NPI records had not been modified in the previous 24 months. According to LexisNexis, 2.5 percent of providers change address and contact information each month and 30 percent change affiliations each year (LexisNexis 2014). Because most data in the Colorado NPPES data set is greater than two years old, substantial location data quality problems are likely.

Third, the NPPES data set records no provider information about practice characteristics (*e.g.*, pediatric or adult), practice setting (*e.g.*, private, safety net, hospital, or federal), or clinical care volume (*e.g.*, hours in direct patient care and patient encounters). As a result, the practice capacity of individual clinicians represented in the NPPES may be assigned to a uniform if not arbitrarily level per clinician. Though expedient, this design decision may fail to account for variations in practice capacity by statutory practice authority (assigned in state statute and not uniform among states), provider age, provider gender, practice location, variable health plan rates for certain behavioral health services by plan or by network, among numerous other factors. The methodological choice to treat each clinician as equivalent in the volume of behavioral health care capacity he or she delivers could have large effects in calculated aggregate capacity of a service area. The overcount of capacity of several part-time behavioral health providers in a service area may under represent the true need for greater behavioral health care capacity in that service area.

Proxy Risk Indicators

Certain population level risk measures provide another means of measuring behavioral health service needs. For example, rates of prescriptions for pharmaceutical opioids may indicate greater risk for the misuse and diversion[10] of such substances within the service area population.

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[10] The act of transferring a legally prescribed controlled substance from the individual for whom it was prescribed to another person for any illicit use.

Figure 7:   Estimated rate of opioid prescriptions per 100 residents by U.S. County
(Centers for Disease Control and Prevention, 2018)
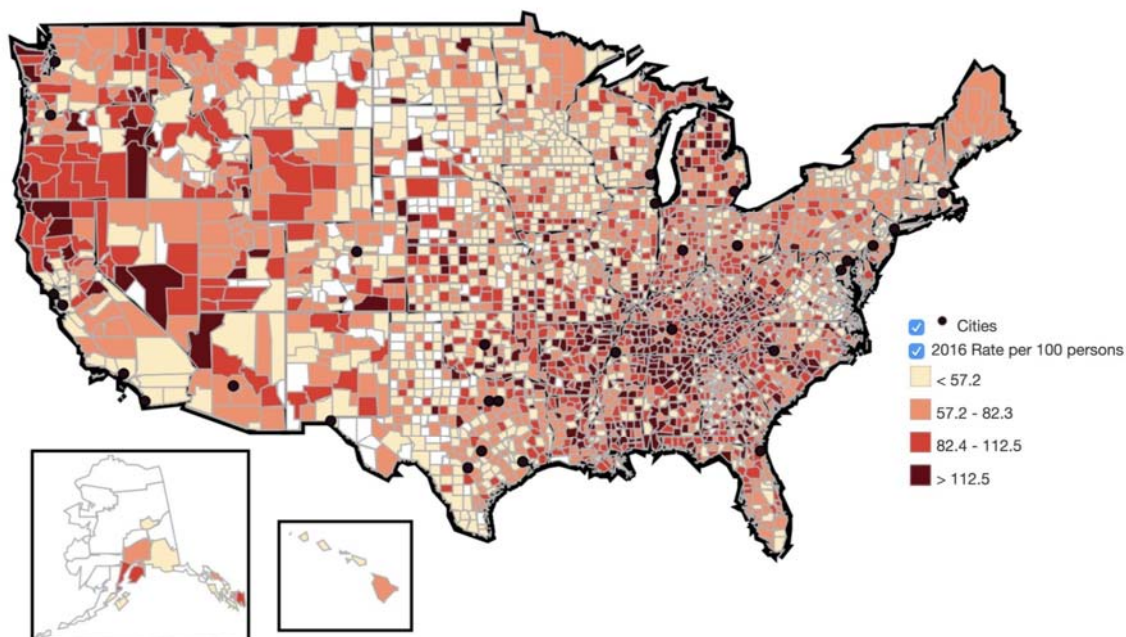
Unlike the enumeration model, this model is less affected by service area construction derived

from county boundaries because population rates are applied and the availability of opioid

prescribers is more ubiquitous than SUD treatment facilities. This measure of service area needs

assessment may, however, be less useful in informing assessment of all illicit drug use and these

rates could be confounded by variables such as the age of the population and the location and

density of pain management clinics.

It is also possible that the directionality of the relationship between opioid prescribing

rates and SUD could be misinterpreted. High opioid prescribing rate patterns could emerge from

the drug seeking behavior of patients who are experiencing SUD rather than the high prescribing

rates being the cause of opioid misuse at the population level (Cochran, *et al.*, 2014). It may in

fact be the case that causal effects occur in both directions. Furthermore, rates of pharmaceutical

opioid prescribing peaked in 2012 at 81.3 prescriptions per 100 persons (Centers for Disease

Control and Prevention, 2018), while per capita illicit drug use has continued to increase since

2012. Though a high opioid prescribing rate is putatively related to the current SUD epidemic, the relationship between local prescribing rates may not be temporally linked in a way that could be easily applied to an assessment of present behavioral health service needs of a service area.

Health Utilization Surveillance

Another approach to behavioral health workforce assessment is to infer needed treatment capacity by monitoring health services utilization for events associated with SUD. The Drug Abuse Warning Network[11] (DAWN) and the Treatment Episode Data Set (TEDS) are two such data systems administered by the Substance Abuse and Mental Health Services Administration (SAMHSA).

These two systems measure presentation of SUD in the health care system when the negative consequences of disease are most acute. The DAWN system aggregated data from a large sample of hospital emergency department visits involving recent drug use. Data was gathered for urgent health events that are directly related to SUD such as overdose and indirectly related to SUD such as injuries experienced during intoxication.

The TEDS system is a minimum data set of individual demographic and drug history information for persons admitted to publicly funded SUD treatment facilities. The TEDS system records 1.5 million substance abuse treatment admissions annually but is not understood to be representative of total national demand for substance abuse treatment (Substance Abuse Mental Health Services Administration 2018). The TEDS system does however reveal an important component of total public financing costs for SUD treatment in the United States.

Health utilization surveillance systems that inform workforce needs assessment have the benefit of providing a direct measure of health services associated with SUD. Data from these

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[11] The DAWN surveillance system was discontinued in 2011. SAMHSA is currently developing alternative methods of gathering data on drug-related emergency care.

systems can reveal trends in drug use when aggregated to large scales. These types of surveillance systems provide important insights into the impact of SUD on the health care system as a whole.

Health utilization surveillance systems also present certain challenges. The data provide lagging indicators of community behavioral health service needs in that the cause (problem drug use) must precede the effect (acute health events requiring hospitalization or emergency care). It is likely that those individuals who are seeking treatment in public systems are experiencing both greater negative consequences of their substance use and are less resourced in their ability to acquire behavioral health care in private systems where data is not routinely provided to these surveillance systems. System utilization surveillance is also challenged by the fact that only ten percent of individuals who are experiencing SUD receive treatment for their disorder (Center for Behavioral Health Statistics and Quality, 2017). It is therefore likely that rates of patient presentation for inpatient SUD care is highly delimited by local behavioral health services capacity.

The lagging characteristic of the indicator, the nonrandom nature of those who present to health care treatment systems, the limits of local capacity once maximum service capacity is reached, and the inability to acquire data at geographies smaller than very large urban areas, restricts the utility of such systems to measure behavioral health service area capacity and related shortage of behavioral health providers at the community level. In addition, the interpretation of changes in emergency department utilization may not always be straightforward. Increases in SUD related admissions may be the outcome of an increase in the prevalence of SUD in a service area, episodic increases in street drug potency or composition resulting in more frequent acute intoxication (*i.e.*, when heroin is cut with fentanyl), a decline in the capacity of community based behavioral health services to meet the needs of those with SUD, or the interrelationship of multiple factors. In the case of the DAWN data system, little can be gleaned for the analysis of local service area needs in that data is only released for states and large metropolitan areas. The

utility for determining community based behavioral health service area needs based on DAWN data is therefore quite limited.

Direct Measures of Illicit Drug Use

The NSDUH is a survey conducted by SAMHSA that measures tobacco, alcohol, and drug use at the population level. The survey is conducted on an age and state stratified random sample of 70,000 U.S. residents each year. The NSDUH is the only nationwide, longitudinal direct measure of drug use conducted in the United States.

