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Primary Care Shortage And Physician Migration In Texas: Analysis And Policy Implications

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PRIMARY CARE SHORTAGE AND PHYSICIAN MIGRATION IN TEXAS:

ANALYSIS AND POLICY IMPLICATIONS

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ANALYSIS AND POLICY IMPLICATIONS

by

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PREFACE

I come from Lebanon, a small country on the Mediterranean. Once known as the "Paris-of-the-Middle-East", Lebanon is now underdeveloped, labeled as "Third-World". In 2012, I *moved* to Houston to pursue my PhD, a path that I share with my now-husband, who is a *physician*. In 2013, we *moved* to New York, for my husband's *internship*. In 2014, my husband transferred to the *residency* program at UT, so we *moved* back to Houston. Between these *moves*, I learned about the American healthcare system, and was shocked to discover that some parts of Texas had fewer doctors than remote areas in my third-world-home-country. At one point, my husband and I considered *moving* to a *shortage area*, to fulfill a waiver of the *physician*-in-training visa. Today, as I am finalizing my dissertation, we are planning another *move*, this time to Florida.

Is our story unique? Or do most *physicians move* frequently during their training and practice years? What were the factors affecting these *moves*? Were policies providing adequate guidance to fill the *physician shortage* gap?

These questions inspired me to study physician migration patterns in Texas, identify the person, place, and policy factors, and determine whether any association existed with choosing shortage areas.

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Finally yet importantly, to Jad, my life-partner and better half, thank you for your unconditional love. Thank you for being my motivation and the inspiration to reach my potential. I cannot wait to climb yet another mountain with you!

PRIMARY CARE SHORTAGE AND PHYSICIAN MIGRATION IN TEXAS: ANALYSIS AND POLICY IMPLICATIONS

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This study aims to gain a better understanding of primary care (PC) physician movements in Texas between 2010 and 2014. The first and second objectives were to identify the person- and place-specific factors associated with those physicians moving to PC shortage counties. The third objective was to clarify the policy landscape related to PC shortage and identify any associations these policies had with changes to PC physicians' movements.

The methods combined quantitative and qualitative approaches. The study used data on licensed physicians from the Texas Medical Board, and data on Health Professionals Shortage Areas from the Texas Health Professions Resource Center. Descriptive, bivariate, and multivariate analyses were conducted to answer the research questions on person- and place-specific factors. The policy component involved a systematic desk review, and comparative analyses to identify whether the introduction of policies was associated with changes in the physician moves.

From 29,343 unique PC physicians, 73% never moved counties. Physicians' gender, age, medical school (public/private), degree (DO/MD), and Medicaid enrollment status, all had significant associations with their movements. At the Texas level, physician outflow was greater than their influx. As for shortage counties, they had lower rates of crime and infant deaths compared to non-shortage counties. Moreover, a population of 50,000 or more, and the presence of Federally Qualified Health Centers increased the odds of PC physicians moving to shortage counties.

The desk review showed that federal policies and programs on PC shortage were stable throughout the study timeframe. While the state policy scene was more dynamic, with over 50 relevant bills enacted between 2007 and 2015. The comparative policy analysis revealed a statistically significant difference in the movement origins for only one bill requiring international physicians to work in underserved areas.

Person- and place-specific factors have a significant association with physician movements in Texas. However, it is challenging to determine the effect of a single policy on the movement patterns of physicians. Additional research is needed, involving primary data collection, covering a longer period, and accounting for other confounding person- and place-specific factors to improve our understanding of physicians' motives to move to shortage areas.

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BACKGROUND

Literature Review

For decades, Primary Care (PC) has held an important position at the axis of every health system. Its value lies in increasing accessibility and continuity of care to improve population health (Rajakumar, 1987; Safran *et al.*, 1998; Macinko, Starfield and Erinosho, 2009; O'Malley, 2013). PC physicians are essential for ensuring the provision of PC services. However, several factors affect PC physicians' availability and can sometimes prevent equal access to PC, leading to geographical shortages in services (Foster and Gorr, 1992; Mitka, 2007; Bodenheimer and Smith, 2013; Frisch, 2013).

The Problem: Primary Care Shortage

According to the American Academy of Family Physicians, PC is the "care provided by physicians specifically trained for and skilled in comprehensive first contact and continuing care for persons with any undiagnosed sign, symptom, or health concern not limited by problem origin or diagnosis" (AAFP, 2015). Hence, PC services include disease prevention, health promotion and maintenance, counseling, patient education, and diagnosis and treatment of illnesses. This all-inclusive definition of PC highlights its public health significance in improving individual and population health (Gulliford, 2002; Macinko, Starfield and Shi, 2003; Macinko, Starfield and Erinosho, 2009). For these reasons, the PC sector is becoming increasingly important from a policy perspective to insure efficiency and equity in a health system (Safran *et al.*, 1998; Starfield, 2012).

Despite being a valuable part of the healthcare industry, PC services were historically associated with a shortage (Bowman, 2008; Kuehn, 2008; Bodenheimer and Pham, 2010; AAMC, 2017, 2018; Pham, 2018). In the economic sense, shortage occurs when the demand of a certain good exceeds its supply (Simoens and Hurst, 2006). This same concept applies for healthcare commodities, with additional considerations due to the nature of health being a public good (Blumenthal, 2010; Anomaly, 2011). In regards to PC shortage, it is usually determined based on a ratio of PC providers to the population. In accordance with the Code of Federal Regulations (42 CFR 5), an area is designated as a PC Health Professional Shortage Area (HPSA)[1], when the physician-to-population ratio is below 1:3,500 (equivalent to ≈29 physicians per 100,000 population) (HRSA, 2015; 42 CFR 5, 2019).

Concerning the geographic distribution of PC shortage, research shows that the problem is significantly higher in rural areas (Keyzer, 1997; Zurn *et al.*, 2004; Rosenthal, Zaslavsky and Newhouse, 2005; Bodenheimer and Pham, 2010). For instance, a national study by MacDowell et al. reported that 70% of healthcare providers in rural areas of the US experienced PC shortage (MacDowell *et al.*, 2010). However, according to recent findings, around 33% of HPSAs are in non-rural areas across the country. This highlights the fact that PC service maldistribution can occur in rural and urban areas alike (Miller, 2015b).

In the state of Texas, the presence of a significant PC shortage problem was evidenced by several studies (Conway, 2010; Holt, 2012; Kaissi, 2012; King and Menon, 2012; AAMC, 2013; TMA, 2014; Miller, 2015b). One report found that, of the 254 Texas

[1] In this document, whenever the HPSA acronym is used, it is referring to the **Primary Care** Health Professionals Shortage Areas only.

counties, 35 had no physicians at all, and 80 counties had five physicians or less. (Commins, 2015; Deam, 2015; Goodman, 2015; Hethcock, 2015a, 2015b). When compared to the rest of the country, Texas ranked 41st in the physician-to-population ratio (183 physicians per 100,000 population), and 47th in active primary care physicians per 100,000 population. Moreover, Texas ranked the second highest nationally in the number of designated PC HPSAs, with a total of 375 in 2015 (HRSA, 2015; The Henry J. Kaiser Family Foundation, 2015).

When it comes to the supply of physicians, Texas has one of the highest numbers of per capita medical students and resident physicians in the nation (AAMC, 2013). Texas also attracts incoming physicians from other states and countries. In 2013, 73% of newly licensed physicians in the state were graduates of medical schools outside of Texas (TMA, 2014). Accordingly, PC shortage is less likely to be the result of limited supply of PC physicians, and is rather an issue of maldistribution. In order to identify possible solutions to the problem of PC shortage and meet current and future physician demands, it is important to take a comprehensive look at physician migration and the different factors that drive their movement behavior.

Physician Migration

According to the Texas Primary Care Office at the Department of State Health Services, a PC physician is any "Medical or Osteopathic Doctor (MD or DO) with training in one or more of the following specialties: Family Practice or Family Medicine, General Practice, Obstetrics and Gynecology, General Internal Medicine, General Pediatrics, Medicine-Pediatrics, Psychiatry and Geriatrics" (DSHS, 2015, 2018b). As such, PC physicians answer to the basic and essential health needs of the population. Furthermore, their role is specifically targeted to the care of vulnerable segments of the population: children, women and the elderly.

Despite the vital role of PC physicians, this profession has been historically the subject of a shortage problem debated since the early 90s (Fruen, Hadley and Korper, 1980; Newhouse, 1990; Rabinowitz *et al.*, 1999; Sheldon, 2003; Lakhan and Laird, 2009; Petterson *et al.*, 2012; Frisch, 2013). Researchers have predicted shortages in the PC workforce, and policy makers responded by devising different programs to address the problem. Some of the most commonly adopted approaches is increasing the number of trained PC physicians (Russell and Parkinson, 1994; Bodenheimer and Smith, 2013; Miller, 2015b). This approach is certainly important in providing access to a higher portion of the population. However, overlooking other factors contributing to the physician shortage is the reason most of the adopted solutions were not effective, nor sustainable (Shipman and Sinsky, 2013a; Chen, Mehrotra and Auerbach, 2014; Phillips, Bazemore and Peterson, 2014).

The geographical distribution of PC physicians is an important contributor to meeting the overall population needs and ensuring equity (Grumbach *et al.*, 1998; Rosenthal, Zaslavsky and Newhouse, 2005; Watkins, 2005; Vanasse *et al.*, 2007; Ricketts and Randolph, 2008). PC physicians are driven by a number of factors to move from one region to another. Some tend to move to areas with lower competition, higher incomes and lower unemployment. While others tend to choose their practice location based on personal motivators, such as, personal mission, self-identity and work-life balance (Ernst and Yett, 1984; Curran and Rourke, 2004; Walker *et al.*, 2010; Ricketts, 2013). Therefore, understanding the factors involved in the geographic movements of physicians over time could serve as a guide to policies and regulations that aim to increase physician recruitment and retention in underserved areas (Ricketts and Randolph, 2008; Cossman and Street, 2010; Baker *et al.*, 2012).

Factors

A relatively large number of studies (44) discuss the different factors that may be associated with the movement of physicians to and from shortage areas. Studies highlighted the need to distinguish between the *recruitment* and *retention* of physicians in underserved areas. Findings showed that problems in successfully recruiting physicians are considered the primary driving factors for shortage. While, creating policies and programs that focus on improving retention could be more promising to resolve the shortage problem. This is because, the retention factors (i.e. job satisfaction, career growth) could be more modifiable compared to common recruitment factors (i.e. place of birth, medical school) (Pathman, Konrad and Agnew, 1994; Rabinowitz *et al.*, 1999; Pathman *et al.*, 2004). However, the most effective approach would be to create programs that are comprehensive and aim to improve both the recruitment and retention of physicians in underserved areas (Porterfield *et al.*, 2003). Table 1 provides a list of factors that were most commonly mentioned in the literature as having an association, whether positive or negative, with physician movements to and from underserved areas.

Table 1: Factors affecting Movements of Physicians to and from Underserved Areas

	Factors	Sources
Personal (17 studies)	Individual ability Performance measures (GPA, MCAT scores) Age; Sex; Race; Religion Socioeconomic status; Marital status Place of birth/upbringing International Medical Graduate (IMG) Family support; Sociocultural integration	(Ernst and Yett, 1984; Pathman, Konrad and Agnew, 1994; Cutchin, 1997c; Humphreys and Rolley, 1998; Rabinowitz *et al.*, 1999; Mick and Lee, 1999a, 1999b; Mick, Lee and Wodchis, 2000; Fink *et al.*, 2003; Pathman *et al.*, 2004; Tolhurst, Adams and Stewart, 2006; Daniels *et al.*, 2007; Vanasse *et al.*, 2007; Hart *et al.*, 2007; Thompson *et al.*, 2009; Hancock *et al.*, 2009; Ricketts, 2013)
Education **Training** (10 studies)	Graduating medical school Specialty and sub-specialty Rural-focused medical school track Community service orientation Training location	(Ernst and Yett, 1984; Talley, 1990; Madison, 1994; Pathman *et al.*, 1999; Acosta, 2000; Jiang and Begun, 2002; Curran and Rourke, 2004; Rabinowitz, Diamond and Markham, 2005; Tolhurst, Adams and Stewart, 2006; Daniels *et al.*, 2007)
Career (8 studies)	Career opportunities Physician Job Satisfaction Personality and practice compatibility Reasonable workload and call schedule	(Ernst and Yett, 1984; Cutchin *et al.*, 1994; Cutchin, 1997c; Hart *et al.*, 2002; Pathman *et al.*, 2004; Cossman and Street, 2010; Walker *et al.*, 2010; Behmann *et al.*, 2012)
Financial (6 studies)	Financial incentives Economic motivations Loan Repayment Program	(Fruen, Hadley and Korper, 1980; Ernst and Yett, 1984; Rabinowitz *et al.*, 2001; Bärnighausen and Bloom, 2009; Duffrin *et al.*, 2014; Miller, 2015a)
Place (8 studies)	Rural vs. Urban Presence of competition Physician-to-population ratio Percentage growth in the physician population Percentage growth in the general population Supply of hospital facilities Hospital diversity Wealth (GDP per capita) Aging population Relative chronic disease prevalence Death rates/ premature death Uninsured population; Payer mix	(Ernst and Yett, 1984; Foster and Gorr, 1992; Humphreys and Rolley, 1998; Jiang and Begun, 2002; Coile, 2003; Cohen, 2009; Gray, Stockley and Zuckerman, 2012; Duffrin *et al.*, 2014)
Policies (6 studies)	Healthcare system reform Medicare and Medicaid State Licensing	(Foster and Gorr, 1992; Russell and Parkinson, 1994; Hofer, Abraham and Moscovice, 2011; Mareck, 2011; Hall and Lord, 2014; Steinbrook, 2014)

Solutions

Recent years have witnessed an increased interest from researchers and policy-makers to devise and implement solutions to address PC shortage (Bärnighausen and Bloom, 2009; Wilson *et al.*, 2009; Grobler, Marais and Mabunda, 2015). The literature is divided between those who advocate for increasing the supply of PC physicians and those who recommend alternative solutions (Foster and Gorr, 1992; Baldwin *et al.*, 1998; Gulliford, 2002; Dill *et al.*, 2013; Green, Savin and Lu, 2013). The most commonly reported strategies in the literature can be grouped into three broad categories: those targeting *physician* recruitment and retention, those aiming to increase the employment of *alternative health providers*, and those that recommend the use of *outreach* services (Table 2).

The majority of studies (30) were concentrated in the first category, describing interventions and strategies directly influencing the physician workforce supply and retention. These strategies could be divided into four groups: *educational*, *financial*, *regulatory*, and personal and professional *support*. Educational programs were the most prominent, and ranged from modifying medical school admission policies to updating curricula by incorporating more exposure to rural health (Rabinowitz, 1993; Rabinowitz *et al.*, 1998, 1999, 2001; Stearns and Stearns, 2000; Wilson *et al.*, 2009; MacDowell, Glasser and Hunsaker, 2013; Grobler, Marais and Mabunda, 2015). On the other hand, strategies that provide financial incentives to physicians, including scholarships, loan repayment and higher salaries, were found to be the most commonly adopted by policy-makers, and at the same time were the most valued by physicians (Foster and Gorr, 1992; Humphreys and Rolley, 1998; Pathman *et al.*, 2000; Hayashi, Selia and McDonnell, 2009). In terms of regulatory strategies, the United States is yet to establish a mandatory rural service program, and is relying on creating policies and visa waivers that attract international medical graduates to serve in these underserved areas (Fink *et al.*, 2003; Terhune and Abumrad, 2009; Thompson *et al.*, 2009). Lastly, the support interventions consisted of a number of initiatives implemented in the work setting (i.e. career development opportunities, effective mentorship programs) and at the personal level (i.e. community support, adequate schooling system) (Wilson *et al.*, 2009; Moran *et al.*, 2014).

The second category included strategies that recommended the employment of non-physician PC health providers to fill the needs of underserved populations. Accordingly, licensed nurses (registered nurses, nurse practitioners, and vocational nurses), physician assistants, midwives, pharmacists, psychologists and social workers, would be empowered to provide more autonomous PC services (Auerbach *et al.*, 2013; Bodenheimer and Smith, 2013; Shipman and Sinsky, 2013b). However, this approach usually receives strong opposition from the physician community which recommends stopping the expansion of non-physician practitioners' responsibilities beyond their education and training (TMA, 2014).

The third and final category of interventions involved the use of outreach programs to provide PC services in remote areas. Innovative technologies such as telehealth/telemedicine and guided patient self-care, proved to be effective in certain contexts (Dolea, Braichet and Stormont, 2009; Wilson *et al.*, 2009). For instance, patients suffering from hypertension, who monitor their blood pressure at home with remote supervision from their PC provider, achieve better blood pressure control than those cared for solely by physicians (McManus *et al.*, 2010; Bodenheimer and Smith, 2013). However, until now, little evidence is available on the associated costs and benefits of such applications. Moreover, several patient advocates have voiced their concerns about privacy and confidentiality issues which could be potentially breached when employing such technologies (Simoens and Hurst, 2006).