Direct measures of drug use have an advantage over proxy or inferential measures of SUD risk for the determination of population level treatment needs. Direct measures of drug use are less ambiguous in revealing the potential for treatment demand, thus the allocation of public resources can be made with more precision and with less dependence upon assumptions made by other indirect or proxy models.

Figure 8: Illicit Drug Use Other Than Marijuana in the Past Month among Individuals Aged 12 or Older, by State (2015 and 2016 NSDUH)
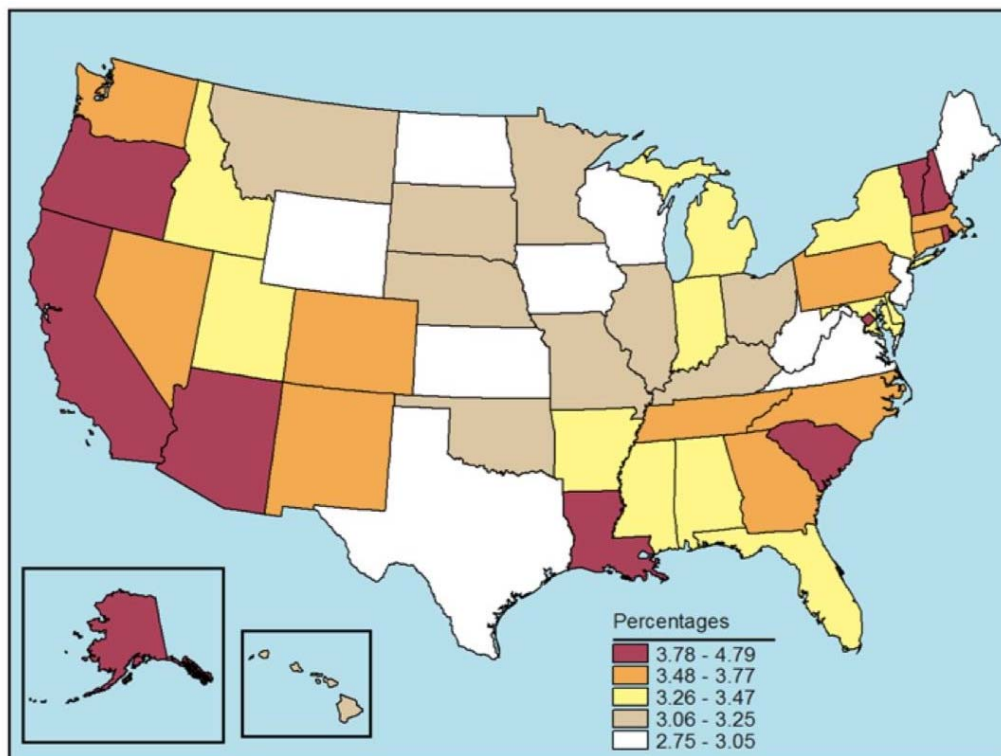
Though the advantages of direct measures of illicit drug use available through the NSDUH is readily apparent at the state and national level, this approach has less utility in localizing drug use to discrete service areas because data is only available at the state level. The data is insufficiently localized to support service area level analysis.

Population Level Predictive Risk Measurement

Population level evaluation of the social determinants of health in the United States is increasingly understood to offer potential for new insights into the origins and causes of disease (Phillips, *et al.,* 2016). For example, the CDC has devised a Social Vulnerability Index to measure the resilience of communities to the effects of external stresses on human health including natural or human-caused disasters, or disease outbreaks (Centers for Disease Control and Prevention, 2018). New Zealand and the United Kingdom have developed similar indexes to

calibrate clinical funding, allocate public resources, and measure the impact of interventions according to material and social deprivation (Phillips, *et al.,* 2016). These two countries benefit from rich datasets available through national census and a national system of health care finance and delivery, which together lend themselves to precise targeting of publicly funded health care resources.

A like index of social or demographic metrics may provide insight into regional variation in either the risk of SUD or barriers to access treatment service for SUD. Though a primary care access index has been proposed for the United States (Butler, Petterson, Phillips & Bazemore, 2012), the authors make no claim to the validity of the index as a proxy measure for SUD access to treatment. No similar risk index methods for the targeting of SUD resources were found in this review of the literature.

Summary of Current Problem and Study Relevance

The epidemic of SUD in the United States is a public health emergency. Access to treatment and recovery services for those affected by SUD is substantially modulated by the treatment capacity of behavioral health providers at the service area level. Local shortages of behavioral health providers are known to exist, yet available assessment models as described in this literature review do not perform well in quantifying service area level behavioral health workforce needs.

In light of the serious social, economic, and health problems caused by the current SUD epidemic, there is an urgent need for assessment models that localize behavioral health workforce deficits so that public resources to address shortages can be well targeted. The assessment methodology proposed in this paper will address the shortcomings of existing models by examining and quantifying service area level behavioral health professional needs. When applied to Colorado, this methodology will inform public policy regarding the allocation of resources intended to address behavioral health workforce shortages. If the resource targeting made

possible by this methodology proves effective, the burden of SUD and associated morbidity and mortality is predicted to decrease.

CHAPTER 3: METHODOLOGY

Introduction

The assessment model defined in this paper applied secondary data sources in a four-step analytical process to quantify and stratify community level behavioral health professional capacity in Colorado. The model resulted in the construction of floating catchment areas that organized census block groups into deciles according to assessed shortage of behavioral health professional capacity relative to need. The catchment area is created to represent a "reasonable" service area for access to behavioral health care of residents within the service area. Geographic Information System (GIS) maps of behavioral health professional capacity needs were produced based upon the results of analysis.

Population

The research population included in this assessment methodology was all persons who were resident[12] in Colorado but not part of a group quarter such as a military base or correctional facility. Group quartered populations were excluded from analysis because behavioral health services are presumed to be provided in closed health care delivery systems that are supported and maintained specifically for the quartered population. The cross interaction of behavioral health services supply and demand between quartered and unquartered populations within the same service area were assumed to be de minimis.

The total civilian noninstitutionalized population of the state was selected for this study because the goal of this assessment model was to produce objective and localized information about where shortages of behavioral health care providers exist across the state. Data collection

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[12] Where individuals live and sleep most of the time. The resident population excludes people whose usual residence is outside of the United States, such as the military and federal civilian personnel living overseas, as well as private U.S. citizens living overseas.

and analysis was conducted statewide so that both absolute and relative measures of behavioral health workforce resource needs could be assessed. A more limited scope of analysis would not have yielded greater evaluative efficiency, reduced risk to the study population, or satisfied the goals of this paper.

Protection of Human Subjects

All data in this study was derived from secondary, publicly available sources. Population data did not contain personally identifiable information (PII). Behavioral health provider data contained PII including name, practice location, license number, boarding and certification, and practice setting (*e.g.*, ambulatory care, long-term care, or tertiary care). The study model was determined not to be clinical investigation by The Emory University Institutional Review Board for the Protection of Human Subjects (IRB). A waiver of human subjects protections was granted on June 15, 2018.

Research Design

The behavioral health workforce assessment framework proposed in this paper was devised using a mixed-methods design. This design was chosen because it permits focus on the general research problem of community level determination of behavioral health workforce needs in context with actual behavioral health treatment supply and demand data for Colorado. Because this model relied on both novel and previously tested analytical tools, no single research design could be applied. In addition, this research design considered general validity testing using qualitative comparisons of these results to the findings of other models described in the review of literature. Comprehensive and quantitative validity testing will be part of future iterations of this work.

Procedures and Analysis Methodology

<u>Estimating Demand for SUD Treatment</u>

A table of civilian population estimates in Colorado was created from data downloaded from

American FactFinder[13] (American Community Survey, 2012-2016 5-year estimates, Table

B21001). The table consisted of civilian noninstitutionalized population totals for each Colorado

census block group[14] broken down by age and sex.

The number of individuals experiencing SUD at the block group level was estimated by

multiplying the male and female population by 11.5 percent and 5.7 percent, respectively. The

SUD multiplier by sex was derived from national data from the report "Behavioral Health, United

States, 2012" page 44, "Table 5. Past year substance use disorders among adults, by sex:

percentage, United States, 2010–2011 combined" row one, "Any substance use disorder"

(Substance Abuse Mental Health Services Administration, 2012). For example, in a block group

with a civilian noninstitutionalized population of 840 males and 1,054 females, an estimated

156.7 individuals would be expected to have experienced a SUD episode within the past year.

$$(840 \times 0.115) + (1,054 \times 0.057) =$$

156.7 *individuals* with experience of SUD in the last year at the census block group level

From the estimate of individuals with SUD at the census block group level, an estimated

treatment encounter demand for community-based services was derived by multiplying the total

individuals with SUD by eight. The treatment encounter demand multiplier was obtained from the

National Comorbidity Survey - Replication (NCS-R) report, which defines minimally adequate

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[13] American FactFinder is the United States Census Bureau's online self-service data tool, which supports public query of population, economic, geographic, and housing data.

[14] Census block groups are statistical divisions of census tracts that generally contain between 600 and 3,000 residents.

treatment[15] for SUD as eight or more visits with any health care or human services professional lasting an average of 30 minutes or more. For example, 156.7 individuals experiencing SUD in a block group would be expected to require 1,253.6 treatment encounters in a barrier free access context.

$$156.7 \times 8 =$$

1253.6 total *demand* for SUD treatment encounters at the census block group level

Estimating Supply of SUD Treatment

A table of behavioral health professionals who were licensed in Colorado and had evidence of recent practice within the state was downloaded from the Colorado Health Systems Directory.[16] The table consisted of the name, license type, professional discipline, and practice location of each behavioral health professional.

Each clinician type in the table was assigned to a benchmark for outpatient provider productivity obtained from the United States Department of Veterans Affairs (VA), Mental Health Benchmarks By Discipline (Open Minds, 2017). This benchmark rate assumes full-time practice in an outpatient public health care system.

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[15] Minimal adequacy for SUD treatment encounters is determined by evaluating recommendations and guidelines from the American Psychiatric Association (APA) and the Agency for Healthcare Research and Quality (AHRQ).

[16] The Colorado Health Systems Directory is a work product of the author, which provides a comprehensive database of all licensed clinicians and health care sites in Colorado. The database aggregates information from multiple data sources, matches records from those sources, standardizes information contained within those sources, and applies a probabilistic algorithm to determine current practice information for clinicians at the date of query.

Figure 9:   Mental Health Benchmarks by Discipline: "Average" Outpatient Provider
Productivity

Behavioral Health Discipline	Panel Size	Encounters/Year
Psychiatrist (MD, DO)	513	1827
Psychologist (Ph.D. Psy.D)	266	1549
Social Worker (LCSW)	207	1575
Individual Therapist (LPC, LAC, LMFT, NP, PA)	275	1740
Group Therapist (CAC)	967	7736

From the estimate of treatment encounter supply by clinician type, an aggregate treatment
encounter supply by census block group was derived. This was accomplished by summing the
total estimated encounters by clinician for all behavioral health clinicians with a practice address
in the block group. For example, a block group with one psychiatrist, two social workers, and two
professional counselors would produce an estimated supply of 8,457 SUD treatment encounters
per year.

$$(1^{psychiatrist} \times 1{,}827) + (2^{social\ workers} \times 1{,}575) + (2^{therapists} \times 1{,}740) =$$

8,457 total *supply* of SUD treatment encounters at the census block group level

Estimating the Spatial Relationship of Supply and Demand for SUD Treatment

The relationship of demand and supply for SUD treatment encounters must be understood at
discrete service areas on the geographic scale of what individuals might choose when accessing
behavioral health care services. For this step, all providers within the area are presumed to be
generally accessible and equally proximate to the population of the service area. Service locations
that lie outside of the service area are assumed to be inaccessible by distance for the purposes of
analysis.

To estimate the availability of treatment resources within a block group, considering the demand for and supply of SUD treatment encounters within the catchment area[17] (*i.e.*, service area) in which the block group is located, the Two-step Floating Catchment Area (2SFCA) method developed by Wei Luo and Fahui Wang was applied (Luo and Wang, 2003). The 2SFCA method was selected because spatial accessibility of treatment for SUD is not defined by the boundaries of a block group or any other census or political subdivision, with the possible exception of state boundaries.[18] This is because most civil boundaries of this type can be easily traversed by patients for the purposes of acquiring health services.

The application of the 2SFCA began with representing the population as a travel centroid[19] for each block group. The boundaries of each catchment area were then calculated by determining a 30-minute travel distance from the population centroid (derived from ESRI Street Map data, ArcGIS v. 10.4x). Thirty minutes by ordinary road travel was selected because it is the current standard for accessible primary care services according to distance as defined in federal primary care HPSA rules (Federal Register, Vol 73, No 41, 42 CFR Part 5 and 51c, 2008). Thirty minutes travel distance was also the measure used in the original development of the 2SFCA method.

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[17] An area defined by a polygon in which residents would reasonably expect to receive care from providers within the polygon if treatment capacity were available and not excessively distant from their place of residence.

[18] State boundaries may present a barrier to access for those covered by state Medicaid programs where providers in relative close proximity to one's residence but across a state line, may not be enrolled in the patient's state Medicaid network and therefore would be inaccessible to the patient on that basis rather than travel distance.

[19] A travel centroid is the geometric center of a group of points within a geographic shape (*e.g.*, Census block group) where the center point generally falls within the shape.

Figure 10: Hypothetical Catchment Area Map with 30-Minute Travel Polygon (Example 1)

Once the catchment area was defined by the 30-minute travel polygon,[20] the sum of predicted *demand* for SUD treatment encounters and the sum of predicted *supply* of SUD treatment encounters for each block group within the boundaries of the catchment area was calculated. In the example represented in Figure 10, estimated SUD treatment encounter demand from block group 1, 2, 3, 4, and 7 would be summed to estimate total encounter demand in the catchment area.

$$163.2^{BG1} + 221.3^{BG2} + 299.5^{BG3} + 378.1^{BG4} + 175.0^{BG7} =$$

1237.1 sum SUD treatment encounter *demand* in the catchment area

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[20] A closed, irregular geometric shape on a map surface that defines equivalent road travel distances from a central point within the shape.

Similarly, estimated treatment encounter supply from block group 1, 2, 3, 4, and 7 would be summed to estimate total encounter supply in the catchment area. In the example represented in Figure 10, block group 2, 3, and 4 had no practicing clinicians. Block group 1 had one practicing social worker and block group 7 had one practicing psychiatrist.

$$1{,}575^{BG1} + 0^{BG2} + 0^{BG3} + 0^{BG4} + 1{,}827^{BG7} =$$

3,402 sum SUD treatment encounter *supply* in the catchment area

Figure 11: Hypothetical Catchment Area Map with 30-Minute Travel Polygon (Example 2)
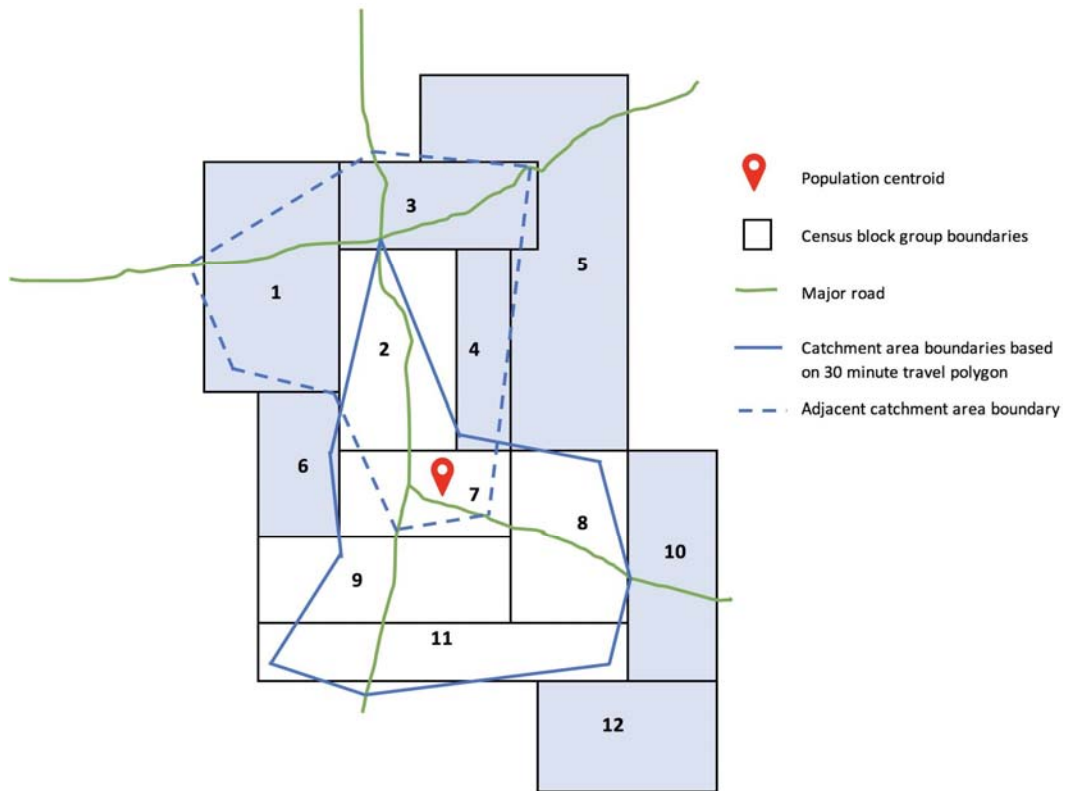
In the example represented in Figure 11, estimated treatment encounter demand from block group 2, 7, 8, 9 and 11 would be summed to estimate total encounter demand in the catchment area.