Table 2: Interventions aimed at solving the Primary Care Shortage Problem

	Interventions	Sources
Physicians (30 studies)	***Educational strategies*** Targeted admission policies for medical schools Location of medical schools and residency programs Undergraduate and postgraduate training exposure and location Rurally located medical school Rurally relevant curricula and rural clinical placements Multifaceted education interventions ***Regulatory strategies*** Mandatory/compulsory period of service in underserved areas Recruiting foreign healthcare professionals ***Financial incentives*** Scholarships, loan repayment and bonding schemes Higher salaries for individuals working in underserved areas Rural allowances Retention grants ***Personal and Professional support*** Functional work environment Effective management, supervision and mentoring Improved professional development Continuing medical education Provision of locum relief Support from colleagues and networks of practitioners Adequate housing and school facilities	(Rowley and Baldwin, 1984; Ernst and Yett, 1984; Rabinowitz, 1993; Humphreys and Rolley, 1998; Rabinowitz *et al.*, 1998, 1999; Council On Graduate Medical Education, 1998; Pathman *et al.*, 2000; Stearns and Stearns, 2000; Sempowski, 2004; Simoens and Hurst, 2006; Daniels *et al.*, 2007; Henderson and Tulloch, 2008; Lehmann, Dieleman and Martineau, 2008; Matsumoto, Inoue and Kajii, 2008; Bärnighausen and Bloom, 2009; Matsumoto and Kajii, 2009; Wilson *et al.*, 2009; Dolea, Braichet and Stormont, 2009; Hancock *et al.*, 2009; Savageau *et al.*, 2011; Baker *et al.*, 2012; Behmann *et al.*, 2012; MacDowell, Glasser and Hunsaker, 2013; Crump *et al.*, 2013; Moran *et al.*, 2014; Grobler, Marais and Mabunda, 2015)
Alternative Health Providers (12 studies)	Nurse-managed health centers Patient-centered medical homes Advanced rural nurse practitioner Empowering licensed personnel (registered nurses, physician assistants, midwives, pharmacists, …)	(Bergeson *et al.*, 1997; Keyzer, 1997; Baldwin *et al.*, 1998; Sox, 2000; Lenz *et al.*, 2004; Daniels *et al.*, 2007; Kaissi, 2012; Auerbach *et al.*, 2013; Shipman and Sinsky, 2013b; Bodenheimer and Smith, 2013; Dill *et al.*, 2013; O'Malley, 2013)
Outreach (12 studies)	Telehealth Mobile Clinics Technology-guided patient self-care After-hours clinics and health centers	(Cutchin, 1997b; Council On Graduate Medical Education, 1998; Acosta, 2000; Hart *et al.*, 2002; Simoens and Hurst, 2006; Daniels *et al.*, 2007; Wilson *et al.*, 2009; Dolea, Braichet and Stormont, 2009; Hayashi, Selia and McDonnell, 2009; Morris *et al.*, 2011; Bodenheimer and Smith, 2013; Steinbrook, 2014)

Overall, the evidence on the effectiveness of all these interventions is limited (Dolea, Braichet and Stormont, 2009; Grobler, Marais and Mabunda, 2015). There is an urgent need to conduct rigorous studies to assess these strategies across all the categories. This could be achieved by performing an evaluation as an integral part of implementing any strategy. Such findings would serve as guidance for policy-makers when developing new strategies or adapting existing interventions (Dolea, Braichet and Stormont, 2009; Grobler, Marais and Mabunda, 2015).

Public Health Significance

Numerous and extensive studies have been conducted to define the PC shortage problem, identify factors affecting physician movement and propose solutions to guide policies and programs. The findings of these studies were not always conclusive and a major knowledge gap remains. Until now, it was not possible to generate models for identifying person-specific factors associated with physician movements into or out of underserved areas. Nor were researchers able to identify place-specific factors that increase the likelihood of a physician moving to underserved areas. Finally, the role of policies and programs in PC geographic shortages remains unknown.

Considering the significant challenges Texas faces in meeting its primary health care workforce needs, a comprehensive analysis of PC physician movements can provide insights on potential solutions (TMA, 2014). This study focused on the state of Texas, looking at movements across its counties. Diverging from the majority of previous studies that considered physician movements at the national and international levels (Mick and Lee, 1999a; WHO, 2002; Zurn *et al.*, 2004; Sheldon, 2006; Simoens and Hurst, 2006; Vanasse *et* *al.*, 2007; OECD, 2008; Ricketts and Randolph, 2008). Another important distinction is that the movements of physician were identified on a monthly basis, over a period of five years. While previous methods only measured the net movements between two points in time. In addition, the use of the Texas Medical Board (TMB) database is an advantage to the usual employment of the American Medical Association (AMA) Masterfile (Ricketts and Randolph, 2007; Petterson *et al.*, 2013). The TMB database is updated every 30 days and represents the most accurate data as it is generated by the sole licensing body for physicians in the state of Texas (TMB, 2016) (§166.1.(d)). In contrast, the AMA Masterfile relies on non-mandatory self-reporting from physicians on updates such as the change of practice location (AMA, 2015). Lastly, information on recent policies and their effects on PC shortages in the state of Texas is lacking. A review of state and federal policy changes, their occurrence at a certain point in time and an analysis of their potential association with physician movements constitutes a comprehensive evaluation of the situation in Texas.

This research attempts to fill the gaps in the literature by providing a better understanding of the PC shortage situation in Texas. The findings could serve as a guide for policy-makers in Texas on influencing the geographic distribution of PC physicians in a quest to eliminate regional shortages in PC services.

Objectives

The study had three major aims outlined below with the specific research questions.

Aim 1

To identify movement outcomes of primary care physicians across Texas, and conduct descriptive analyses for person-specific and place-specific characteristics.

Question 1.1. What were the movement outcomes of primary care physicians across Texas between 2010 and 2014?
Question 1.2. What were the descriptive statistics for each movement outcome, and for a number of person-specific and place-specific characteristics?

Aim 2

To identify person-specific and place-specific factors having a significant association with the movement outcomes of primary care physicians across Texas.

Question 2.1. What were the person-specific factors in PC physicians having a significant association with their movement outcomes in Texas between 2010 and 2014?
Question 2.2. What were the place-specific factors of counties having a significant association with PC physician movement outcomes in Texas between 2010 and 2014?
Question 2.3. What were the person-specific factors in PC physicians having a significant association with their movements outside of Texas?

Aim 3

To review federal and state policies related to the primary care physician movements and identify any associations with their movement outcomes.

Question 3.1. What are the federal and state policies issued between 2007 and 2015 directed towards encouraging and supporting PC physicians to practice in shortage areas?
Question 3.2. Did the PC physician movement outcomes vary significantly after the implementation of the identified policies?

METHODS

Study Design

The study used retrospectively collected data on PC physicians in Texas between the years of 2010 and 2014. The overall design of the study is thus a retrospective cohort. The type of analysis for each of the three aims is different as outlined below.

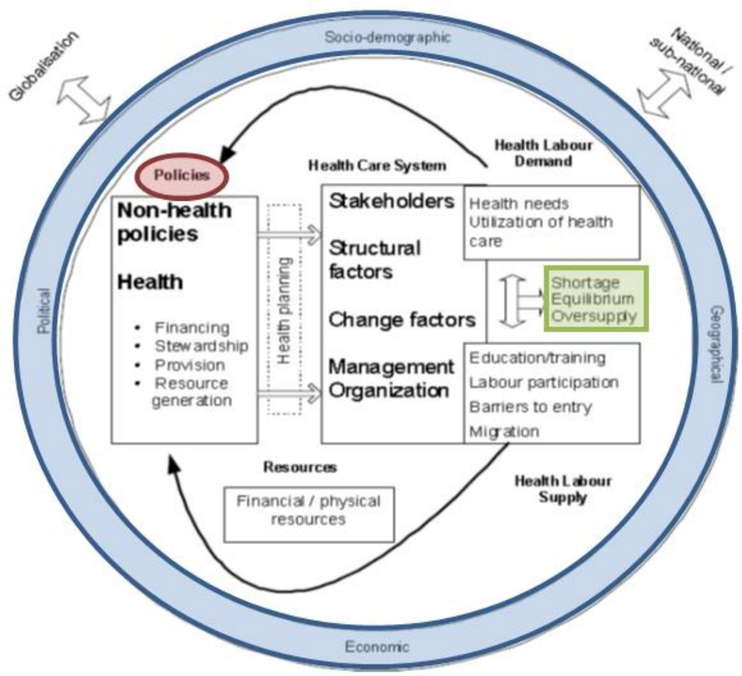
For aim 1, the researcher conducted summary and descriptive statistics on all PC physician movement outcomes, and then ran comparative bivariate analyses to identify any differences in person-specific (PC physician movers vs. non-movers) and place-specific (shortage vs. non-shortage counties) characteristics. As for aim 2, multiple logistic regressions were conducted to identify person- and place-specific factors having a significant association with movement outcomes of PC physicians. Lastly, the researcher conducted a desk review of federal and state policies, and pre-post analyses of PC physician movements to answer the research questions under aim 3.

Conceptual Framework

Based on the literature, experts agree that physician movements are governed by a number of *factors* that are interrelated and range across three layers: person, place and policy (Cutchin, 1997a; Jiang and Begun, 2002; Bärnighausen and Bloom, 2009; Dolea, Braichet and Stormont, 2009; Wilson *et al.*, 2009; Grobler, Marais and Mabunda, 2015; Ricketts, 2015). Policy-makers historically relied on studying these factors to predict physician movements, project possible workforce needs, and ultimately devise effective *interventions*. The assumption is that a physician decides to move (or stay) based on his/her exposure to certain *factors* and based on the existing policy *interventions* that would facilitate (or hinder) the move (Bärnighausen and Bloom, 2009; Wilson *et al.*, 2009; Grobler, Marais and Mabunda, 2015). On the outcome side, a physician moving from one area to another, could result in either a shortage, surplus or equilibrium situation in the origin and destination regions.

When a shortage occurs, this indicates an imbalance between the demand and supply of the health workforce. The World Health Organization's framework (Figure 1), highlights this process at the international level (WHO, 2002). A number of factors in a health system affect the workforce demand and supply, and these factors are governed by different policies.

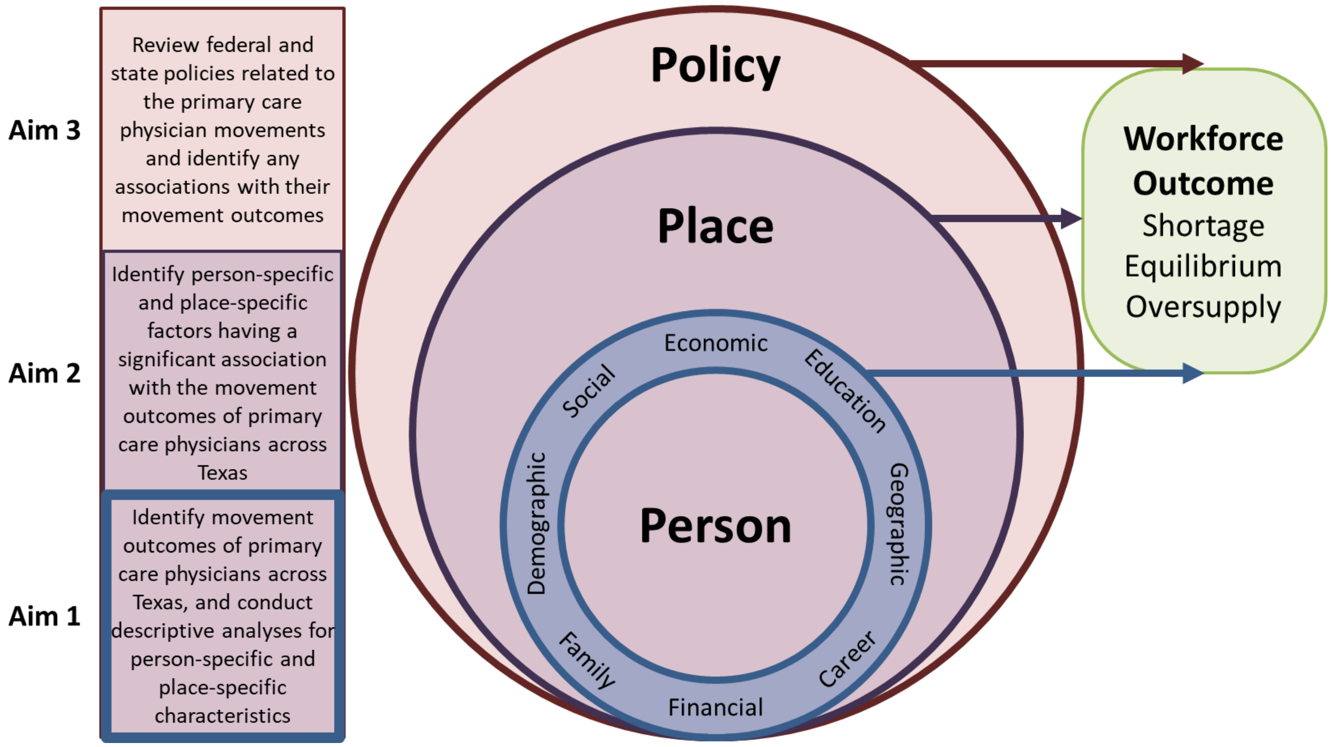
Figure 1: World Health Organization framework on imbalances in health workforce



This observed hierarchy affecting individual physician behaviors is similar to the one behind the Social Ecological Model (Glanz, Rimer and Viswanath, 2008). The ecological model highlights the importance of behavioral settings. Including the home and community environments, as well as interactions across individual, social, and policy levels of influence.

In this study, the individual behavior consists of a PC physician's decision to move from one county to another. The different socio-ecological and policy settings affect this decision. In turn, the outcome of a physician's move could represent a change in the access to PC services (shortage, surplus, or equilibrium). These assumptions establish the conceptual framework of this study (Figure 2). In this context, the "Person" domain includes all the personal factors that constitute the physician's self (i.e. identity, upbringing) (Jiang and Begun, 2002). The "Place" domain is the county and its characteristics (i.e. health institutions, shortage status). On the border between "Person" and "Place" are a set of twofold factors, such as financial status, and could be measured from the personal and the place perspective. For example, the socio-economic status of a physician's family is a *personal* factor, while the county per capita income is a *place* factor. The last domain, "Policy", includes interventions and programs that regulate the movement of physicians either directly or indirectly. The interactions between these three domains contribute to the eventual outcomes of the PC workforce availability (shortage, surplus, or equilibrium). The assumption is that, modifying the factors at the "Person", "Place", and "Policy" levels, would change the PC physician movement outcomes, and eventually the availability of PC workforce.

Figure 2: Illustration of the study conceptual framework



Study Setting and Subjects

The study was conducted in the state of Texas, the largest among the contiguous states. Texas also has the highest number of counties (254), and is the second most populous state after California. The timeframe was set between the years 2010 and 2014. The study focused on the licensed PC physician population in Texas and collected different measures at the county level to assess place-specific factors.

Data Collection

Data Sources

The primary data source is from the Texas Medical Board (TMB), the state agency responsible for regulating the practice of physicians (M.D.'s and D.O.'s) and other health providers in Texas. As part of its function, the TMB issues licenses to physicians intending to practice in Texas and regularly collects and disseminates data on all licensed physicians. This data is publically available and governed by the Open Records and The Texas Public Information Act. The use of this database has two main advantages to previous similar studies which employed the American Medical Association (AMA) Masterfile (Ricketts and Randolph, 2007; Petterson *et al.*, 2013). First, since the TMB is the only licensing body in Texas, a physician cannot practice in the state without first receiving a license from the TMB. This means that the database is as comprehensive as possible. Second, the TMB updates the database every 30 days, and according to the board rules, the physician is required to report "any change of mailing or practice address" to the TMB within 30 days of the event (TMB, 2016) (§166.1.(d)). Thus representing the most updated data on physician practice locations in Texas. The researcher also used the Texas Medicaid Provider Database to identify physicians in the TMB dataset enrolled as Medicaid providers during the study timeframe.

As for the place-specific characteristics, the researcher collected data from multiple sources including the Health Resources and Services Administration, US Census Bureau, the Bureau of Economic Analysis, and the National Vital Statistics System. In order to determine the PC shortage status of each county by year of observation (2010 to 2014), the researcher used reported data from the Texas Health Professions Resource Center (DSHS, 2018a).

For the policy desk review, the researcher used a combination of sources to review federal and state policies related to PC physicians and shortage areas. The review of federal policies, focused on national physician incentive programs, using the Library of Congress to identify any changes that occurred over time (Congress, 2019). At the state level, the researcher used the Texas Legislature Online database to retrieve relevant bills (TLO, 2019). The review period included five legislative sessions (80^{th} – 84^{th}) covering nine years from 2007 to 2015.

Data Cleaning

Data on Texas-licensed physicians from the TMB was received in Excel Format and included 36 variables describing the physicians' licensing, personal characteristics, geographic location, education, training and practice (TMB, 2014). The dataset consisted of 58 Excel spreadsheets corresponding to each month from March 2010 to December 2014. Given the format and large size of this dataset, extensive data cleaning steps were completed in order to render it compatible to answer the research questions.

First, YEAR and MONTH variables were added to each Excel file. Then, using Stata, all files were merged into one large "Master Dataset" that includes information on all physicians for each month and year (StataCorp, 2013). Second, since the proposed study is looking at PC physicians, only those with one of the following primary specialties were included in the analysis: Family Practice or Family Medicine, General Practice, Obstetrics and Gynecology, Internal Medicine, Pediatrics, Medicine-Pediatrics, Psychiatry and Geriatrics. These were chosen in accordance with the definition of Primary Care adopted by the Texas Primary Care Office (DSHS, 2018b). Third, the dataset was converted from long to wide format in order to capture the movements of each physician from 2010 to 2014 with 58 variables corresponding to the "County of Practice" name in each Month/Year period (CNTY01→CNTY58). Fourth, using an algorithm in R programming language, the researcher identified the origin and destination counties for each physician move (R Development Core Team, 2008). The county location for each month was compared to the subsequent month, if the two locations were different, then a move was recorded in that particular month. From the resulting mover data, the researcher reviewed each individual move for accuracy, keeping the ones where the physician stayed in the destination county for more than six months.

Data cleaning resulted in a list of physician movers, their origin-destination counties, and the month-year of the move occurrence. Using the "Unique ID Number" variable, the researcher retrieved the person-specific characteristics from the "Master Dataset" and merged them with the movers' and non-movers' data to conduct the analyses. In order to limit the effects of censored data (Retired or Deceased), the researcher excluded 396 observations involving physicians older than 80 years of age. This is in agreement with published articles indicating that the Association of American Medical Colleges sets the maximum cutoff age of their datasets at 80 (Petterson et al., 2016). The same TMB database was used to retrieve a number of person-specific characteristics, including demographics, graduating medical school (US or international), medical specialty, and practice setting.

For the place-specific characteristics, county-level data was compiled from a variety of sources and combined into one file. County information was then merged to the physician movement database in order to run the regression models. For each record in the dataset corresponded an Origin (From) and Destination (To) county. Since the focus of the analysis is to identify factors of destination counties associated with physician moves, the spatial characteristics variables were merged using the Destination (To) variable as key.

Data Analysis

Aim 1

Using reported data from the Texas Health Professions Resource Center, the researcher determined the PC shortage status for a Texas county by year of observation (2010 to 2014) (DSHS, 2018a). The county designation variable was then merged to the dataset containing physician movements while accounting for the year the move occurred. This allowed the identification of the outcome for each physician move between 2010 and 2014; there were eight possible movement outcomes based on the status of the origin and destination counties (Table 3).

Table 3: Possible Outcomes for each Physician Movement

	Destination		
Origin	**Non-Shortage County**	**Shortage County**	**Outside***
Non-Shortage County	Remain Non-Shortage *Outcome 1*	Non-Shortage to Shortage *Outcome 2*	Non-Shortage to Outside *Outcome 5*
Shortage County	Shortage to Non-Shortage *Outcome 3*	Remain Shortage *Outcome 4*	Shortage to Outside *Outcome 6*
Outside*	Outside to Non-Shortage *Outcome 7*	Outside to Shortage *Outcome 8*	NA
*Outside of Texas, Retired, Inactive, or Deceased			

For outcomes 5 and 6, the physician move involved *exiting* the TMB dataset. This could be for a multitude of *unknown* reasons including, retirement, death or moving to another state. Similarly, for outcomes 7 and 8, the physician *entered* the TMB dataset for *unknown* reasons, such as moving from outside of Texas or joining the workforce for the first time after completing residency. Accordingly, when merging the place-specific variables to the physician dataset, the researcher excluded those observations involving a move to or from an *unknown* area. This resulted in two large datasets: (A) the first included only person-specific variables for all movement outcomes (n = 30,967); (B) and the second included both person-specific and place-specific variables for a subset of the observations (n = 25,795). It is important to note that the total number of observations represents the *movement occurrence* and not *unique physicians*, which was 29,434 for dataset (A) and 24,877 for dataset (B). This is because some physicians (n = 1,290) moved more than once during the study timeframe, and the researcher needed to include each of these moves as a separate observation in the dataset.

Descriptive analyses were conducted using Stata 15.1 to gain a better understanding of the frequency and distribution of movement outcomes, person-specific and place-specific characteristics (StataCorp, 2017). The researcher then conducted comparative analyses contrasting physician movers and non-movers in terms of their personal characteristics such as age, gender, place of birth, medical school, and Medicaid enrollment. As for the county data, shortage and non-shortage counties were compared in terms of place-specific characteristics such as population density, crime, and poverty. For both sets of comparative analyses, the researcher used the Chi-square test for categorical variables, and the t-test for continuous variables, adopting a significance level of 0.05 as is customary in social studies.

Lastly, in order to visualize the data, ArcMap 10.6 was used to illustrate physician movements across Texas. The researcher created a spider diagram for physician movements and highlighted county hubs for in- and out-flows of physicians between 2010 and 2014 (ESRI, 2017).

Aim 2

The researcher conducted multivariate analyses using Stata 15.1 (StataCorp, 2017). The first three sets of multiple logistic regression models focused on person-specific factors, studying their association with (1) physician movers to any destination (vs. non-movers), (2) movers to a shortage county (vs. non-shortage county), and (3) movers exiting the TMB dataset (vs. staying). The fourth model looked at place-specific factors of destination counties, to identify if they had a significant effect on physicians moving to a shortage county as opposed to a non-shortage county. Table 4 provides the measurement matrix for variables included in each model. A significance level of 0.05 was adopted.

Table 4: Variables Matrix for Multiple Logistic Regression Models

Model	Outcome Variables	Independent Variables
Person-specific factors – Any move	• Physician non-mover (0) • Physician mover (1)	Gender: Female (0); Male (1) Age (continuous) Medical School: Private (0) IMG (1) Public (2) Medical Degree: MD (0); DO (1) Enrolled in Medicaid: No (0); Yes (1)
Person-specific factors – Move to shortage	• Move to non-shortage county (0) *Outcomes 1, 3, and 7* • Move to shortage county (1) *Outcomes 2, 4, and 8*	
Person-specific factors – Exit [a]	• Stay in Texas (0) *Outcomes 1, 2, 3, 4, 7, and 8* • Exit [a] (1) *Outcomes 5 and 6*	
Place-specific factors – Move to shortage	• Move to non-shortage county (0) *Outcomes 1, 3, and 7* • Move to shortage county (1) *Outcomes 2, 4, and 8*	Population size [b]: < 50,000 (0); ≥ 50,000 (1) Number of annual births [b] Number of annual deaths [b] Land area *(mi^2)* County has NHSC PC sites [c]: No (0); Yes (1) County has FQHCs [c]: No (0); Yes (1) Percentage of infant deaths [d] *(under 1yo, per 100,000)* Percent of individuals aged > 65 years [c] Percent of adult current smokers [e] Medicare enrollment rate [f] Crime rate [g] *(per 100,000)* Uninsured rate [b] Percentage of individuals below poverty level [c]

[a] Outside of Texas, Retired, Inactive, or Deceased; [b] Average 2010-2014; [c] Data from 2015; [d] Average 2010-2013; [e] Data from 2014; [f] Average 2012-2014; [g] Average 2009-2014.
NHSC: National Health Services Corps; PC: Primary Care; FQHC: Federally Qualified Health Center.

Aim 3

The researcher conducted a desk review and thematic analysis of federal and state policies. The physician movement data was then used to discern whether certain policies resulted in possible changes in physician movement patterns. To this purpose, the analysis focused on three state policies that appeared to have a direct effect on physicians in Texas. Stata 15.1 was used to run the analyses, comparing physician movements before and after the policies became effective (StataCorp, 2017).

Ethical Considerations

This research was submitted to the University of Texas School of Public Health Institutional Review Board (IRB) to ensure proper study design and data management. The IRB determined that the research project qualifies for exempt status according to 45 CFR 46.101(b) Category #4: "research, involving the collection or study of existing data, documents, records, […], if these sources are publicly available".

All the data was stored on a password protected computer, behind the UT School of Public Health's firewall. Any physical notes with confidential information were kept in a locked cabinet on the school's premises.

The data collected from the TMB is publicly available and entails minimal risk to the studied population. An apparent confidentiality concern could be related to physicians' names and employment places. However, this information is easily accessible by the public through popular websites (i.e. HealthGrades, ZocDoc, WebMD, and the "Find a Doctor" option on health institutions' webpages). Therefore, this data does not violate the physicians' rights or impose any risks on them.

JOURNAL ARTICLE I

Title: Movement Outcomes of Primary Care Physicians in Texas: person and place characteristics

Journal: Health & Place

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Abstract (100 words):

Purpose: We aim to identify the primary care physicians' moves across Texas between 2010 and 2014. In addition, we provide a snapshot of the person- and place-specific characteristics that could contribute to the movement outcomes in terms of primary care shortage.

Results: From 29,343 physicians, 73% never moved counties. At the Texas level, physician outflow was greater than their influx. As for shortage counties, they had lower rates of crime and infant deaths compared to their non-shortage counterparts.

Conclusions: Additional research is needed to identify the person- and place-specific factors significantly affecting movement outcomes of primary care physicians in Texas.

Keywords: primary care physician, health professional shortage, physician migration, healthcare workforce.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Introduction

For decades, Primary Care (PC) has held an important position at the axis of every health system. Its value lies in increasing accessibility and continuity of care to improve population health (Macinko et al., 2009; O'Malley, 2013; Rajakumar, 1987; Safran et al., 1998). PC physicians are essential for ensuring the provision of PC services. However, several factors affect PC physicians' availability and can sometimes prevent equal access to PC, leading to geographical shortages in services (Bodenheimer and Smith, 2013; Foster and Gorr, 1992; Frisch, 2013; Mitka, 2007).

PC services include disease prevention, health promotion and maintenance, counseling, patient education, and diagnosis and treatment of illnesses. This all-inclusive definition of PC highlights its public health significance in improving individual and population health (Gulliford, 2002; Macinko et al., 2009, 2003). For these reasons, the PC sector is becoming increasingly important from a policy perspective to insure efficiency and equity in a health system (AAFP, 2015; Safran et al., 1998; Starfield, 2012).

Despite being a valuable part of the healthcare industry, PC services were historically associated with a shortage problem (AAMC, 2018, 2017; Bodenheimer and Pham, 2010; Bowman, 2008; Kuehn, 2008; Pham, 2018). In the State of Texas, the presence of a significant PC shortage problem was evidenced by several studies (AAMC, 2013; Conway, 2010; Holt, 2012; Kaissi, 2012; King and Menon, 2012; Miller, 2015; TMA, 2014). One report found that, of the 254 Texas counties, 35 had no physicians at all, and 80 counties had five physicians or less. (Commins, 2015; Deam, 2015; Goodman, 2015; Hethcock, 2015a, 2015b). When compared to the rest of the country, Texas ranked 41st in the physician-to-population ratio (183 physicians per 100,000 population), while ranking second highest nationally in the number of designated Primary Care HPSAs (a total of 375 in 2015) (AAMC, 2018; HRSA, 2015; Miller, 2015; The Henry J. Kaiser Family Foundation, 2015).

When it comes to the supply of physicians, Texas has one of the highest numbers of per capita medical students and resident physicians in the nation (AAMC, 2013). Texas also attracts incoming physicians from other states and countries. In 2013, 73% of newly licensed physicians in the State were graduates of medical schools outside of Texas (TMA, 2014). Accordingly, PC shortage is less likely to be the result of limited supply of PC physicians, and is rather an issue of maldistribution. In order to identify possible solutions to the problem of PC shortage and meet current and future physician demands, it is important to take a comprehensive look at physician migration and the person and place characteristics that may drive their movement behavior.

Objectives

The primary aim of this study is to identify the PC physicians' moves across the state of Texas between 2010 and 2014. More specifically, the objective is to determine the outcome of such moves based on the PC shortage/non-shortage status of the origin and destination counties. The secondary aim of this study is to provide a snapshot of the person- and place-specific characteristics, which may be contributing factors to the outcome of the PC Physicians' moves.

Methods

Data Collection

This analysis focused on the licensed PC physician population in the State of Texas, the largest among the contiguous States. Texas also has the highest number of counties (254), and is the second most populous State after California. We collected physician data from the Texas Medical Board (TMB), the state agency responsible of regulating the practice of physicians (M.D.'s and D.O.'s) and other health providers in Texas, between the years 2010 and 2014. As part of its function, the TMB issues licenses to physicians intending to practice in Texas and regularly collects and disseminates data on all licensed physicians. This data is publically available and governed by the Open Records and The Texas Public Information Act.

We used the TMB database to identify PC physicians who moved at any point in time during the 5-year study timeframe. The study included physicians with one of the following primary specialties: Family Practice or Family Medicine, General Practice, Obstetrics and Gynecology, Internal Medicine, Pediatrics, Medicine-Pediatrics, Psychiatry and Geriatrics. These were chosen in accordance with the definition of Primary Care adopted by the Texas Primary Care Office (DSHS, 2018a). In order to limit the effects of censored data (Retired or Deceased), we excluded 396 observations involving physicians older than 80 years of age. This is in agreement with published articles indicating that the Association of American Medical Colleges sets the maximum cutoff age of their datasets at 80 (Petterson et al., 2016). Furthermore, recent data showed an increasing number of active physicians practicing beyond the traditional retirement age, with 10% being 70 years or older (AAMC, 2017;

Young et al., 2017). We defined a "move" to indicate the physician changing their county of practice, and remaining in the destination county for more than six months. Using the same TMB database, we retrieved a number of person-specific characteristics, including demographics, graduating medical school (US or international), medical specialty, and practice setting. Lastly, we used the Texas Medicaid Provider Database to identify physicians in our dataset who were enrolled as Medicaid providers during our study timeframe.

For the place-specific characteristics, we collected data from multiple sources including the Health Resources and Services Administration, US Census Bureau, the Bureau of Economic Analysis, and the National Vital Statistics System. In order to determine the PC shortage status of each county, we used data from the Texas Department of State Health Services – Health Professions Resource Center (HPRC) (DSHS, 2018b, 2018c).

Data Analysis

PC shortage areas have historically been designated based on a ratio of PC providers to the population. In accordance with the Code of Federal Regulations (42 CFR 5), an area is designated as a PC Health Professional Shortage Area (HPSA)[2], when the physician-to-population ratio is below 1:3,500 (equivalent to ≈29 physicians per 100,000 population) (42 CFR 5, 2019; HRSA, 2015). We used reported data from the Texas Health Professions Resource Center to determine the PC shortage status for a Texas County by year of observation (2010 to 2014) (DSHS, 2018b). We then merged the county designation variable to the dataset containing physician movements. The county status was merged based on the

[2] In this paper, whenever the HPSA acronym is used, it is referring to the **Primary Care** Health Professional Shortage Areas only.

year the move occurred. This allowed us to identify the outcome for each physician move between 2010 and 2014; there were eight possible movement outcomes based on the status of the origin and destination (Table I-1).

Table I-1: Possible Outcomes for each Physician Movement

	Destination		
Origin	**Non-Shortage County**	**Shortage County**	**Outside***
Non-Shortage County	Remain Non-Shortage *Outcome 1*	Non-Shortage to Shortage *Outcome 2*	Non-Shortage to Outside *Outcome 5*
Shortage County	Shortage to Non-Shortage *Outcome 3*	Remain Shortage *Outcome 4*	Shortage to Outside *Outcome 6*
Outside*	Outside to Non-Shortage *Outcome 7*	Outside to Shortage *Outcome 8*	NA
*Outside of Texas, Retired, Inactive, or Deceased			

For outcomes 5 and 6, the physician move involved *exiting* the TMB dataset. This could be for a multitude of *unknown* reasons including, retirement, death or moving to another state. Similarly, for outcomes 7 and 8, the physician *entered* the TMB dataset for *unknown* reasons, such as moving from outside of Texas or joining the workforce for the first time after completing residency. Accordingly, when merging the place-specific variables to the physician dataset, we excluded those observations involving a move to or from an *unknown* area. This resulted in two large datasets: (A) the first included only person-specific variables for all movement outcomes (n = 30,967); (B) and the second included both person-specific and place-specific variables for a subset of the observations (n = 25,795). It is important to note that the total number of observations represents the *movement occurrence* and not *unique physicians,* which was 29,434 for dataset (A) and 24,877 for dataset (B). This is because some physicians moved more than once during the study timeframe, and we needed to include each of these moves as a separate observation in the dataset.