$$221.3^{BG2} + 175.0^{BG7} + 275.2^{BG8} + 198.4^{BG9} + 301.8^{BG11} =$$

1,171.7 sum SUD treatment encounter *demand* in the catchment area

Estimated treatment encounter supply from block group 2, 7, 8, 9, and 11 would be summed to estimate total encounter supply in the catchment area. In the example represented in Figure 11, only block group 7 had one practicing psychiatrist.

$$0^{BG2} + 1{,}827^{BG7} + 0^{BG8} + 0^{BG9} + 0^{BG11} =$$

1,827 sum SUD treatment encounter *supply* in the catchment area

The catchment area definition process was repeated for each block group in the state. The aggregate *demand for* and *supply of* SUD treatment encounters was calculated for each catchment area. As expected under the 2SFCA model, adjacent block groups of relatively small geographies tended to create overlapping or "floating" catchment areas. For example, block group 2 and block group 7 are included in both hypothetical catchment area constructions (Figure 11).

Calculating the Ratio of Supply and Demand for SUD Treatment and Stratifying Shortage

The ratio of demand to supply was calculated for all 3,532 census block group catchment areas in Colorado. Where the ratio of demand to supply was less than or equal to one, the supply of estimated SUD treatment encounters exceeded the predicted demand for treatment encounters in that catchment area. These catchment areas were not considered to be shortage areas for SUD

workforce. Where the ratio of demand to supply was calculated to be greater than one, the supply of estimated SUD treatment encounters fell short of predicted demand for treatment encounters in the catchment area. The catchment areas with a deficit of supply were then assigned to a decile within the range of all catchment areas in Colorado. These catchment areas were considered to be shortage areas for SUD workforce. The relative shortage of SUD workforce was represented by the catchment area's position in deciles of all catchment areas in the state.

Instruments

1. ArcView GIS® Version 10.4.1 © 2018 Esri. All rights reserved.

   ArcView GIS is a desktop geographic information system software commonly used in public health applications. This data tool was used to translate the methodology and data into graphic representations of the proposed model on a map of Colorado. The ArcView GIS interface includes frames that present geographic information in shapefiles[21]and layers.[22]

2. Microsoft® Excel, Version 16.13.1 (180523). © 2018 Microsoft. All rights reserved.

   Excel is a common desktop spreadsheet software that can be used to store data in worksheet tables. Basic calculations were performed in Excel before data was exported into ArcView GIS.

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[21] A shapefile is a nontopological data file format that stores geometric location and attribute information of geographic features.
[22] Layers represent the process used to display geographic datasets in ArcView. Each layer references a dataset and specifies how that dataset should be displayed on a map surface.

Data Sources

1. Colorado Health Systems Directory, Version 2.0. Colorado Department of Public Health and Environment – variables associated with clinician name, unique identifiers, practice location, and practice setting

2. Behavioral Health, United States, 2012; page 44 "Table 5. Past year substance use disorders among adults, by sex: percentage, United States, 2010–2011 combined"; row one "Any substance use disorder" – variables describing the percentage of the United States population that are actively experiencing SUD

3. Esri Street Network Analyst v. 10.4 – variables associate with road speed, travel distance, and road attributes (*e.g.*, highway, rural, or city), which inform travel time calculations

4. National Comorbidity Survey - Replication; Minimally Adequate Treatment for Substance Use Disorder – referenced for the minimally adequate treatment multiplier

5. United States Census Bureau, American FactFinder; American Community Survey, 2012-2016 5-year estimates, Table B21001 – variables related to the civilian noninstitutionalized population according to sex and age at the census block group level

6. United States Department of Veterans Affairs, Mental Health Benchmarks by Discipline – variables related to the clinician productivity benchmark by professional discipline

CHAPTER 4: RESULTS

Introduction

The results of analysis have tested the hypothesis that a novel index of population level data can be constructed to more effectively determine behavioral health service area workforce capacity needs at the community level for those who are experiencing substance use disorder than existing models. The results described in this chapter support the alternative hypothesis of this thesis.

Figure 12: Map of Colorado (Nations Online Project, 2018)
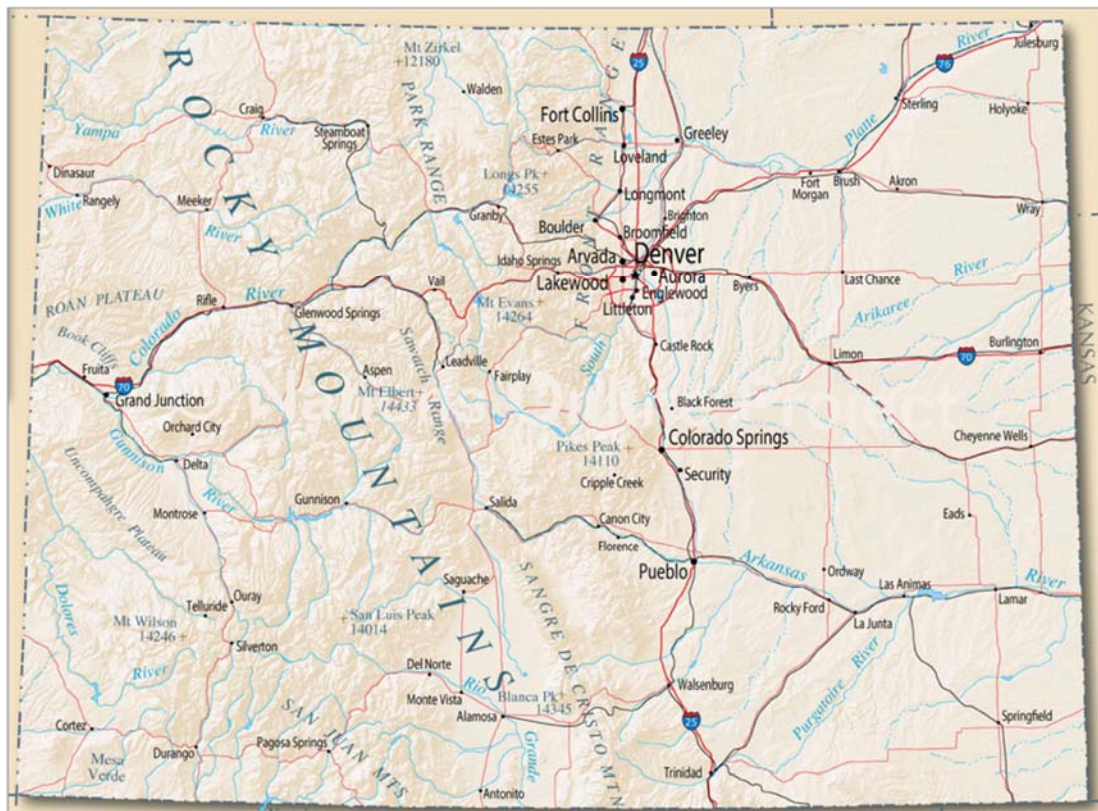
Key Findings

<u>Floating Catchment Areas</u>

Figure 13 represents floating catchment areas (pale yellow) defined as 30 minutes travel distance from the population centroid of each census block group in Colorado. Geographies that are blue-gray lie outside of the travel polygon created from the population centroid of all census block groups. These areas of Colorado are generally sparsely populated and most meet the definition of a frontier area.[23]