We conducted descriptive analyses using Stata 15.1 to gain a better understanding of the frequency and distribution of movement outcomes, person-specific and place-specific characteristics (StataCorp, 2017). We then conducted comparative analyses contrasting physician movers and non-movers in terms of their personal characteristics such as age, gender, place of birth, medical school, and Medicaid enrollment. As for the county data, we compared shortage and non-shortage counties in terms of place-specific characteristics such as population density, crime, and poverty. For both sets of comparative analyses we used the Chi-square test for categorical variables, and the t-test for continuous variables, adopting a significance level of 0.05 as is customary in social studies.

Lastly, in order to visualize our data, we used ArcMap 10.6 to illustrate physician movements across Texas. We created a spider diagram for physician movements and highlighted county hubs for in- and out-flows of physicians between 2010 and 2014 (ESRI, 2017).

Results

Physician Movement Outcomes

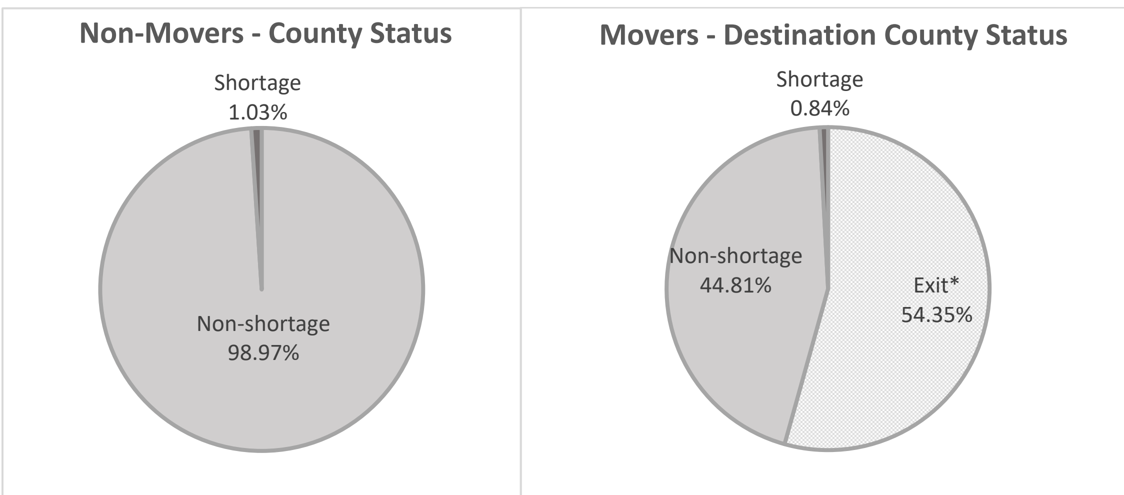
Overall, we tracked the movements of 29,343 unique physicians. They appeared to be stable, with almost 73% (21,379) of the sample remaining in the same County between 2010 and 2014 (Table I-2). Interestingly, of those 21,379 non-movers, only around 1% remained in a shortage county, while less than 1% of movers chose a shortage county as their destination

(Figure I-1). This was the first indication that the majority of physicians were less likely to move to a shortage areas in Texas.

Table I-2: Unique Physicians by Number of Times Moved (2010-2014)

Times Moved	**n**	**%**
0	21,379	**72.63%**
1	6,765	22.98%
2	1,077	3.66%
3	186	0.63%
4	24	0.08%
5	3	0.01%
Total	**29,434**	

Figure I-1: County Status for Non-Movers and Destination County Status for Movers



***Exit = Outside of Texas, Retired, Inactive, or Deceased**

Looking more closely at the previously defined movement outcomes, an overwhelming majority of physicians (83.23%) remained in a non-shortage county (Table I-3). The next most commonly encountered outcome was physicians who "exited" the database from a non-shortage County. To re-iterate an "exit" signifies an unknown reason for a physician's removal from the TMB database including moving outside of Texas, retiring, becoming inactive or deceased. Among movers, only three physicians moved from one shortage county to another (Outcome 4), while more than 3,000 movers went from a non-shortage county to another (Outcome 1). Lastly, of those physicians who entered the Texas workforce during our study period, only one physician chose to practice in shortage county while 178 chose a non-shortage county as their home. This further highlights the imbalance in physicians' choices, with clear preferences towards staying in or moving to non-shortage counties.

Table I-3: Movement Outcomes of Primary Care Physicians in Texas (2010-2014)

	Overall Movers and Non-Movers		**Among Movers**		**Among Non-movers**	
Outcome	**n**	**%**	**n**	**%**	**n**	**%**
1. Remain Non-Shortage	24,497	**83.23%**	**3,339**	41.45%	21,158	98.97%
2. Move from Non-Shortage to Shortage	63	0.21%	63	0.78%	-	-
3. Move from Shortage to Non-Shortage	93	0.32%	93	1.15%	-	-
4. Remain Shortage	224	0.76%	**3**	0.04%	221	1.03%
5. Move from Non-Shortage to Exit	4,336	**14.73%**	4,336	53.83%	-	-
6. Move from Shortage to Exit	42	0.14%	42	0.52%	-	-
7. Move from Exit to Non-Shortage	178	0.60%	**178**	2.22%	-	-
8. Move from Exit to Shortage	1	0.00%	**1**	0.01%	-	-
Total	**29,434**		**8,055**		**21,379**	
***Exit = Outside of Texas, Retired, Inactive, or Deceased**						

Person-specific Characteristics

After reviewing the distribution of movement outcomes, we summarized the physician characteristics from data provided by the TMB and Medicaid. Table I-4 highlights the key variables of interests for the 29,434 unique physicians. Since the dataset contained missing values for some of these characteristics, the total number of observations is notated in the table where applicable. Around 58% of physicians in our dataset are males, and predominantly white (74%). As for international origins, around 36% of the physicians were born outside of the US, with 30% graduating from an international medical school. Lastly, the majority (77%) were enrolled as Medicaid providers. Next, we conducted comparative analyses between physician movers and non-movers in terms of certain person-specific characteristics (Table I-5). A number of physicians in our dataset (n = 1,290) moved more than once (Table I-2), this resulted in duplicate observations for each of these physicians. Since most person-specific variables are stable over time (with the exception of age), we ran the comparative analyses on unique physicians (n = 29,434), keeping the observations of their first recorded move.

Physician movers and non-movers did not significantly differ in terms of gender, country of birth, or country of medical school. In terms of age however, non-movers were on average significantly older than movers were during the study timeframe [46.90 vs 45.67 years ($t = 7.6172$; $P < 0.000$)]. Additionally, we detected significant differences between the two groups of physicians in terms of their place of birth (Texas, US-non-Texas, international; $P < 0.000$), the type of medical school they graduated from (private, public, international; $P = 0.003$), the medical school degree type (MD, DO; $P < 0.000$), and being enrolled as a Medicaid provider ($P < 0.000$).

Table I-4: Person-specific Characteristics of PC Physicians in Texas (2010-2014)

Person-specific characteristic (n = 29,434) [a]	**N**	**Percent**
Gender		
Male	17,021	57.83%
Female	12,413	42.17%
Age Group		
< 40 years old	10,387	35.29%
40-49 years old	7,662	26.03%
50-59 years old	6,297	21.39%
≥ 60 years old	5,088	17.29%
Race (n=25,124) [a]		
White	18,587	73.98%
Asian	3,395	13.51%
Black/African American	1,918	7.64%
Other	1,224	4.87%
Ethnicity (n=29,229) [a]		
Not Hispanic	25,169	86.11%
Hispanic	4,060	13.89%
Place of birth (n=29,188) [a]		
US	18,588	63.68%
International	10,600	36.32%
Medical school		
US Medical Graduate	20,596	69.97%
International Medical Graduate	8,838	30.03%
Primary care specialty		
Family Practice	8,538	29.01%
Internal Medicine	8,507	28.90%
Pediatrics	5,126	17.42%
Obstetrics and Gynecology	3,192	10.84%
Psychiatry	2,820	9.58%
Other (General Practice, Medicine-Pediatrics, and Geriatrics)	1,252	4.25%
Practice time (n=29,429) [a]		
40+ hours per week	21,826	74.16%
20-39 hours per week	4,801	16.31%
≤19 hours per week	1,488	5.06%
Not applicable	1,314	4.47%
Practice setting (n=29,267) [a]		
Partnership/group	7,507	25.65%
Hospital	5,905	20.17%
Solo	5,494	18.77%
Direct medical care	4,541	15.52%
Medical school faculty	1,751	5.98%
Not applicable	1,498	5.12%
Other	2,571	8.79%
Enrolled in Medicaid		
Yes	22,589	76.74%
No	6,845	23.26%
[a] Adjusted to account for missing values where applicable		

Table I-5: Comparison of Person-specific Characteristics between PC Physician Movers and Non-movers in Texas (2010-2014)

Person-specific characteristic (n = 29,434) [a]	**Mover (n, %)** (n = 8,055)	**Non-Mover (n, %)** (n = 21,379)	**p-value** [b]
Gender			
Male	4,631 (57.49%)	12,390 (57.95%)	0.474
Female	3,424 (42.51%)	8,989 (42.05%)	
Age (yrs) M (SD)	45.67 (13.76)	46.90 (11.79)	**0.000** [c]
Country of birth (n=29,188) [a]			
US	5,057 (63.57%)	13,531 (63.73%)	0.805
International	2,898 (36.43%)	7,702 (36.27%)	
Place of birth (n=29,188) [a]			
US-Non-Texas	2,846 (35.78%)	7,075 (33.32%)	**0.000**
US-Texas	2,211 (27.79%)	6,456 (30.41%)	
International	2,898 (36.43%)	7,702 (36.27%)	
Medical school			
US Medical Graduate	5,653 (70.18%)	14,943 (69.90%)	0.635
International Medical Graduate	2,402 (29.82%)	6,436 (30.10 %)	
Medical school			
US-Public Medical School	4,250 (52.76%)	11,570 (54.12%)	**0.003**
US-Private Medical School	1,403 (17.42%)	3,373 (15.78%)	
International Medical School	2,402 (29.82%)	6,436 (30.10%)	
Medical school degree type			
DO	875 (10.86%)	1,894 (8.86%)	**0.000**
MD	7,180 (89.14%)	19,485 (91.14%)	
Enrolled as Medicaid provider			
Yes	6,059 (75.22%)	16,530 (77.32%)	**0.000**
No	1,996 (24.78%)	4,849 (22.68%)	

[a] Adjusted to account for missing values where applicable
[b] Significance level $\alpha = 0.05$
[c] Used t-test because age is a continuous variable
t-value = 7.6172; diff = mean(non-movers) - mean(movers)

Place-specific Characteristics

Texas is divided into 254 counties, more than any other American state. The counties are very diverse in terms of demographic, geographic and economic characteristics. It is worth noting that a total of 23 counties never appeared in our dataset, and 21 of those had a PC shortage designation throughout the duration of our study (Table I-6). This means that the Texas Medical Board had no record of a practicing PC physician in these counties between 2010 and 2014, further highlighting the significant shortage in certain counties in Texas.

Table I-6: List of Counties that did not appear in the Origin or Destination Variables for PC Physician Moves in Texas (2010-2014)

Counties	**Status**	**Average Population (2010-2014)**	**Counties**	**Status**	**Average Population (2010-2014)**
1. Armstrong	Shortage	2,076	13. Kenedy	Shortage	447
2. Borden	Shortage	701	14. King	Shortage	325
3. Briscoe	Shortage	1,739	15. Lipscomb	Many*	3,337
4. Carson	Shortage	6,496	16. Loving	Shortage	75
5. Cottle	Shortage	1,672	17. Mason	Shortage	5,992
6. Duval	Shortage	12,040	18. McMullen	Shortage	1,1853
7. Foard	Shortage	1,438	19. Oldham	Shortage	2,195
8. Glasscock	Shortage	1,370	20. Real	Shortage	3,371
9. Hall	Shortage	3,546	21. Roberts	Shortage	955
10. Hartley	Non-shortage	6,014	22. Sherman	Shortage	3,235
11. Hudspeth	Shortage	3,714	23. Sterling	Shortage	1,293
12. Irion	Shortage	1,715			
*Many: a county which status changed between shortage and non-shortage multiple times between 2010-2014					

As described earlier, county designation status was determined using reported data from the Texas Health Professions Resource Center (DSHS, 2018b). The majority of counties had a stable status designation with 158 non-shortage counties and 43 shortage counties between 2010 and 2014. The remaining 53 counties changed status with nine becoming non-shortage, 20 becoming shortage, and 24 switching multiple times between the two designations. Accordingly, when identifying the status of origin and destination counties in our dataset, we considered the year the move occurred when inputting data for the 53 counties with unstable designations. The purpose was to reflect the counties' designation status accurately at the time of the physician move.

For the purpose of our place-specific comparative analysis, and in order to facilitate the interpretation of findings, we re-grouped our counties into two categories depending on their PC shortage designation. We adopted the majority rule accordingly: (a) counties designated with a shortage status for three years or more of our five-year observation period were coded as "shortage" (n = 66); (b) counties designated with a non-shortage status for three years or more were coded as "non-shortage" (n = 188).

We then conducted comparative analyses between the two groups of counties in terms of certain place-specific characteristics and presented our findings in Tables I-7 and I-8. As expected, counties in these two groups significantly differed in terms of population size ($P = 0.002$) and growth ($P < 0.000$), with non-shortage counties being on average more populous and dense than shortage counties ($P = 0.0135$, $P = 0.0061$). Following the same trend, non-shortage counties had on average a higher number of annual births ($P = 0.0171$), and annual deaths ($P = 0.0087$). In terms of social and economic determinants of health, there were no significant differences between the two groups of counties for all indicators except for infant deaths ($P = 0.0009$) and crime rate ($P = 0.0012$).

Table I-7: Comparison of Categorical Place-specific Characteristics between Shortage and Non-Shortage Counties in Texas (2010-2014)

Place-specific characteristic (n = 254)	**Shortage n (%)** (n = 66)	**Non-Shortage n (%)** (n = 188)	**p-value** [a]
Stable designation over time			
No	23 (34.85%)	30 (15.96%)	**0.001**
Yes	43 (65.15%)	158 (84.04%)	
Population size [b]			
< 50,000	59 (89.39%)	131 (69.68%)	**0.002**
≥ 50,000	7 (10.61%)	57 (30.32%)	
Population change [c]			
Decrease	39 (59.09%)	65 (34.57%)	**0.000**
Increase	27 (40.91%)	123 (65.43%)	
County has NHSC primary care sites [d]			
No	32 (48.48%)	66 (35.11%)	0.055
Yes	34 (51.52%)	122 (64.89%)	
County has FQHCs [d]			
No	41 (62.12%)	99 (52.66%)	0.184
Yes	25 (37.88%)	89 (47.34%)	
County has Hospitals [d]			
One hospital or less	64 (96.97%)	126 (67.02%)	**0.000**
More than one hospital	2 (3.03%)	62 (32.98%)	

[a] Significance level α = 0.05; [b] Average 2010-2014; [c] Calculated: population in 2014 minus population in 2010; [d] Data from 2015

Abbreviations: NHSC: National Health Services Corps; FQHC: Federally Qualified Health Center;

Table I-8: Comparison of Continuous Place-specific Characteristics between Shortage and Non-Shortage Counties in Texas (2010-2014)

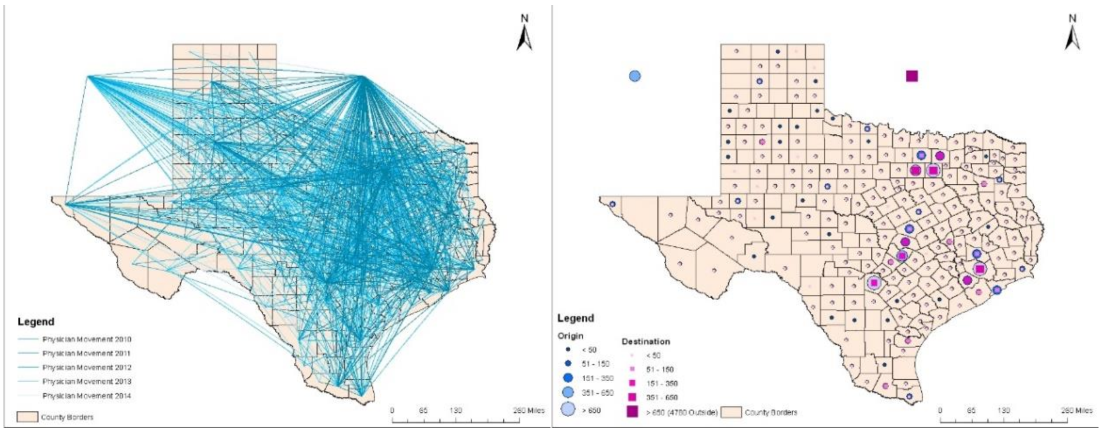
Place-specific characteristic (n = 254)		**Shortage (n = 66)**	**Non-Shortage (n = 188)**	***t*-value** [a]	**p-value** [b]
Population size [c]	M (SD)	17,662 (23,916)	133,406 (42,1830)	-2.2250	**0.0135**
Land area (mi²)	M (SD)	987.81 (606.69)	1,042.75 (676.82)	-0.5823	0.2804
Population density [c,d]	M (SD)	25.60 (40.35)	139.21 (364.52)	-2.5235	**0.0061**
Number of annual births [c]	M (SD)	226.35 (335.84)	1,975.91 (6,666.28)	-2.1285	**0.0171**
Number of annual deaths [c]	M (SD)	162.12 (205.10)	871.08 (2,397.91)	-2.3958	**0.0087**
Percentage of infant deaths [e] *(under 1yo, per 100, 000)*	M (SD)	0.16 (0.94)	1.53 (3.48)	-3.1542	**0.0009**
Percentage of individuals aged > 65 years [f]	M (SD)	18.01 (4.97)	16.95 (5.19)	1.4504	0.0741
Percentage of adult current smokers [g]	M (SD)	15.50 (2.11)	15.64 (1.70)	-0.5539	0.2901
Per capita income [f]	M (SD)	44,320.86 (12,725.86)	43,142.53 (13,656.40)	0.6136	0.2700
Percentage of unemployed individuals [h]	M (SD)	5.82 (2.09)	5.85 (1.87)	-0.1255	0.4501
Percentage of individuals below poverty level [f]	M (SD)	16.44 (5.54)	16.95 (5.26)	-0.6767	0.2496
Percent of social security benefit recipients [c]	M (SD)	2.57 (1.47)	2.76 (1.86)	-0.7621	0.2233
Crime rate [i] *(per 100,000)*	M (SD)	211.71 (144.28)	284.65 (173.43)	-3.0637	**0.0012**
Percent of Medicare enrollment [h]	M (SD)	18.20 (6.40)	17.70 (6.26)	0.5485	0.2919
Percent of uninsured [c]	M (SD)	25.86 (5.13)	25.73 (3.89)	0.2100	0.4169

[a] diff = mean(shortage) - mean(non-shortage); [b] Significance level $\alpha = 0.05$; [c] Average 2010-2014; [d] Calculated: Population Size / Land Area; [e] Average 2010-2013; [f] Data from 2015; [g] Data from 2014; [h] Average 2012-2014; [i] Average 2009-2014 (number of crimes reported per 100,000 population).