Figure 13: Floating Catchment Areas Defined by 30 Minutes Drive Time from 2010 Block Group Population Centroids in Colorado (Benjamin White, 2018)

Legend:
- ♦ Unique provider address
- 30-minute travel polygon
- Region outside of all travel

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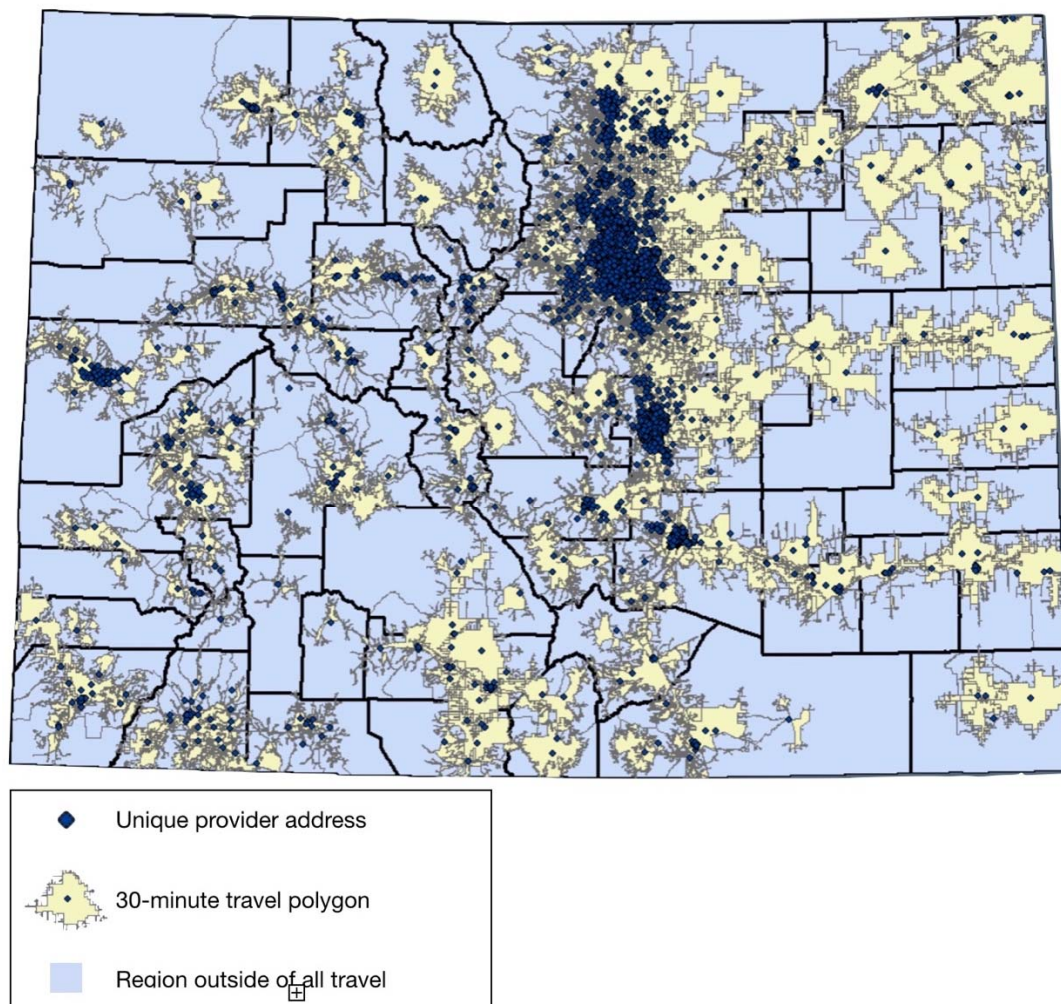
[23] A population density of six or fewer persons per square mile.

Travel polygons tend to be geographically larger in the eastern half of the state where the topography is flat and the population centers are rural. Travel polygons in the western half of the state tend to be geographically smaller because of mountain ranges and nonlinear travel routes between population centers.

Denver's urban corridor is easily recognized by the density of providers (dark blue points) in the area slightly north and east of the center of the state. The density of providers represented on the map correspond to the density of population in the state overall. The population center of Colorado Springs is recognizable as the cluster of provider addresses south and slightly east of the Denver cluster.

Stratification of Block Groups by Decile

Figure 14 represents the assignment of each census block group in Colorado to one of ten deciles. Deciles were created by the ordering of the ratio of estimated supply of treatment encounters to predicted demand for SUD treatment encounters. Each decile bin contains 353 census block groups (3,532/10).

More than 90 percent of Colorado's land area meets the definition of shortage under this model. These areas contain about half of Colorado's residents. Forty-four of 64 Colorado counties have no catchment area within them that indicates adequate or surplus SUD treatment capacity.

Figure 14: Substance Use Disorder Health Professional Shortage Area by Decile in Colorado (Benjamin White, 2018).
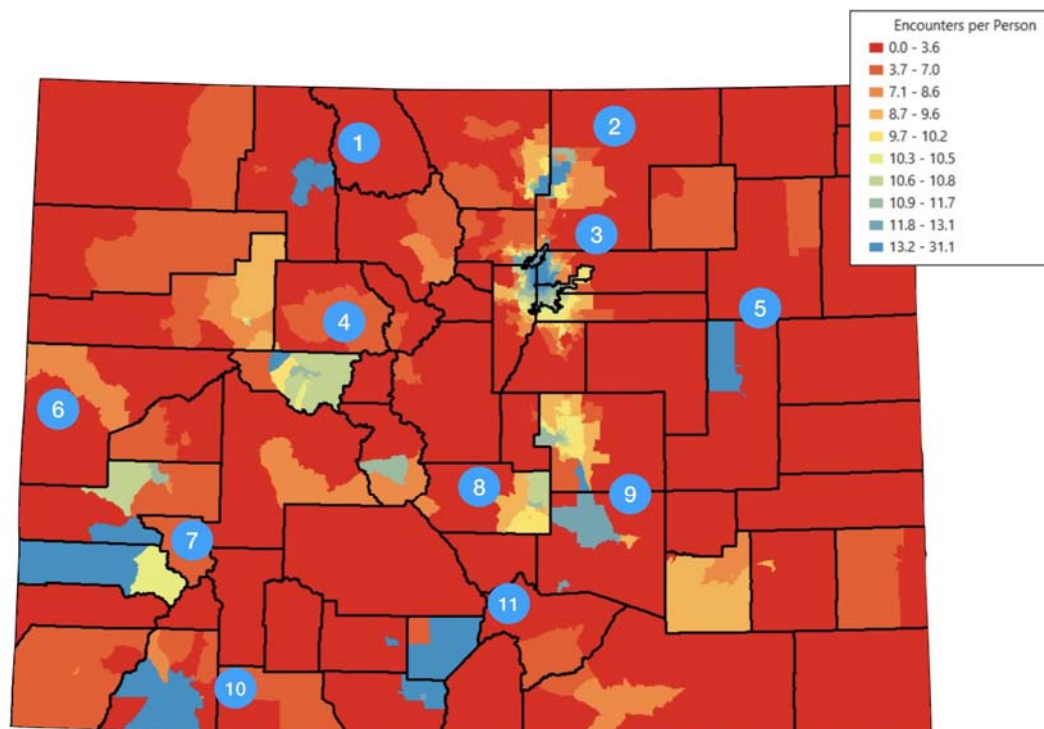
Census block groups assigned the color of deep red, red, and orange have a deficit of provider capacity to treat SUD (< 8.6 treatment visits per resident with predicted SUD). If all residents of these census block groups who are presumed to have an active experience of SUD sought treatment within 30 minutes of home, they would likely experience significant barriers to access due to limited provider capacity. As a consequence, individuals in very low capacity catchment areas would either be forced to travel farther to receive care or forgo care.

Regional and Local Characteristics

Resort Communities

Clusters 1, 4, 7 and 10 are in or near mountain resort communities. These areas tend to have higher median incomes and a greater density of health care services. These communities also tend to have more transient populations and significant numbers of low

paid and seasonal service workers. These individuals may also be underrepresented in the census data applied in this model. These individuals could experience higher rates of SUD than the general population because they tend to be younger, less likely to be married, have fewer local familial connections, and could be more prone to workplace injury.

Other Local Effects of the Methodology

Cluster 5 is rural and not otherwise well resourced for health care services. The difference of one licensed behavioral health professional in this census block group could have positively affected the encounter capacity ratio of this catchment area. This area appears to be the only census block group in the state where the difference of a single provider could have potentially changed the position of the area within deciles to one that suggests high SUD treatment capacity.