Visualizing Physician Migration Patterns

Using ArcMap, we plotted the identified movements and highlighted those hub counties with frequent in- and out-flow of PC physicians (Figure I-2).

Figure I-2: Origin and Destination Counties for Physician Outflows and Inflows (2010-2014)

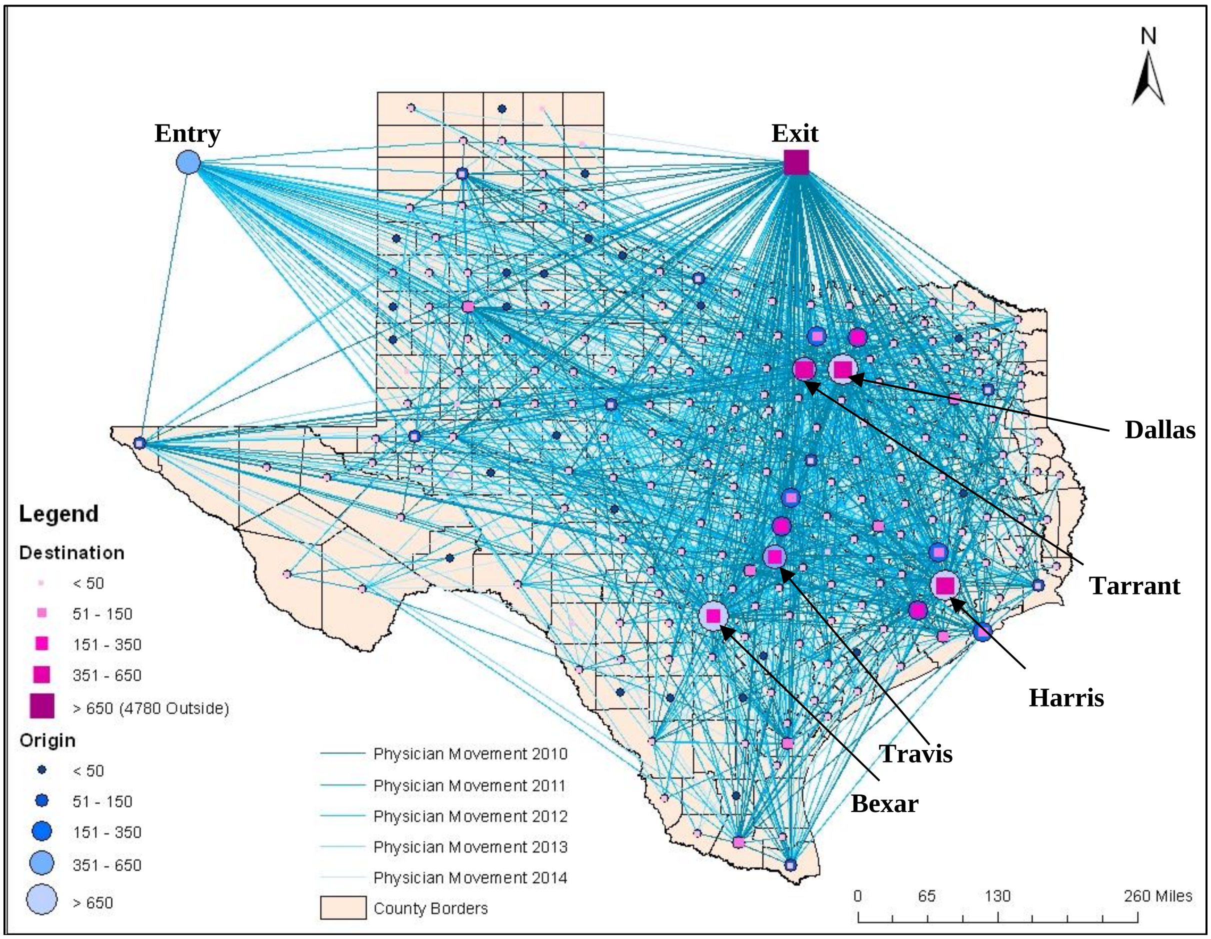


This included all the physician moves between 2010 and 2014, hence each line in the spider diagram represents one move, and not one physician [using dataset A; (n = 30,967)]. The circles represent origins and the squares are for destinations. Looking at Texas overall, there were 4,780 moves exiting the state, compared to only 392 moves entering Texas. When overlaying the two maps (Figure I-3), we observed that the most concentrated areas of the spider diagram overlapped with five major counties: Harris, Travis, Bexar, Dallas, and Tarrant. For all of these counties the outflow of physicians was higher than the influx between 2010 and 2014 (Table I-9).

Table I-9: Outflow and Influx of Physicians for County Hubs (2010-2014)

County	Outflow	Influx
Harris	6,388	615
Travis	1,732	300
Bexar	2,594	271
Dallas	4,170	477
Tarrant	2,092	362

Figure I-3: Spider Diagram for Physician Flows in Texas and Major County Hubs (2010-2014)



Discussion

Our study adopted a multi-faceted approach to understand the physician migration patterns in Texas. We found that from 29,343 physicians practicing in Texas between 2010 and 2014, the majority were stable and never moved counties (73%). This is consistent with other published work on this topic at the national level (AAMC, 2017; Jiang and Begun, 2002; Ricketts and Randolph, 2008). To our knowledge, this study represents the largest report evaluating the movement of PC physicians at a state level. We attempted to identify person- and place-specific factors impacting a national problem – PC physician shortage – by taking an intricate and closer look at Texas. Interestingly, from the 8,055 physicians who moved, only 67 chose a shortage county as their destination, further exacerbating the PC shortage status of these areas.

The person-specific analysis revealed that our sample is in line with the reported literature on physicians in terms of gender, age, race and ethnicity (Xierali and Nivet, 2018; Young et al., 2017, 2015). However, our sample from Texas included a marginally higher percentage of physicians graduating from international medical schools (30%) compared to national data reported in the 2014 and 2016 census of Actively Licensed Physicians in the United States (22.2% in 2010; 22.4% in 2012; 22.7% in 2014 and 2016) (Young et al., 2017, 2015). This could be due to the fact that our sample was restricted to primary care physicians, in comparison to the national census that includes all physician specialties which are known to have a higher percentage of US medical graduates (Duvivier et al., 2019; Fordyce et al., 2012). Our comparative analysis for physician movers and non-movers revealed possible associations with person-specific factors. Namely, age, place of birth, medical school, degree type (MD, DO) and Medicaid enrollment status. However, we are unable to determine any causal relationship between these factors and the physicians' decisions to move or stay in a certain county.

As for the counties, our comparison between shortage and non-shortage designation status identified that, shortage counties were on average less populous (with lower birth and death counts). Interestingly, they had a lower rate of infant deaths and reported crime compared to the non-shortage counties. Similar to our person-specific analysis, these results do not establish any causal relationships, and our aim was to gain a better understanding of how these two groups of counties compare.

We understand that our study is limited by the inherent biases and limitations of a large secondary data analysis, including the missing information for outcomes 5-8 in our movement pattern analysis, which lacked any descriptive data from the TMB. Given the large number of moves with an "outside" destination (n = 4,780), we understand that this information would have added more value to our analyses of movement outcomes. But the use of this database has two main advantages to previous similar studies which employed the American Medical Association (AMA) Masterfile (Petterson et al., 2013; Ricketts and Randolph, 2007). First, since the TMB is the only licensing body in Texas, a physician cannot practice in the State without first receiving a license from the TMB. This means that the database is as comprehensive as possible. Second, the TMB updates the database every 30 days, and according to the board rules, the physician is required to report "any change of mailing or practice address" to the TMB within 30 days of the event (TMB, 2016)

(§166.1.(d)). Thus representing the most updated data on physician practice locations in Texas.

Conclusion

This is the largest study analyzing PC physician movements at a state level. We aimed to get a better understanding of the different person- and place-specific factors that could possibly influence those moves. Our findings showed that the majority of physicians are stable, and when they decide to move, their outflow is greater than their influx. As for counties, the results were in line with the general perceptions of shortage counties being smaller and less populous. Our analyses were limited by missing information on physicians exiting the TMB database, the five-year timeframe, and the use of bivariate tests that do not establish causation. A multivariate analysis is needed to identify the person-specific and place-specific factors that have a significant effect on movement outcomes of primary care physicians in Texas.

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JOURNAL ARTICLE II

Title: Primary Care Physician Movements in Texas: Person- and Place-Specific Factors

Journal: Health & Place

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Abstract (100 words):

Purpose: We aim to identify the person- and place-specific factors affecting primary care physicians' moves across Texas between 2010 and 2014.

Results: Physicians' gender, age, medical school (public/private), degree (DO/MD), and Medicaid enrollment status, all had a significant association with their movement patterns. As for the destination county characteristic, a population of 50,000 or more, and the presence of FQHCs increased the odds of physicians moving to shortage counties.

Conclusions: Physician movements are significantly impacted by person- and place-specific factors. Research involving primary data collection would improve our understanding of physicians' motives to move to shortage areas.

Keywords: primary care physician, health professional shortage, physician migration, healthcare workforce, multiple logistic regression.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Introduction

The United States has witnessed decades of documented physician shortage (Fruen, Hadley and Korper, 1980; Newhouse, 1990; Rabinowitz *et al.*, 1999; Sheldon, 2003; Lakhan and Laird, 2009; Petterson *et al.*, 2012; Frisch, 2013). A trend expected to continue in the future, with researchers projecting a deficit of around 43,000 to 121,000 physicians by the year 2030 (AAMC, 2018; Kuehn, 2008; Pham, 2018). This shortage of physicians is even more critical in the primary care (PC) sector. For instance, in 2015, Texas ranked 41st nationwide in the physician-to-population ratio, while ranking 47th in the number of active primary care physicians per 100,000 population (AAMC, 2018).

Policy-makers responded by devising different programs to address the shortage problem. Some of the most commonly adopted approaches is increasing the number of trained PC physicians (Russell and Parkinson, 1994; Bodenheimer and Smith, 2013; Miller, 2015b). This approach is certainly important in providing access to a higher portion of the population. However, overlooking other factors contributing to the physician shortage is the reason most of the adopted solutions were not effective or sustainable (Shipman and Sinsky, 2013a; Chen, Mehrotra and Auerbach, 2014; Phillips, Bazemore and Peterson, 2014).

According to published reports, the shortage problem in Texas is not the result of limited supply of PC physicians, but rather an issue of inadequate distribution. In fact, Texas has one of the highest numbers of per capita medical students and resident physicians in the nation (AAMC, 2013). Moreover, 73% of newly licensed physicians in the State in 2013 were graduates of medical schools outside of Texas (TMA, 2014).

The geographical distribution of PC physicians is an important contributor to meeting the overall population needs and ensuring equity (Grumbach *et al.*, 1998; Rosenthal, Zaslavsky and Newhouse, 2005; Watkins, 2005; Vanasse *et al.*, 2007; Ricketts and Randolph, 2008). PC physicians are driven by a number of factors to move from one region to another. Some tend to move to areas with lower competition, higher incomes and lower unemployment. While others tend to choose their practice location based on personal motivators, such as, personal mission, self-identity and work-life balance (Ernst and Yett, 1984; Curran and Rourke, 2004; Walker *et al.*, 2010; Ricketts, 2013). Therefore, understanding the factors involved in the geographic movements of physicians over time could serve as a guide to policies and regulations that aim to increase physician recruitment and retention in underserved areas (Ricketts and Randolph, 2008; Cossman and Street, 2010; Baker *et al.*, 2012).

Objectives

The goal of this study is to identify the person-specific and place-specific factors with a significant effect on the movements of PC physicians across Texas between 2010 and 2014. More specifically, we aimed to determine those factors that increased the likelihood of physician movements to shortage counties in Texas.

Methods

Data Collection

This analysis focused on the licensed PC physician population in the State of Texas. We collected physician data from the Texas Medical Board (TMB), to identify PC physicians who moved at any point in time during the 5-year study timeframe (2010-2014). The study included physicians with one of the following primary specialties: Family Practice or Family Medicine, General Practice, Obstetrics and Gynecology, Internal Medicine, Pediatrics, Medicine-Pediatrics, Psychiatry and Geriatrics. These were chosen in accordance with the definition of Primary Care adopted by the Texas Primary Care Office (DSHS, 2018a). In order to limit the effects of censored data (Retired or Deceased), we excluded 396 observations involving physicians older than 80 years of age. This is in agreement with published articles indicating that the Association of American Medical Colleges sets the maximum cutoff age of their datasets at 80 (Petterson et al., 2016). We defined a "move" to indicate the physician changing their county of practice, and remaining in the destination county for more than six months. Using the same TMB database, we retrieved a number of person-specific characteristics, including demographics, graduating medical school (US or international), medical specialty, and practice setting. Lastly, we used the Texas Medicaid Provider Database to identify physicians in our dataset who were enrolled as Medicaid providers during our study timeframe.

For the place-specific characteristics, we collected data from multiple sources including the Health Resources and Services Administration, US Census Bureau, the Bureau of Economic Analysis, and the National Vital Statistics System. In order to determine the PC shortage status of each county, we used data from the Texas Department of State Health Services – Health Professions Resource Center (HPRC) (DSHS, 2018b, 2018c).

Data Analysis

PC shortage areas have historically been designated based on a ratio of PC providers to the population. In accordance with the Code of Federal Regulations (42 CFR 5), an area is designated as a PC Health Professional Shortage Area (HPSA)[3], when the physician-to-population ratio is below 1:3,500 (equivalent to ≈29 physicians per 100,000 population) (42 CFR 5, 2019; HRSA, 2015). We used reported data from the Texas Health Professions Resource Center to determine the PC shortage status for a Texas County by year of observation (2010 to 2014) (DSHS, 2019). We then merged the county designation variable to the dataset containing physician movements. The county status was merged based on the year the move occurred. This allowed us to identify the outcome for each physician move between 2010 and 2014; there were eight possible movement outcomes based on the status of the origin and destination (Table II-1).

Table II-1: Possible Outcomes for each Physician Movement

	Destination		
Origin	**Non-Shortage County**	**Shortage County**	**Outside***
Non-Shortage County	Remain Non-Shortage *Outcome 1*	Non-Shortage to Shortage *Outcome 2*	Non-Shortage to Outside *Outcome 5*
Shortage County	Shortage to Non-Shortage *Outcome 3*	Remain Shortage *Outcome 4*	Shortage to Outside *Outcome 6*
Outside*	Outside to Non-Shortage *Outcome 7*	Outside to Shortage *Outcome 8*	NA
*Outside of Texas, Retired, Inactive, or Deceased			

For outcomes 5 and 6, the physician move involved *exiting* the TMB dataset. This could be for a multitude of *unknown* reasons including, retirement, death or moving to another state. Similarly, for outcomes 7 and 8, the physician *entered* the TMB dataset for *unknown* reasons, such as moving from outside of Texas or joining the workforce for the first time after completing residency. Accordingly, when merging the place-specific variables to

[3] In this paper, whenever the HPSA acronym is used, it is referring to the **Primary Care** Health Professional Shortage Areas only.

the physician dataset, we excluded those observations involving a move to or from an *unknown* area. This resulted in two large datasets: (A) the first included only person-specific variables for all movement outcomes (n = 30,967); (B) and the second included both person-specific and place-specific variables for a subset of the observations (n = 25,795). It is important to note that the total number of observations represents the *movement occurrence* and not *unique physicians*, which was 29,434 for dataset (A) and 24,877 for dataset (B). This is because some physicians moved more than once during the study timeframe, and we needed to include each of these moves as a separate observation in the dataset.

We conducted multivariate analyses using Stata 15.1 (StataCorp, 2017). The first three sets of multiple logistic regression models focused on person-specific factors, studying their association with (1) physician movers to any destination (vs. non-movers), (2) movers to a shortage county (vs. non-shortage county), and (3) movers exiting the TMB dataset (vs. staying). The fourth model looked at place-specific factors of destination counties, to identify if they had a significant effect on physicians moving to a shortage county as opposed to a non-shortage county. Table II-2 provides the measurement matrix for variables included in each model. For all the analyses, we adopted a significance level of 0.05 as is customary in social studies.

Table II-2: Variables Matrix for Multiple Logistic Regression Models

Model	Outcome Variables	Independent Variables
Person-specific factors – Any move	• Physician non-mover (0) • Physician mover (1)	Gender: Female (0); Male (1) Age (continuous) Medical School: Private (0) IMG (1) Public (2) Medical Degree: MD (0); DO (1) Enrolled in Medicaid: No (0); Yes (1)
Person-specific factors – Move to shortage	• Move to non-shortage county (0) *Outcomes 1, 3, and 7* • Move to shortage county (1) *Outcomes 2, 4, and 8*	
Person-specific factors – Exit [a]	• Stay in Texas (0) *Outcomes 1, 2, 3, 4, 7, and 8* • Exit [a] (1) *Outcomes 5 and 6*	
Place-specific factors – Move to shortage	• Move to non-shortage county (0) *Outcomes 1, 3, and 7* • Move to shortage county (1) *Outcomes 2, 4, and 8*	Population size [b]: < 50,000 (0); ≥ 50,000 (1) Number of annual births [b] Number of annual deaths [b] Land area *(mi^2)* County has NHSC primary care sites [c]: No (0); Yes (1) County has FQHCs [c]: No (0); Yes (1) Percentage of infant deaths [d] *(under 1yo, per 100,000)* Percent of individuals aged > 65 years [c] Percent of adult current smokers [e] Medicare enrollment rate [f] Crime rate [g] *(per 100,000)* Uninsured rate [b] Percentage of individuals below poverty level [c]

[a] Outside of Texas, Retired, Inactive, or Deceased; [b] Average 2010-2014; [c] Data from 2015; [d] Average 2010-2013; [e] Data from 2014; [f] Average 2012-2014; [g] Average 2009-2014.
NHSC: National Health Services Corps; FQHC: Federally Qualified Health Center.

Results

Person-specific Factors

Overall, we tracked the movements of 29,343 unique physicians. They appeared to be stable, with almost 73% (21,379) of the sample remaining in the same County between 2010 and 2014. As noted earlier, the unit of analysis in our regression models was the movement occurrence and not a unique physician. This is because a number of physicians in our dataset (n = 1,290) moved more than once, resulting in duplicate observations for each of these physicians (Table II-3).

Table II-3: Unique Physicians by Number of Times Moved (2010-2014)

Times Moved	**n**	**%**
0	21,379	**72.63%**
1	6,765	22.98%
2	1,077	3.66%
3	186	0.63%
4	24	0.08%
5	3	0.01%
Total	**29,434**	

We ran separate models on three groups of physician moves and summarized our findings in Table II-4. All the models were statistically significant as a whole compared to an empty model (Prob > chi2 = 0.0000).

First, we looked at how person-specific characteristics are associated with the occurrence of any move. To this purpose, we used the entire physician dataset (n = 30,967 moves) and compared observations associated with physician movers, to those linked with non-movers. Three person-specific factors in this model were negatively associated with a physician moving. Older physicians (P < 0.000), those graduating from a public medical school (P = 0.035), and those enrolled as Medicaid providers (P = 0.034) were all significantly less likely to move regardless of the destination. On the other hands, the odds of moving for an osteopathic physician was 1.27 times higher than that of an allopathic physician (P < 0.000).

Second, we focused on the moves with a shortage county as a destination. Accordingly, we excluded all stable physicians (non-movers), as well as observations resulting in an “exit”. The data included PC physicians who moved, but remained in the

TMB dataset (n = 4,808). We found that male physicians were significantly more likely to move to a shortage county compared to female physicians (P = 0.041). Moreover, older age was associated with choosing a shortage county (P < 0.000), and physicians who went to a public medical school were twice as likely to move to a shortage county compared to private medical school graduates (P = 0.039).

The third and last model aimed at identifying the person-specific factors associated with physicians exiting the TMB dataset. We excluded all non-movers and ran the analysis on 9,588 observations related to physicians who moved at one point in time during the study timeframe. Similar to shortage county destinations, we found that men and older physicians were more likely to exit (P < 0.000). The remaining person-specific characteristics were all negatively associated with leaving the dataset. Accordingly, physicians who went to public or international medical schools, earned a DO, or enrolled in Medicaid, were all significantly less likely to exit (P < 0.000).

Table II-4: Multiple Logistic Regression of Person-specific Factors Associated with Primary Care Physician Movement Outcomes

Person-specific Factors	**Movement Outcomes**								
	Any Move			**Move to Shortage**			**Exit**		
	OR (95% CI)	z	p-value	OR (95% CI)	z	p-value	OR (95% CI)	z	p-value
Gender									
Female	1	-	-	1	-	-	1	-	-
Male	1.02 (0.97-1.08)	0.92	0.357	**1.61 (1.02-2.54)**	**2.05**	**0.041**	**1.25 (1.14-1.36)**	**4.96**	**0.000**
Age (continuous) *Mean = 46.56* *SD = 12.39*	**0.99 (0.990-0.994)**	**-7.24**	**0.000**	**1.03 (1.02-1.05)**	**3.78**	**0.000**	**1.02 (1.02-1.03)**	**12.71**	**0.000**
Medical School									
Private	1	-	-	1	-	-	1	-	-
IMG	0.97 (0.89-1.04)	-0.89	0.375	1.56 (0.68-3.57)	1.05	0.293	**0.58 (0.51-0.66)**	**-8.04**	**0.000**
Public	**0.93 (0.87-0.99)**	**-2.11**	**0.035**	**2.21 (0.68-3.57)**	**2.07**	**0.039**	**0.60 (0.53-0.68)**	**-8.39**	**0.000**
Medical Degree									
MD	**1**	-	-	1	-	-	1	-	-
DO	**1.27 (1.17-1.38)**	**5.78**	**0.000**	1.09 (0.59-2.014)	0.26	0.791	**0.58 (0.51-0.67)**	**-7.58**	**0.000**
Enrolled in Medicaid									
No	**1**	-	-	1	-	-	1	-	-
Yes	**0.94 (0.89-0.99)**	**-2.12**	**0.034**	1.33 (0.74-2.39)	0.96	0.337	**0.45 (0.41-0.50)**	**-15.48**	**0.000**
Overall model details	N = 30,967 Prob > chi2 = 0.0000			N = 4,808 Prob > chi2= 0.0000			N = 9,588 Prob > chi2 = 0.0000		

Significant associations are bolded; α = 0.05.
OR: Odds Ratio; z: z statistic; CI: Confidence Interval; IMG: International Medical Graduate; MD: Allopathic Medical Degree; DO: Osteopathic Medical Degree.

Place-specific Factors

Texas is divided into 254 counties, more than any other American state. The counties are very diverse in terms of demographic, geographic and economic characteristics. We conducted a comparative analysis of shortage and non-shortage counties and found that the two groups were significantly different in most metrics. The results were in line with the general perceptions of shortage counties being smaller and less populous, while highlighting the better general socio-economic status of these smaller counties in comparison to their large, metropolitan counterparts.

In order to identify which of these factors had an association with a physician moving to a shortage destination, we conducted a multivariate analysis. We started with dataset (B) which included both person-specific and place-specific variables for a subset of the observations, excluding moves with an “outside” destination (n = 25,795). Before running our model, we excluded all observations related to stable physicians (non-movers), resulting in a sample size of 4,808 observations.

Our multiple logistic regression model as a whole was statistically significant (Prob > chi2 = 0.0000) (Table II-5). It included dependent variables covering demographic characteristics (population size, births, deaths, population aged > 65), geographic characteristics (land area), physician loan repayment opportunities (National Health Service Corps (NHSC) sites, and Federally Qualified Health Centers (FQHC)), health indicators (infant mortality, adult smokers) and socio-economic factors (poverty, crime, Medicare enrollment, uninsured).

Our results showed, that the odds of a move occurring to a shortage county was around three times higher if that county had a population of 50,000 or more (P = 0.019). The presence of an NHSC site in a shortage county did not increase the odds of a physician moving there (P = 0.019). In contrast, the presence of an FQHC increased the likelihood of moving to a shortage county by around four times compared to a county without such centers (P < 0.000). Counties with higher infant death rates and more elderly, appeared to have a significant association with moves to a shortage area (P < 0.000), while crime and higher Medicare enrollment decreased the chances of moving to a shortage county (P = 0.049; P < 0.000).

Table II-5: Multiple Logistic Regression of Place-specific Factors Associated with Primary Care Physician Movement Outcomes

Place-specific Factor	**Move to shortage**		
	OR (95% CI)	z	p-value
Population size (categorical) [a]			
< 50,000	1	-	-
≥ 50,000	3.22 (1.21- 8.55)	2.35	**0.019**
Number of annual births [a]	0.998 (0.997-0.999)	-2.48	**0.013**
Number of annual deaths [a]	0.996 (0.994-0.999)	-2.21	**0.027**
Land area (mi^2)	0.9996 (0.9992-1.000)	-1.49	0.137
County has NHSC primary care sites [b]			
No	1	-	-
Yes	0.37 (0.16-0.85)	-2.35	**0.019**
County has FQHCs [b]			
No	1	-	-
Yes	3.66 (1.61-8.31)	3.10	**0.002**
Percentage of infant deaths [c] *(under 1yo, per 100, 000)*	1.36 (1.17-1.59)	3.90	**0.000**
Percentage of individuals aged > 65 years [b]	1.31 (1.17-1.46)	4.77	**0.000**
Percentage of adult current smokers [d]	1.31 (1.01-1.69)	2.04	**0.042**
Crime rate [e] *(per 100,000)*	0.998 (0.996-0.999)	-1.97	**0.049**
Medicare enrollment rate [f]	0.69 (0.64-0.76)	-8.01	**0.000**
Uninsured rate [a]	0.92 (0.84-1.01)	-1.72	0.085
Percentage of individuals below poverty level [b]	0.97 (0.89-1.05)	-0.69	0.490

[a] Average 2010-2014; [b] Data from 2015; [c] Average 2010-2013; [d] Data from 2014; [e] Average 2009-2014; [f] Average 2012-2014
Overall model details: N = 4,808; Prob > chi2 = 0.0000; Significant associations are bolded; α = 0.05.
OR: Odds Ratio; z: z statistic; CI: Confidence Interval

Discussion

We conducted a multivariate analysis to understand the factors affecting physician migration patterns in Texas. From 29,343 physicians practicing in Texas between 2010 and 2014, the majority were stable and never moved counties (73%). This is consistent with other published work on this topic at the national level (AAMC, 2017; Jiang and Begun, 2002; Ricketts and Randolph, 2008). To our knowledge, this study represents the largest report evaluating the movement of PC physicians at a state level. We attempted to identify person- and place-specific factors impacting a national problem – PC physician shortage – by taking an intricate and closer look at Texas. Interestingly, from the 8,055 physicians who moved, only 67 chose a shortage county as their destination, further exacerbating the PC shortage status of these areas.

The person-specific analysis revealed that osteopathic physicians (DO) were more likely to move compared to their allopathic counterparts ($P < 0.000$), which is consistent with another study conducted at the national level (Ricketts, 2015). However, the association did not hold when looking at the likelihood of DOs moving to a shortage Texas county. This contradicts findings by Fordyce et al, about DOs having a vital role in the rural health care workforce at the national level (Fordyce et al., 2012). It is possible however, that their conclusion does not apply to DOs practicing in Texas. In terms of age, younger physicians were more likely to move in general, while older physicians had higher odds of choosing a shortage county as their destination, as well as exiting the TMB database ($P < 0.000$). The latter is more likely due to older physicians becoming inactive or retiring, as opposed to moving outside of Texas. However, there is no reliable method for us to determine their exact destination, due to missing information from the TMB dataset. Lastly, graduates from public medical schools had a higher likelihood of moving to a shortage county compared to physicians who went to private medical school (P = 0.039). This association held at the national level, with a study showing that public medical school graduates were more likely to move from an urban county to a rural HPSA county (Ricketts, 2015).

As for the place-specific factors, we want to highlight the importance of having FQHCs in shortage counties, as they significantly increased the likelihood of physicians moving there (P < 0.000). This is consistent with national findings by Xue et al, reporting that the presence of FQHCs in a county reduced the primary care provider gap. One difference is that their definition of providers included nurse practitioners and physician assistants, in addition to physicians (Xue et al., 2018). Nevertheless, in terms of improving access to primary care, there is a certain need to increase the number of FQHCs in shortage counties.

We understand that our study is limited by the inherent biases and limitations of a large secondary data analysis, including the missing information for outcomes 5-8 in our movement pattern analysis, which lacked any descriptive data from the TMB. Given the large number of moves with an “outside” destination (n = 4,780), we understand that this information would have added more value to our analyses of movement outcomes. But the use of this database has two main advantages to previous similar studies which employed the American Medical Association (AMA) Masterfile (Petterson et al., 2013; Ricketts and Randolph, 2007). First, since the TMB is the only licensing body in Texas, a physician cannot practice in the State without first receiving a license from the TMB. This means that the database is as comprehensive as possible. Second, the TMB updates the database every 30 days, and according to the board rules, the physician is required to report “any change of mailing or practice address” to the TMB within 30 days of the event (TMB, 2016) (§166.1.(d)). Thus representing the most updated data on physician practice locations in Texas.

Another limitation of our findings is the inability to account for some key factors at the personal level, such as family ties, receipt of financial incentives (scholarships, loan repayment), and career aspirations. Including these factors would have improved our understanding of the physicians’ motives to move to shortage counties. However, data on these factors is not readily available, hence the need for future research to conduct active data collection from physicians on person- and place-specific factors affecting their movement decisions.

Conclusion

This is the largest study analyzing PC physician movements at a state level. We aimed to identify person- and place-specific factors that could possibly influence those moves. Our findings showed that physicians’ gender, age, medical school (public vs. private), medical degree (DO vs. MD), and Medicaid enrollment status, all had a significant association with their movement patterns. As for the destination county characteristics, a population of 50,000 or more, and the presence of FQHCs increased the odds of a physician moving to a shortage county. There is a need for research involving primary data collection from physicians to improve our understanding of person- and place-specific factors affecting their movement decisions, especially their motives to move to shortage counties.

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JOURNAL ARTICLE III

Title: Primary Care Shortage in Texas: a review of relevant policies and their effect on physician movements

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Abstract (250 words):

Purpose: This study aimed to clarify the policy landscape related to primary care shortage and identify any associations with changes to the movements of primary care physicians in Texas.

Methods: We conducted a desk review of relevant federal and state policies and identified three bills with possible effects on physician movements. Using physician data from the Texas Medical Board, we ran quantitative analyses to determine whether these policies were significantly associated with changes in physician movements.

Findings: Federal policies and programs on primary care shortage were stable throughout our study timeframe (2010-2014). While the state policy scene was more dynamic, with over 50 bills enacted between 2007 and 2015. Our comparative analysis for SB 894 did not detect a statistically significant difference in the movements of physicians to small counties (population ≤ 50,000) before and after the bill was enacted ($P = 0.796$). As for SB 189/SB 949 relevant to physicians on an H-1B visa, we identified a statistically significant difference in terms of the origin county status ($P < .000$). A higher percentage of moves from the "outside" (52.68%) and "non-shortage" (38.34%) counties occurred during the time SB 189 was effective, compared to a higher percentage of moves originating from "shortage" (43.40%) counties prior to SB 189.

Conclusions: It is challenging to determine the effect of a single policy on the movement patterns of physicians. Additional research is needed, covering a longer period and accounting for other confounding person- and place-specific factors.