Clusters 6 and 11 are related to one another in that they both represent major regional centers of health care that are at a significant distance from Colorado's large urban areas. Cluster 6 is centered on the city of Grand Junction in a region referred to as the Western Slope. Grand Junction provides regional health services to five geographically large counties and much of eastern Utah. Cluster 11 is centered on the town of Alamosa and represents a central hub of a six-county region known as the San Luis Valley.

In each of these clusters, a 30-minute travel polygon may have impacted the results of analysis. This impact is neither positive nor negative but simply the result of the decision to set the boundaries of the catchment area to 30 minutes travel time. In the case of Grand Junction, the assessed shortage may be larger than that represented within the catchment area because it is likely that residents of neighboring communities are traveling long distances to acquire care from providers in Grand Junction. The added

demand for SUD treatment services created by those who travel from surrounding areas beyond 30 minutes travel time is not represented by this analysis.

In the case of cluster 11, the central city of Alamosa serves as a regional health care services hub. None of the travel polygons in the county extend far beyond the boundaries of Alamosa county. It is likely that those traveling from surrounding counties to receive care in Alamosa city are absorbing excess capacity of the Alamosa catchment areas. These individuals are not represented in the resident data forming the estimated treatment needs of the area. If a larger travel polygon were applied to this model, the sum of demand supply ratios would likely be lower and result in a determination of greater need for the valley.

Effects of Institutional Behavioral Health Care

Cluster 8 includes one of the largest groupings of state and federal correctional institutions in the United States. Some clinicians included in the provider capacity estimates for catchment areas in this cluster may not be available to the civilian noninstitutionalized population because they are employed by a correctional facility.

Similarly, cluster 9 includes the state mental health institute where many behavioral health clinicians are employed in an inpatient behavioral health care setting. Cluster 8 and 9 represent regions of the state that may require additional analysis to assure that behavioral health providers not available to the civilian noninstitutionalized population are not included in provider analysis of outpatient behavioral health care capacity.

Urban Areas

Figures 14, 15 and 16 represent urbanized areas of the state, corresponding to clusters 3, 2, and 9 on the annotated map in Figure 14, respectively. These areas appear to be

adequately resourced within the urban core; however, provider capacity declines rapidly at increasing distances from the central dense population cluster.

These urban region map representations provide the clearest example of the benefits of the 2SFCA method. Floating catchment areas allow for the depiction of a gradient of relative provider capacity between small census block group geographies. The variation across a "continuous surface" is clearly discernible in the representation of Denver and its close-in suburbs (Figure 15). A continuous surface refers to the representation of a transition between the highest and lowest possible values across all deciles on the map surface.

This figure and those following illustrate the core strength of the model proposed in this thesis as compared to other models described in the review of literature. The continuous surface does not force a binary representation between an area that is well resourced and an area that is poorly resourced. Additionally, the discrete analysis of small geographies allows for clear representation of changes and variations across the map surface, particularly in dense population regions.

Figure 15: Substance Use Disorder Health Professional Shortage Area by Decile in the Denver Metropolitan Area (Benjamin White, 2018)
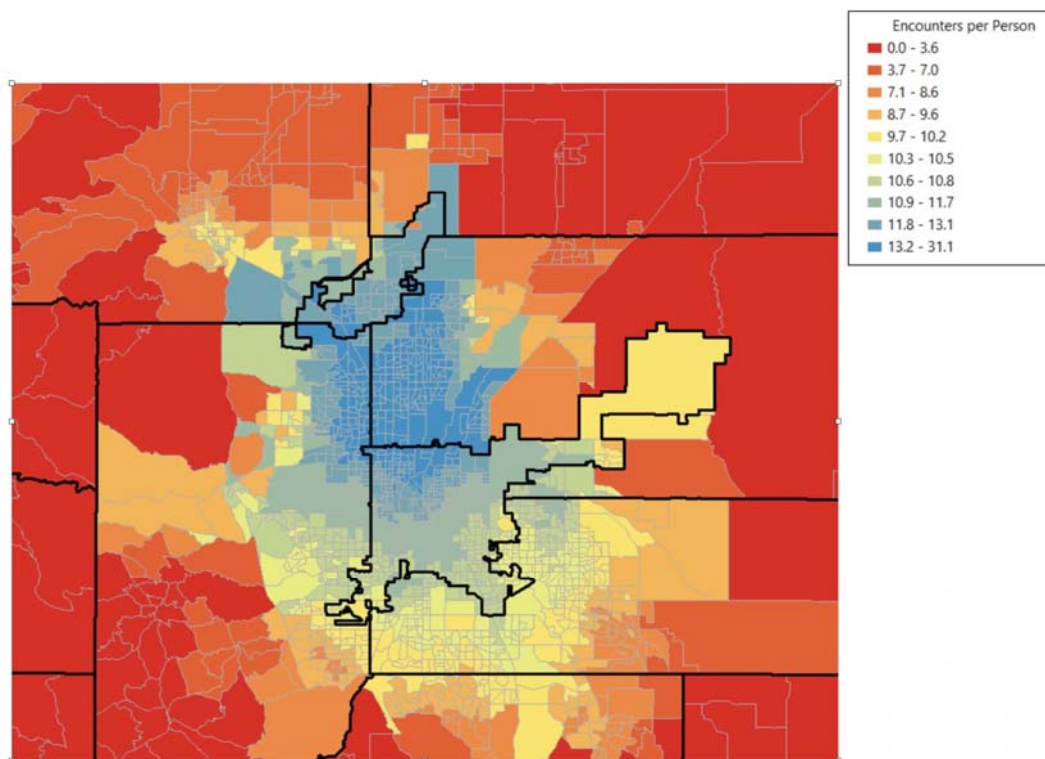
Figure 16 represents catchment areas in and surrounding the city of Colorado Springs. The features of the analysis in this area suggest that all areas of the city and its near suburbs could supply predicted demand for SUD treatment. Notably, there is little if any excess capacity in the densest population areas of Colorado Springs, where the "surplus" of treatment capacity may only be one to three visits per capita for those with a SUD.

Figure 16: Substance Use Disorder Health Professional Shortage Area by Decile in the Colorado Springs Metropolitan Area (Benjamin White, 2018)
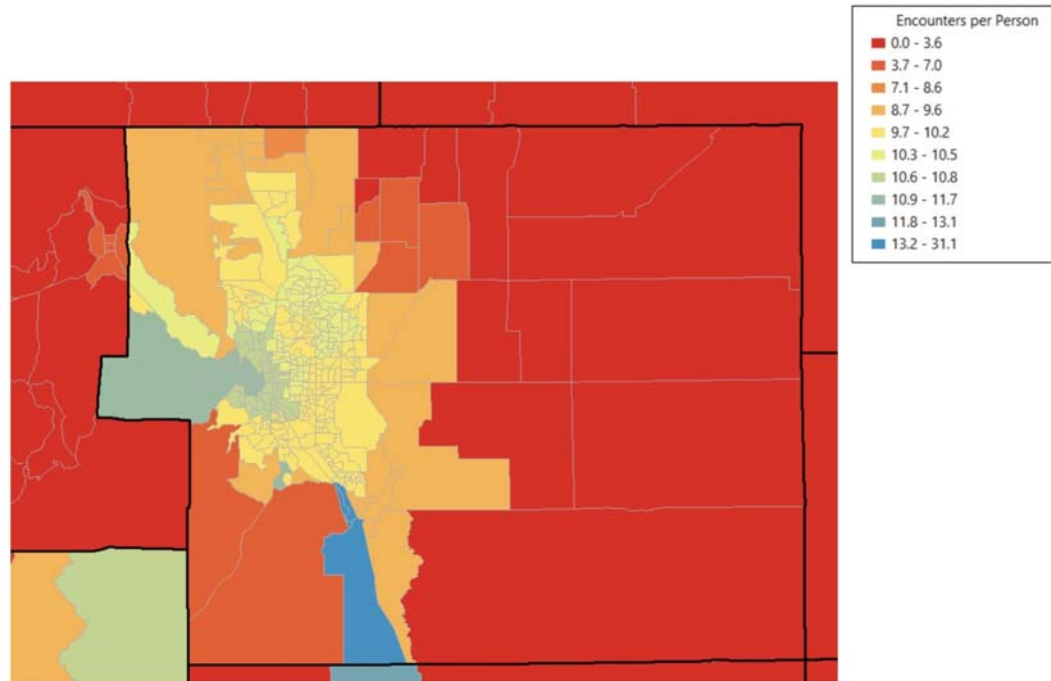
Figure 17 represents the intersection of three smaller urban communities in northern Colorado. Similar to Colorado Springs, this tri-city area appears to have provider capacity that could support care needs of those with SUD in the densest urban catchment areas; however, there is little excess capacity available to provide treatment services to those who reside just outside of the urban core and might attempt to access care within the urban center.