Keywords: primary care physician, health professional shortage, health policy, healthcare workforce.

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Introduction

Recent years have witnessed an increased interest from researchers and policy-makers to devise and implement solutions to address primary care (PC) shortage (Bärnighausen and Bloom, 2009; Grobler et al., 2015; Wilson et al., 2009). The literature is divided between those who advocate for increasing the supply of PC physicians and those who recommend alternative solutions (Baldwin et al., 1998; Dill et al., 2013; Foster and Gorr, 1992; Green et al., 2013; Gulliford, 2002). The most commonly reported strategies in the literature can be grouped into three broad categories: those targeting *physician* recruitment and retention, those aiming to increase the employment of *alternative health providers*, and those that recommend the use of *outreach* services (III-Table 1).

The majority of studies on the topic (30) were concentrated in the first category, describing interventions and strategies directly influencing the physician workforce supply and retention. These strategies could be divided into four groups: *educational*, *financial*, *regulatory*, and personal and professional *support*. Educational programs were the most prominent, and ranged from modifying medical school admission policies to updating curricula by incorporating more exposure to rural health (Grobler et al., 2015; MacDowell et al., 2013; Rabinowitz, 1993; Rabinowitz et al., 2001, 1999, 1998; Stearns and Stearns, 2000; Wilson et al., 2009). On the other hand, strategies that provide financial incentives to physicians, including scholarships, loan repayment and higher salaries, were found to be the most commonly adopted by policy-makers, and at the same time were the most valued by physicians (Foster and Gorr, 1992; Hayashi et al., 2009; Humphreys and Rolley, 1998; Pathman et al., 2000). In terms of regulatory strategies, the United States is yet to establish a mandatory rural service program, and is relying on creating policies and visa waivers that attract international medical graduates to serve in these underserved areas (Fink et al., 2003; Terhune and Abumrad, 2009; Thompson et al., 2009). Lastly, the support interventions consisted of a number of initiatives implemented in the work setting (i.e. career development opportunities, effective mentorship programs) and at the personal level (i.e. community support, adequate schooling system) (Moran et al., 2014; Wilson et al., 2009).

The second category included strategies that recommended the employment of non-physician health providers to fill the needs of underserved populations. Accordingly, licensed nurses (registered nurses, nurse practitioners, and vocational nurses), physician assistants, midwives, pharmacists, psychologists and social workers, would be empowered to provide more autonomous PC services (Auerbach et al., 2013; Bodenheimer and Smith, 2013; Shipman and Sinsky, 2013). However, this approach usually receives strong opposition from the physician community which recommends stopping the expansion of non-physician practitioners' responsibilities beyond their education and training (TMA, 2014).

The third and final category of interventions involved the use of outreach programs to provide PC services in remote areas. Innovative technologies such as telehealth/telemedicine and guided patient self-care, proved to be effective in certain contexts (Dolea et al., 2009; Wilson et al., 2009). For instance, patients suffering from hypertension, who monitor their blood pressure at home with remote supervision from their PC provider, achieve better blood pressure control than those cared for solely by physicians (Bodenheimer and Smith, 2013; McManus et al., 2010). However, until now, little evidence is available on the associated costs and benefits of such applications. Moreover, several patient advocates have voiced their concerns about privacy and confidentiality issues which could be potentially breached when employing such technologies (Simoens and Hurst, 2006).

Overall, the evidence on the effectiveness of all these interventions is limited (Dolea et al., 2009; Grobler et al., 2015). There is an urgent need for evaluations to determine whether new and existing policies are effective in addressing the shortage of primary care physicians in the US. Such findings would serve as guidance for policy-makers when developing new strategies that target the recruitment and retention of physicians in shortage areas.

Objectives

First, we aimed to get a better understanding of the policy landscape related to primary care physician shortage. To do so, we conducted a desk review to identify and summarize federal and state policies on the topic. Our second aim was to determine whether these policies were associated with any changes to the movements of primary care physicians in Texas. For this purpose, we ran quantitative analyses using physician data from the Texas Medical Board.

Table III-1: Interventions Aimed at Solving the Primary Care Shortage Problem

	Interventions	Sources
Physicians (30 studies)	***Educational strategies*** Targeted admission policies for medical schools Location of medical schools and residency programs Undergraduate and postgraduate training exposure and location Rurally located medical school Rurally relevant curricula and rural clinical placements Multifaceted education interventions	(Baker et al., 2012; Bärnighausen and Bloom, 2009; Behmann et al., 2012; Council On Graduate Medical Education, 1998; Crump et al., 2013; Daniels et al., 2007; Dolea et al., 2009; Ernst and Yett, 1984; Grobler et al., 2015; Hancock et al., 2009; Henderson and Tulloch, 2008; Humphreys and Rolley, 1998; Lehmann et al., 2008; MacDowell et al., 2013; Matsumoto et al., 2008; Matsumoto and Kajii, 2009; Moran et al., 2014; Pathman et al., 2000; Rabinowitz, 1993; Rabinowitz et al., 1999, 1998; Rowley and Baldwin, 1984; Savageau et al., 2011; Sempowski, 2004; Simoens and Hurst, 2006; Stearns and Stearns, 2000; Wilson et al., 2009)
	Regulatory strategies Mandatory/compulsory period of service in underserved areas Recruiting foreign healthcare professionals	
	Financial incentives Scholarships, loan repayment and bonding schemes Higher salaries for individuals working in underserved areas Rural allowances Retention grants	
	Personal and Professional support Functional work environment Effective management, supervision and mentoring Improved professional development Continuing medical education Provision of locum relief Support from colleagues and networks of practitioners Adequate housing and school facilities	
Alternative Health Providers (12 studies)	Nurse-managed health centers Patient-centered medical homes Advanced rural nurse practitioner Empowering licensed personnel (registered nurses, physician assistants, midwives, pharmacists, …)	(Auerbach et al., 2013; Baldwin et al., 1998; Bergeson et al., 1997; Bodenheimer and Smith, 2013; Daniels et al., 2007; Dill et al., 2013; Kaissi, 2012; Keyzer, 1997; Lenz et al., 2004; O'Malley, 2013; Shipman and Sinsky, 2013; Sox, 2000)
Outreach (12 studies)	Telehealth Mobile Clinics Technology-guided patient self-care After-hours clinics and health centers	(Acosta, 2000; Bodenheimer and Smith, 2013; Council On Graduate Medical Education, 1998; Cutchin, 1997; Daniels et al., 2007; Dolea et al., 2009; Hart et al., 2002; Hayashi et al., 2009; Morris et al., 2011; Simoens and Hurst, 2006; Steinbrook, 2014; Wilson et al., 2009)

Methods

Desk Review

We used a combination of sources to review federal and state policies related to primary care physicians and shortage areas. For the federal policies, we focused our review on national physician incentive programs. We used the Library of Congress to review relevant policies and identify any changes that occurred over time (Congress, 2019).

At the state level, we used the Texas Legislature Online database to retrieve relevant bills (TLO, 2019). The review period included five legislative sessions (80^{th} – 84^{th}) covering nine years from 2007 to 2015. We ran multiple searches using several combinations of the following keywords: "Physician, Primary Care, Shortage, Underserved, and Rural". We also reviewed the published Summary of Enactments for each of the aforementioned sessions to generate a comprehensive list of bills. For each retrieved bill, we reviewed the text, the accompanying analysis, and the sub-chapters and sections of the amended statutes. We then conducted a thematic analysis of all the bills, highlighting common areas and possible relationships.

Physician Movement Data

Our study focused on the licensed PC physician population in the State of Texas between the years 2010 and 2014. We obtained data from the Texas Medical Board (TMB), the state agency responsible for regulating the practice of physicians. As part of its function, the TMB issues licenses to physicians intending to practice in Texas and regularly collects and disseminates data on all licensed physicians. This data is publicly available and represents the most regularly updated information on physicians in Texas (TMB, 2016).

We employed the TMB database to identify PC physicians who moved at any point in time during the 5-year study timeframe. The study focused on physicians with one of the following primary specialties: Family Practice or Family Medicine, General Practice, Obstetrics and Gynecology, Internal Medicine, Pediatrics, Medicine-Pediatrics, Psychiatry and Geriatrics. These were chosen in accordance with the definition of Primary Care adopted by the Texas Primary Care Office (DSHS, 2018). In order to limit the effects of censored data (Retired or Deceased), we excluded 396 observations involving physicians older than 80 years of age. This is in agreement with published reports by the Association of American Medical Colleges indicating an increasing number of active physician practicing beyond the traditional retirement age, with 10% being 70 years or older (AAMC, 2017; Petterson et al., 2016; Young et al., 2017). We defined a "move" to indicate the physician changing their county of practice, and remaining in the destination county for more than six months.

After completing the desk review, we used the physician movement data to discern whether certain policies resulted in possible changes in physician movement patterns. To this purpose, we focused on three State policies that appeared to have a direct effect on physicians in Texas. We employed Stata 15.1 to run the analyses, which varied depending on the studied policy and associated scenarios (StataCorp, 2017). To avoid redundancy, we describe the detailed methods for the quantitative analyses in the respective sections B.1 and B.3.

Results

A. Desk Review of Federal Policies

Our search revealed six federal programs and policies aimed at addressing primary care shortage in underserved areas of the country. Congress passed most of these policies more than 20 years ago, and they all appeared to be stable over the course of our study period (2010-2014). Accordingly, we did not run a comparative analysis in our TMB dataset on any of these programs and policies. The sections below provide a brief description of each federal program, highlighting their impact and any relevant changes when applicable.

1. The National Health Service Corps (NHSC)

The National Health Service Corps (NHSC) is administered by the Bureau of Health Workforce (BHW) (previously Bureau of Health Professions, prior to June 3, 2014) of the Health Resources and Services Administration (HRSA) (HRSA, 2017). Under the Emergency Health Personnel Act of 1970 (P.L. 91-623), Congress created the NHSC and its programs have been reauthorized serval times under **Title VII** of the Public Health Service Act (Heisler, 2018). The NHSC includes two components: (a) Federal Scholarship Program passed in 1972, providing assistance to health professions students in exchange for serving in a health professional shortage area for at least two years after graduation; (b) Federal Loan Repayment Program, initiated in the 1980s and targeted towards health professions graduates requiring service at an NHSC-approved work site for two years (full-time) or four years (part-time) (Institute of Medicine, 2012).

Most research evaluating the NHSC studied physician retention, as opposed to their recruitment. Some found that NHSC physicians had lower retention rates compared to their non-NHSC counterparts (Pathman et al., 1994, 1992). Other studies reached contradictory conclusions with documented increases in retention rates for NHSC physicians (Politzer et al., 2000).

In 2010, the Patient Protection and Affordable Care Act (ACA) provided a permanent reauthorization to the NHSC, removing the previously adopted funding with discretionary appropriations (Heisler, 2018). This provided some stability for the NHSC between 2011 and 2015. Afterwards, funding has been extended every two years, expiring in 2019 with uncertainties for the future.

2. Area Health Education Centers (AHECs) Program

Established by Congress through the Comprehensive Health Manpower Training Act (Public Law 92-157) in 1972, the Area Health Education Centers (AHECs) Program aims at improving the supply and retention of primary care providers in medically underserved areas of the country (Bacon et al., 2000; Gessert and Smith, 1981; NAO, 2019a). The AHECs Program is currently administered under **Title VII** by the HRSA, Bureau of Health Workforce (HRSA, 2017). AHECs work directly with medical schools by recruiting and training students and residents to provide primary care services in medically underserved communities and rural settings. Over time, these organizations generally appear to benefit the communities, schools, students, and residents (Fowkes et al., 1991). Some studies evaluating this program confirm a positive association between the participation of medical students in AHEC-supported training, and their intent to practice in medically underserved and rural areas (Taylor et al., 2015; Taylor and Goletz, 2016). While others found no significant effect of the program on the students' choice of primary care as a medical specialty after graduating from medical school (Brooks, 1992).

Texas was one of the pioneering states joining the AHEC program in 1972, with the University of Texas Medical Branch in Galveston being one of eleven universities in the country to first receive the award (Odegaard, 1979). Currently, there are 13 AHECs in Texas mainly serving rural areas of the state (NAO, 2019b). One study conducted in Texas reported on some of the barriers that face AHECs including, diverging priorities and cultural differences between schools and communities, and the lack of a strong health care delivery system in severely underserved areas (Fowkes et al., 1990).

In terms of funding, the AHEC program was authorized $125 million for FY 2010 through FY 2014. This allowed the program some financial stability to function during that period. However, the fate of AHECs is not certain with subsequently reported funding restrictions for FY 2017 and FY 2018 (Gessert and Smith, 1981).

3. Federally Qualified Health Centers (FQHCs)

Federally Qualified Health Centers (FQHCs) receive funds from HRSA under section 330 of the Public Health Service Act, to offer primary care services in medically underserved areas (Engel, 2006; HRSA, 2018). The concept of federally funded community health centers has been in existence since the early 1960s, it was not until 1990 when the Omnibus Reconciliation Acts created the definition of FQHCs (Jedele, 2016).

The literature reported on the success of FQHCs in terms of their positive impact on the communities. One study showed that FQHCs were able closed the primary care gap in shortage counties while addressing the imbalanced distribution of the health workforce (Xue et al., 2018). Another study reported that FQHCs played an important role in reducing cancer mortality-to-incidence ratios in populations with access to these centers (Adams et al., 2015).

Funding to FQHCs fluctuated over the years depending on political and economic factors. However, the American Relief and Recovery Act of 2009 (ARRA), and the Patient Protection and Affordable Care Act of 2010 (ACA) provided substantial financial support to FQHCs amounting to $2 billion and $11 billion respectively. These funds were intended for ongoing operations and expanding to new sites and services.

4. Public Service Loan Forgiveness (PSLF) Program

Congress established the Public Service Loan Forgiveness Program in 2007 by the College Cost Reduction and Access Act. This program is not restricted to health professionals, as individuals in other public sector jobs (i.e. military, law enforcement, and education) also qualify to receive forgiveness of their loans. In exchange, they need to serve for at least 10 years at an eligible institution (FSA, 2014). This program is not targeted towards working in shortage or rural areas, and for this reason we determined it would be out of scope for the purposes of our review.

5. Title VII and Title VIII

Titles VII and VIII of the Public Health Service Act authorize a number of programs for institutions to "expand the geographic, racial, and ethnic distribution of the health care workforce" (Dixon et al., 2015; Institute of Medicine, 2012). The BHW in HRSA is in charge of administering these programs. Title VII is geared towards physicians, mainly primary care training, including the NHSC and AHECs programs described above. While Title VIII funds nursing education and workforce diversity.

In 2010, The ACA reauthorized the Title VII and VIII health professions education and training programs for the first time in a decade, and increased the total appropriated funds (AAMC, 2010; Curtis, 2010).

6. Conrad 30 Waiver Program (Conrad 30)

The Conrad 30 Waiver Program (Conrad 30) allows International Medical Graduates (IMGs) on a J-1 visa to apply for a waiver of the 2-year home requirement upon completion of their training. In exchange, the physicians serve in a health professions shortage area for three years, which is how this program addresses the shortage of qualified physicians in the US. Originally, the Conrad 30 bill was enacted in 1994 and has been reauthorized multiple times since then, with no major revisions (AMA, 2017). Texas, like the other states, has 30 new positions to fill every year. Although priority is given to primary care and general practice physicians, specialists are also able to benefit from this waiver (DSHS, 2019).

B. Desk Review of State Policies

Our review at the state level resulted in 53 bills covering a variety of topics related to primary care physician shortage in Texas. In order to simplify the analysis, we grouped the bills into six themes that are in line with the identified interventions from the literature (Table III-2). In the following sub-sections, we will provide a summary of the bills and any findings pertaining to physician movement outcomes in relation to the enacted policies.

Table III-2: Thematic Groupings of Bills Enacted by the Texas Legislature (2007-2015)

Theme	**N**	**Theme**	**N**
1. Physician Employment*	18	4. Telemedicine	6
2. Loan Repayment and Medical Education	10	5. Alternative Health Providers	5
3. Physician Licensing*	5	6. Miscellaneous	9

** Has an associated quantitative analysis on physician movements*

1. Physician Employment

The topic that appeared most frequently in bills submitted to the Texas legislature during the review period pertained to the employment of physicians in this state. Since the early 1900s, the US enacted a strict prohibition against the **corporate practice of medicine**. The intent was to control the rise of unlicensed medical practice, when a number of unqualified groups were pretending to cure serious medical and psychological ailments. In addition, the medical profession was developing and private businesses began opening clinics and hiring physicians. This triggered concerns in the medical community leading many states to establish a requirement that "only **individuals** could be licensed to practice medicine", which has since been interpreted as a prohibition against the corporate practice of medicine (Duncan et al., 2011a; West, 2009a).