Figure 17: Substance Use Disorder Health Professional Shortage Area by Decile in the Fort Collins, Loveland, Greeley Area (Benjamin White, 2018)
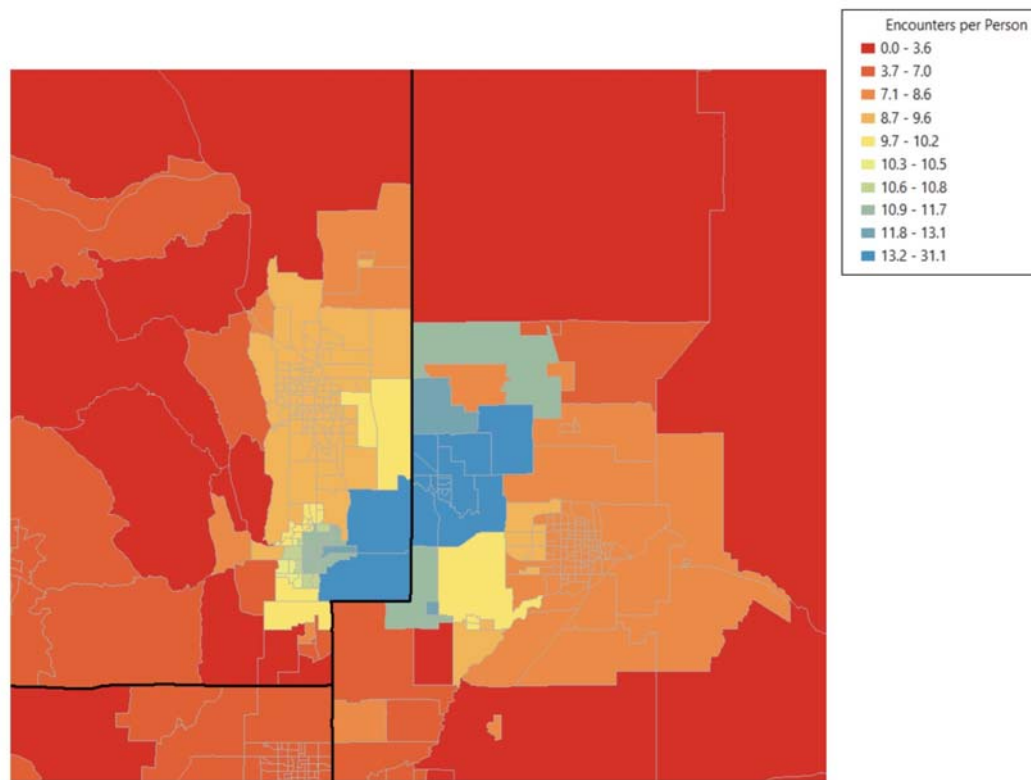
Other Findings

The analytical output in ArcView GIS reported that the average distance to the nearest source of behavioral health care in urban areas was just 0.6 miles. This stands in contrast to the average distance to the nearest source of care in rural and frontier areas of 59 miles. This 100-fold difference in proximity to behavioral health care providers speaks to the geographic isolation of many non-urbanized regions of the state.

About half of Colorado's residents live in a community that is determined to have a shortage of provider capacity according to this model. Eighty-four percent of these individuals reside in an urban community. This proportion of urban to rural residents is similar to the overall proportion of urban to rural residents in Colorado, suggesting that provider capacity shortage should not be understood to be primarily a function of rurality.

Finally, these results suggest that an additional 50,000 hours of behavioral health care clinical time is needed to bring treatment capacity of shortage areas up to a minimally adequate treatment standard for those with SUD residing within those census block groups. This estimate is likely to be conservative in that more detailed provider data collection may reveal that some behavioral health clinicians should be excluded from analysis because they are in clinical practice in noncommunity settings or not in practice at all but maintain a professional license.

Summary

The analysis produced through the design and testing of this model indicates that the alternative hypothesis of this thesis is supported. Individual features of the maps indicate strengths and some weaknesses of the approach. Overall, these results are an improvement over alternative methodologies described in the review of literature in that they are more representative of community level needs on both a relative and absolute scale. Improvements in data inputs could further improve these results and will be considered in future iterations of this work.

CHAPTER 5: IMPLICATIONS AND RECOMMENDATIONS

Introduction

The aim of this thesis is to improve decisions about the allocation of public resources towards

areas of greatest need for SUD treatment services in Colorado. The implementation and findings

of the model indicate that targeting of resources to areas with a deficit of SUD treatment capacity

is possible. The results of this effort will have immediate application to policy and decisions in

Colorado in response to the epidemic of SUD. This could lead to reduced morbidity and mortality

associated with SUD as access to care improves in underserved Colorado communities.

Summary of Study

The burden of SUD in the United States and in Colorado is an urgent matter for public health to

address through effective assessment, promotion of sound public policy, and assurance of

evidence-based intervention. Though primary prevention in response to the epidemic of SUD is

an essential response, public health must also consider secondary and tertiary prevention in the

form of support for access to treatment for those who are already experiencing SUD.

As a primary determinant of access to SUD services, behavioral health workforce

capacity must be analyzed and understood at the scale of community. Prior attempts to enumerate

and evaluate behavioral health workforce have not effectively addressed the question of SUD

treatment capacity at the scale of individuals who require care near to where they reside. This

thesis proposes a means to resolve this problem.

The methodology begins with quantitative assessment of community level needs by

predicting the demand for SUD treatment at small geographies and comparing that predicted

demand with the estimated supply of SUD treatment. By evaluating the ratio of need to supply in

the 2SFCA framework, this model enables discrete, localized spatial evaluation of SUD

workforce capacity. The resulting continuous surface output reveals more localized and variant

detail across a gradient of relative capacity. This feature of the model produces an important

advantage over alternative models of workforce capacity assessment for behavioral health. When

applied to public health practice in Colorado, this model will facilitate greater understanding of

SUD treatment needs in the state, more efficient targeting of workforce resources, and support for

longitudinal evaluation of public health interventions that promote increased access to SUD

treatment.

Discussion of Key Results

The methodology proposed and tested in this thesis produced positive results in support of the

alternative hypothesis. The effort to construct a novel approach to service area behavioral health

workforce analysis was born out of a recognized lack of assessment tools that perform well in this

regard. The validity of the method proposed in this paper is considered primarily through

qualitative comparisons of the results to other means of inferring local SUD treatment capacity.

The areas of Colorado that are identified in the results of this analysis as having a

shortage of SUD treatment capacity correspond to areas of the state that are currently designated

by HRSA as Mental Health HPSAs. Though the federal designations only consider psychiatry in

its provider assessment and do not consider variable population needs according to demographic

factors, the reasons for insufficient psychiatry capacity are likely similar to the reasons for

insufficient capacity of other behavioral health provider types at the service area level. It is

therefore reasonable to expect that similar geographies where deficit exists would be identified by

both analytical approaches.

The results of this analysis also roughly correspond to Health Statistics Regions[24] (HSR)

in Colorado where higher numbers of residents report difficulty in accessing mental health care in

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[24] Colorado HSRs are large counties and aggregations of smaller counties that form 21 regions in the state. The regions were created using statistical and demographic information. HSR are used for the purpose of comparing health and environmental data among regions of the state.

the last 12 months (Manocchio, *et al.*, 2018). Though HSRs are substantially larger than census block groups, data sources reporting the access to care experiences of individuals provide a point of comparison that is independent of the indirect access assessment strategies employed in this model and in other models discussed in the review of literature. Direct measures of reported behavioral health care access may have important utility in future tests and refinements of this model.

Though direct comparisons of the performance of this model relative to other models is difficult because of the differences in the geographic unit of analysis, it is reasonable to surmise that the results produced provide new and reliable information on behavioral health workforce capacity in Colorado. The principle reason for this conclusion lies in the straightforward assessment of supply and demand for SUD treatment at discrete service area geographic scales. If one accepts that a preponderance of residents should normally seek and reasonably expect to receive community based behavioral health services within 30 minutes from home, then a failure of systems to adequately supply SUD treatment within this travel radius would be interpreted from the perspective of individual patients to be a provider shortage.

Limitations

Though this analysis has produced evidence that the model described in this paper can effectively determine behavioral health service area workforce capacity needs at the community level, several limitations of the method and approach are recognized by the author.

Census Block Group Data

Census block group level population estimates have a higher error rate than larger census geographies such as census tracts or metropolitan statistical areas. The error rate in the data could have affected estimates of treatment encounter demand within each catchment area calculation. It is possible that the overlapping nature of the floating catchment area analysis reduced the overall

effect of individual block group population error rates. Further testing of the model with alternative geographic units such as census tracts could better evaluate the effect and magnitude of population error rates at the block group level.

Stratification of Demand According to Population Characteristics

The estimated number of individuals experiencing SUD at the block group level was stratified by sex but not other factors associated with SUD risk such as age, employment status, marital status, or adult disability. With the exception of age, population level data for these demographic characteristics are not available at the census block group level so they could not easily be applied to future iterations of this methodology. The addition of age adjustment could increase the accuracy of predicted demand especially in regions of the state that have a higher median age such as rural agricultural communities and a lower median age such as mountain resort communities. Future iterations of this model will attempt to stratify predicted SUD by both sex and age.

Behavioral Health Provider Productivity

A lengthy literature search revealed few examples of standardized productivity rates for behavioral health care providers by discipline. The choice to apply productivity rates established by the VA was utilitarian for the purposes of constructing this model. The patient population of the VA is not analogous to the general population. Veterans are insured by virtue of their presence in the VA health care system and they experience SUD more frequently than the general population (Teeters, Lancaster, Brown & Back, 2017). Furthermore, clinicians who are employed by a large health care system often benefit from productivity tools that are less available to small or individual practices. This could result in higher mean productivity than might be found in certain community-based settings. Future analysis of this model will attempt to refine

productivity rates of behavioral health professionals through claims analysis, direct survey data collection, and statistical methods.

Individual Behavioral Health Capacity

Individual provider encounter capacity was assigned in this model according to VA productivity standards. Because no direct survey of clinicians was feasible in the scope of this thesis, some providers may have been included in the assessment of provider capacity that should not have been excluded. Examples include providers who are retired but maintain a license, providers who are not practicing in clinical care (*e.g.*, teaching, administration, research), and providers who practice in institutional settings. The final category would be individuals who are providing clinical capacity but are not available to the civilian noninstitutionalized population. Future iterations of this model will attempt data collection from clinicians to reduce the capacity of those providers who are not appropriate for consideration in the treatment supply side of the ratio.

Minimally Adequate Treatment Benchmark

The benchmark standard for minimally adequate treatment for SUD was reported as eight visits of 30 minutes or longer. Though the NCS-R reported this rate as derivative of analysis of AHRQ and APA sources, its determination was made prior to the enactment of the ACA and the Mental Health Parity and Addiction Equity Act (2008). These two changes in federal law increased standard minimum coverage for behavioral health care services. It may be that the standard of eight visits established a decade ago was somewhat suppressed by lack of insurance or inadequate insurance. Total coverage for behavioral health care in both private and public plans has improved since 2008, which may have led to changes in care acquisition or care referral, causing typical SUD treatment intensity per patient to rise.

There may be reason to maintain the standard minimum treatment rate of eight visits per episode of SUD in the model even if changes to this recommendation become known in the future. This is because the modest standard of treatment eight visits results in significant portions of Colorado being deficient in encounter capacity. If a higher standard for minimum treatment were applied to the predicted demand formula, fewer areas of the state would be determined to have adequate or surplus treatment supply. This would effectively reduce the resolution of analysis in determining areas of greatest need and thus reduce the value of the tool in identifying those areas with the most significant shortages.

Implications

It appears that the proposed methodology in this thesis is unique among strategies for SUD workforce analysis in the United States. This is certainly the case with respect to SUD workforce analysis in Colorado. As such, this thesis may be particularly timely as the awareness of the problem of SUD continues to grow.

As this model is refined and informed by new data inputs, there will be immediate applications in the Colorado Health Service Corps[25] (CHSC) program. The CHSC requires analytical tools to determine where best to direct clinician practice incentive resources. This model will inform choices on the placement of behavioral health care professionals as soon as the fall of 2018. This model may also be adapted for other health service categories supported by the CHSC such as primary care and oral health. Many of the deficiencies of the federal methodologies with regard to SUD identified in the review of literature are also deficiencies with regard to primary care and oral health.

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[25] The CHSC is a program administered by the author that reduces student loan debt of clinicians in exchange for a contracted period of clinical service to underserved populations in Colorado.

There also could be opportunities to use this analysis to inform public policy on the midst of the public-sector response to the opioid epidemic. The Colorado Legislature has convened an "Opioid and Other Substance Use Disorders Interim Study Committee" to study the issues of addiction and drug use in Colorado. The approach and output of the determination of SUD clinician shortage described in this paper could inform choices about the investment of public dollars in behavioral health care systems and health professional training in public institutions of higher learning. This thesis will be provided to the Colorado Department of Public Health and Environment's Legislative Liaison upon its completion in order to facilitate opportunities for broader use.

As discussed throughout this paper, the problem of illicit drug use is not limited to Colorado. HHS announced $350 million in funding to for community health centers to respond to the "opioid crisis" (U.S. Department of Health and Human Services, June 15, 2018) just days prior to the submission of this manuscript. According to the press release, these new funds are intended to "increase personnel to help expand access to SUD and mental health services." Federal partners may be receptive to analysis that better informs the distribution of these new dollars on a national scale. A summary of results of this thesis will be provided to the state association of community health centers upon completion of this thesis in order to facilitate opportunities for application within the distribution of these new federal funds.

Recommendations

The methodology proposed in this thesis was intended from its conception to have practice applications in Colorado. Some of the limitations to the model as discussed in the previous section can be addressed though additional model validation testing and improved data quality. Areas of particular focus will include the following.

Data Collection

Data will be collected by survey from behavioral health clinicians to determine practice setting, practice hours, and the nature of care delivered. This data will be valuable in refining encounter rates from the baseline set by the VA behavioral health clinician productivity standard. This data will also be valuable in excluding clinicians who are not in practice and reducing productivity estimates for clinicians that are not caring for patients full time in a community-based setting.

Enhanced 2SFCA

The model will be tested with an "enhanced" 2SFCA method and compared against the results of the standard 2SFCA. The enhance method seeks to address the problem of treating relative access to care of all residents of a given catchment area as uniform. In other words, the standard 2SFCA model assumes the same level of access for those residents who are most distant from a provider and those that are closest. The enhanced 2SFCA model applies weights to various distances from the central point of care. The further one migrates away from that care, the lower the access to treatment is presumed to be. This enhanced model considers "distance decay" of accessibility as transit times increase. The enhanced model has an intuitive appeal particularly in rural and mountainous areas where providers are not evenly distributed within a catchment area and distances from one boundary to the opposite boundary can be large.

Partner Feedback

The results of this model will be distributed among stakeholders, partner organizations, and sister state public health programs. The purpose of this process will be to gather information on face validity of the model among third party reviewers. Feedback from this process may further refine aspects of the model and may inform future enhancements

that could increase utility and application of this work to other public health initiatives in

Colorado.

Conclusion

There is no indication that the current epidemic of SUD is waning in Colorado or nationally. The

conditions that have led to or intensified the current crisis require broad and evidenced based

policy intervention from public health and other public sectors. Though policy responses will be

varied and extensive, those involving access to SUD care will hopefully be better informed in

Colorado as a result of this work.

The results of analysis support the alternate hypothesis that a novel index of population

level data can be constructed to more effectively determine behavioral health service area

workforce capacity needs at the community level for those who are experiencing substance use

disorder than existing models. In light of these findings, this model will be applied to the

challenge of effective resource allocation for enhanced SUD provider capacity in Colorado. This

model may also be successfully applied to other areas of health systems and health workforce

research as the landscape for health care delivery in the United States continues to evolve in the

context of the SUD epidemic. Ultimately, I hope that this work will measurably contribute to

reductions in health inequity caused by poor access to care for those who suffer from SUD.

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