Texas remains one of few states that enforce this prohibition. However, exceptions to this rule prevailed with time, and the state allowed certain entities to employ physicians (i.e. private nonprofit medical schools, nonprofit health organizations, federally qualified health centers, state hospitals, and prisons). Proponents of bills supporting the employment of physicians argue that small Texas communities are suffering from this prohibition. They report that requiring an individual physician to establish a solo practice is costly and impractical, creating a deterrence to recruit and retain physicians to serve in small communities. Hence, such bills would allow certain counties and their hospital districts to provide needed economic security (i.e. health insurance and retirement plans), attracting a physician to "relocate and reside in the community" (Bonnen and Dennis, 2013a; Clardy, 2013a; Craddick, 2009a; Duncan et al., 2011a; McClendon, 2011a; Rodriguez, 2011; Seliger, 2011a, 2011b; Taylor, 2013a; West, 2009a, 2011a).

Table III-A-I in Appendix A provides a summary of the 18 bills addressing physician employment in Texas. Of these, 17 were enacted and one was vetoed by the governor because of amendments capping physician liability to $250,000 (Coleman, 2009).

Based on our review, the first bill (SB 1107) authorizing the employment of physicians by a county health district was enacted in 2007 (Watson, 2007). The bill was intended for larger counties with a population of more than 800,000. The physician employment bills continued in 2009, with SB 1705 authorizing Dallas County to hire 145 primary care physicians, and HB 4730 allowing Martin County to employ physicians and other health care providers. This trend peaked during the 82nd legislative session in 2011 and involved seven counties: Harris, Dallam, Hartley, Ochiltree, El Paso, Bexar, and Tarrant. Additionally, in that same legislative session, SB 894 amended the Health and Safety code Ch. 311 to enable hospitals in counties with a *population of 50,000 or less* to hire physicians directly (Duncan et al., 2011b). In 2013, Brazoria County and Nacogdoches County were authorized to employ physicians by the 83rd legislature.

Quantitative Analysis

Allowing specific hospital districts to hire physicians is certainly progress towards increasing accessibility to health services in these counties. We used the TMB dataset to assess whether the introduction of SB 894 was significantly associated with any changes in the number of physicians moving to counties with a population of 50,000 or less. We restricted our analysis to the 4,808 physician movements in Texas between 2010 and 2014, and generated a chart to visualize the monthly physician moves for each group of counties before and after the introduction of SB 894 in May 2011 (Figure III-1). Next, we divided the observations into two policy groups to reflect (1) pre-SB 894 and (2) post-SB 894. The Chi-square test showed no significant changes in the county destinations of physician moves between the two policy groups (Table III-3).

Figure III-1: Physician Moves by Destination County Population, n = 4,808 (2010-2014)

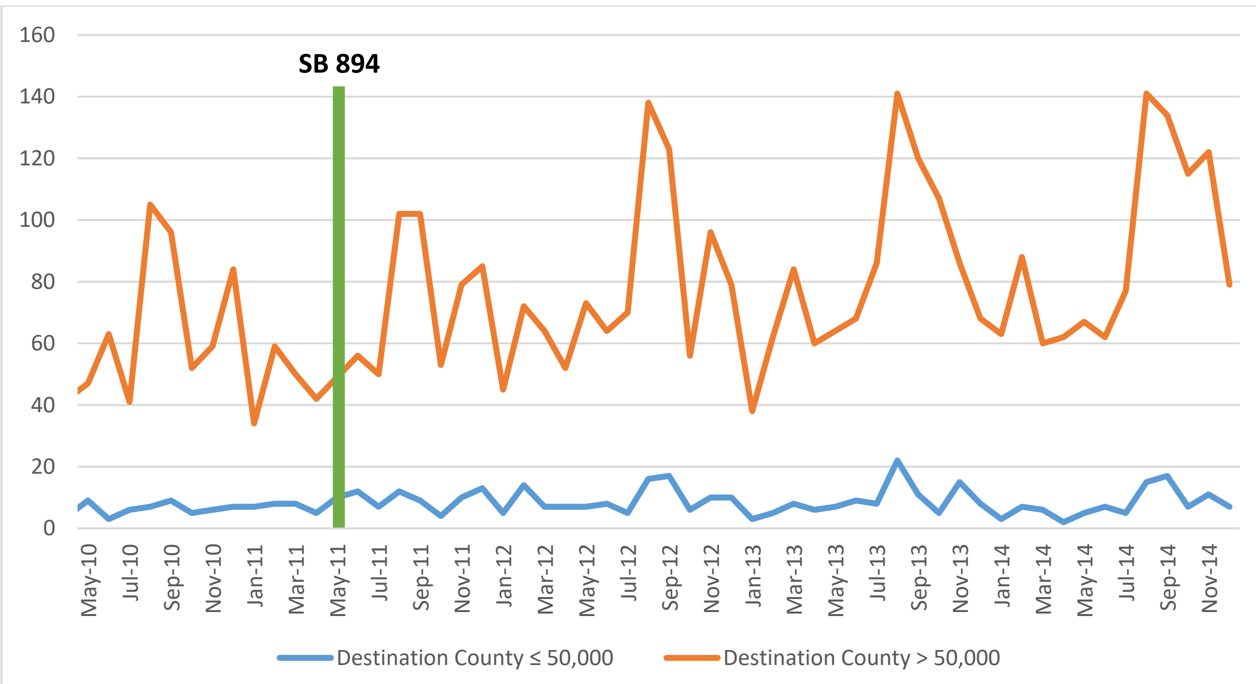

Table III-3: Physician Moves by County Population Pre- and Post- SB 894

Population Size of Destination Counties				
Policy Group (n = 4,808)	≤ 50,000	> 50,000	**Total**	Chi-square test [a]
Pre-SB 894	10.25% (94)	89.75% (823)	**917**	P = 0.624
Post-SB 894	9.71% (378)	90.29% (3,153)	**3,891**	
Total	**472**	**4,336**	**4,808**	
[a] Significance level α = 0.05				

2. Loan Repayment and Medical Education

Table III-A-2 in Appendix A provides a summary of the ten bills in the category of loan repayment and medical education. We focused our review on HB 2154, HB 3456, SB 24/SB 317, and SB 18 given their introduction of important changes to the health policy landscape. The remaining four bills were not directly related to primary care physician practice in shortage areas.

Loan repayment programs have historically been a major incentive for physicians to practice in medically underserved areas and health professional shortage areas (Dolea et al., 2009; Duffrin et al., 2014; Friedberg et al., 2017; Walker et al., 2010). The 81st legislature enacted a bill in 2009 (HB 2154) decreasing the number of years for which a physician can receive assistance from five to four. It also established maximum amounts of repayment for each of the four years with an overall maximum of $160,000 per physician for the entire service duration (Edwards, 2009a, 2009b). From our perspective, this bill could possibly serve as a disincentive for physicians to move to a shortage area, and more importantly, it would further affect their retention in such areas. Since this policy precedes the start date of our physician dataset, we were unable to run any comparative analyses to identify whether its introduction had any effect on physician movements.

The 81st legislature enacted another bill (HB 3456) specific to Baylor College of Medicine's (BCM) residency program by removing the priority previously given to applicants demonstrating a willingness to practice in medically underserved areas of Texas. It also removed percentage goals for the appointment of first-year residents in certain primary care areas of family practice. Previously, BCM was required to have 50% of the first-year resident physicians in the primary care areas, with 25% of those residents in family practice. HB 3456 was certainly a step in the opposite direction of addressing primary care physician shortage in Texas. However, given its restriction to one institution and its introduction in 2009, we were unable to determine whether this bill had any bearing on our physician dataset.

Two bills (SB 24 and SB 317) were related to the creation of The University of Texas Rio Grande Valley and were enacted by the 83rd and 84th legislatures respectively. SB 24 established the university in 2013, while SB 317 simply renamed it as the University of Texas Rio Grande Valley in 2015 (Hinojosa et al., 2015a, 2013a). The creation of a new medical school in South Texas has an unquestionable significance in improving the status of the four underserved counties making up the Rio Grande Valley (Hidalgo, Cameron, Willacy, and Starr). The University of Texas anticipated an increase of medical residents to 150 per year, thus expanding access to health care services in a region designated as a medically underserved area with severe physician shortage (Hinojosa et al., 2013b). In 2016, the school of medicine welcomed its first class of 55 students (Pascual Figal et al., 2003). Accordingly, we did not run any comparative analyses since the effect of this policy would take years to materialize into changes in physician moves.

Lastly, HB 2908 enacted by the 82nd legislature aimed at understanding mechanisms to improve the retention of medical school graduates in residency programs. Advocates of the bill asserted that Texas has more students graduating from medical schools, than it has graduate medical education program slots for completing residency programs. This leads many medical graduates to move out of state and ultimately practice medicine in the same area where they completed their residency (Branch and Davis, 2011a). HB 2908 sought to address this problem by commissioning an assessment of the adequacy of opportunities for graduates of medical schools in Texas to enter residency programs in the state. This included the development of methods and strategies for achieving a ratio for the number of first-year graduate medical education positions to the number of medical school graduates in this state of at least 1.1 to 1 (Branch and Davis, 2011b). Four years later, based on the results of this assessment, the 84th legislature enacted SB 18 to address shortages in residency slots in Texas by creating a permanent endowment of around $300 million to be dedicated for expanding graduate medical education starting in 2018. The ultimate goal is to reach that 1.1-to-1 ratio of residency slots to medical graduates in Texas, while prioritizing areas of critical shortage (Nelson et al., 2015a). HB 2908 and SB 18 are significantly important in addressing the physician shortage in Texas. However, since the actual endowment was set to begin in 2018 it places any effects this policy might have had beyond the scope of our physician dataset.

3. Physician Licensing

We identified five bills on physician licensing (Table III-A-3), two of which were unrelated to physician shortage or primary care underserved areas, so we excluded them from our review. In the following, we cover the remaining three bills SB 202, SB 189, and SB 949.

The 81st legislature enacted SB 202 in 2009, allowing physicians to acquire a provisional license to practice medicine in a health professional shortage or medically underserved area. This provisional license is valid for a maximum of 270 days after which the physician needs to acquire a license from the Texas Medical Board (Shapleigh and Uresti, 2009a). The option for that provisional license is available on the TMB website (TMB, 2019). Since the provisions of the bill apply to a license application submitted on or after January 1, 2010, which is the start of our physician dataset timeline, we were unable to run any comparative analyses due to the absence of a baseline.

Then, SB 189 came into effect in 2011 requiring physicians on an H-1B visa who apply for a Texas medical license to provide three years of service in a health professional shortage area, medically underserved area, or at a graduate medical training program (Nelson, 2011a). Around two years later, the 83rd legislature repealed SB 189 by enacting SB 949. At face value, it is possible that such a policy could specifically affect international physician movements in Texas. SB 189, which was in effect from September 2011 to June 2013, could have discouraged certain international physicians from moving to Texas, while incentivizing others to move to shortage areas. When SB 949 was enacted in 2013, the circumstances reverted to pre-SB 189 for physicians on H-1B visas.

Quantitative Analysis

Using our TMB dataset, we employed available data on international medical graduates (IMGs) to identify any changes in their movements. It is important to note that not all IMGs hold an H-1B visa. Hence, we adopted this variable as a proxy measure. We divided the observations into three policy groups to reflect (1) pre-SB 189, (2) when SB 189 was effective, and (3) after it was repealed by SB 949. We focused our analysis on IMGs who had at least one documented move between 2010 and 2014, reaching a total of 2,836 moves. Since some physicians moved more than once, our unit of analysis in this case was a "move" and not a "unique physician". Table III-4 below outlines the status of origin and destination counties of IMG movers by policy group. We used Fisher's exact test to determine whether any differences exists between the three policy groups of physician moves and the status of the origin and destination counties. Based on our findings, there was not a statistically significant change in physician movements in terms destination county status (P = 0.091), while that difference was statistically significant with the status of origin counties (P < 0.000).

Table III-4: Origin and Destination Status by SB189/SB949 Policy Groups

Origin				
Policy Group	Outside [a]	Non-shortage	Shortage	Fisher's exact test [b]
IMGs pre-SB189	2 (1.79%)	639 (23.92%)	23 (43.40%)	**P < 0.000**
IMGs during SB 189	59 (52.68%)	1,024 (38.34%)	14 (26.42%)	
IMGs after SB 949	51 (45.54%)	1,008 (37.74%)	16 (30.19%)	
Total	**112**	**2,671**	**53**	
Destination				
Policy Group	Outside [a]	Non-shortage	Shortage	Fisher's exact test [b]
IMGs pre-SB 189	348 (25.53%)	309 (21.35%)	7 (26.92%)	P = 0.091
IMGs during SB 189	523 (38.37%)	565 (39.05%)	9 (34.62%)	
IMGs after SB 949	492 (36.10%)	573 (39.60%)	10 (38.46%)	
Total	**1,363**	**1,447**	**26**	
[a] Outside of Texas, Retired, Inactive, or Deceased; [b] Significance level $\alpha = 0.05$				

4. Telemedicine

Telemedicine is defined as health care services delivered by a **physician** via remote web technologies, such as videoconferencing and review of patient records. Telehealth is a broader term encompassing telemedicine as well as health care services delivered by **other providers**, such as nurses, physician assistants, and pharmacists (HealthIT.gov, 2017). Given the large rural areas of Texas, lawmakers argued that telehealth would be a cost-effective and convenient solution to bring needed health care services to these underserved communities (Laubenberg et al., 2015a; Nelson, 2007a; Watson and Nelson, 2011a).

The Texas legislature has been relatively active in expanding the use of these technologies and making necessary amendments to ensure physicians are reimbursed for such services. Our search returned six bills related to the provision of Telemedicine and Telehealth between 2007 and 2015 (Table III-A-4). Four of these bills (SB 24, SB 760, SB 293, and HB 1878) amended the Government Code to provide reimbursement under the Medicaid program for Telemedicine and Telehealth services (Laubenberg et al., 2015b; Nelson, 2007b, 2007c; Watson and Nelson, 2011b). It is worth noting that the 85th legislature was even more active in 2017, allowing for reimbursement by insurance companies, and removing the requirement of an in-person visit to establish a practitioner-patient relationship (Schwertner and Perry, 2017a, 2017b). The remaining two bills were also in line with expanding telemedicine and telehealth, but not directly related to primary care service.

Reinforcing telemedicine as a solution for primary care shortage in rural areas is inarguably a move in the right direction to fill the gap for underserved populations in Texas. In terms of how this would affect physician movements, it remains too early to determine whether these initiatives will deter primary care physicians from moving to rural areas, preferring to practice remotely. Accordingly, we did not have sufficient information to run a comparative analysis that would generate reliable findings using our physician dataset.

5. Alternative Health Providers (Nurses and Physician Assistants)

As reported in the literature, employing non-physician health providers could fill the primary care shortage gap in certain areas (Auerbach et al., 2013; Bodenheimer and Smith, 2013; Shipman and Sinsky, 2013). However, those alternative health providers also suffer from shortages themselves and are limited by their scope of practice (Chan et al., 2013; Pelayo, 2013). This prompted the Texas legislature to enact five bills on this topic (Table III-A-5).

The 80th and 81st legislatures attempted to address the nursing shortage problem in Texas, which was reported at around 22,000 registered nurses in 2009. One reason is the inability of nursing schools to graduate enough nurses due to difficulties in recruiting and retaining faculty. Accordingly, SB 289 and HB 4471 allow for additional grants, and the use of funds for hiring part-time faculty (Kolkhorst et al., 2009a; Nelson, 2007d).

As for physician assistants (PAs), SB 1984 (81st legislature) granted them the authority to issue a prescription for a disabled parking placard, which was previously restricted to a licensed physician. This bill specified that this authorization is only applicable when the applicant for a disabled parking placard resides in a county with a population of 125,000 or less (Uresti and Hegar, 2009a). Two years later, the 81st legislature removed the restriction on county population size, and extended the authorization to all healthcare providers acting under the delegation and supervision of a licensed physician. The reasoning behind this is that certain larger counties still contain medically underserved areas (King, 2011a).

The fifth and final bill of this category (SB 406) relates to the number of advanced practice registered nurses and physician assistants with whom a physician may enter into a prescriptive authority agreement. According to Sec. 157.0512.(c) of the Occupations Code

(Subchapter B, Chapter 157), that number cannot exceed seven. However, this cap does not apply in a practice located in a medically underserved area (Nelson et al., 2013a).

Since all these bills are focused on non-physician providers, we did not conduct a comparative analysis as our dataset only contains physician data.

6. Miscellaneous (Rural and Studying Physician Shortage)

This last category of nine bills covered important issues relevant to rural health in general, but did not specifically enact any changes that would affect physician movements in Texas. Without going into a detailed description of these bills, they are summarized in Table III-A-6, and covered topics on primary care, studying physician shortage, and general rural health needs.

Discussion

Our study combined a qualitative review and analysis of policies, with quantitative methods in an attempt to understand the effect of policies on physician movements in Texas. Of all the federal and state policies included in this review, only three had an applicable quantitative analysis. Federal policies were stable, and did not allow for any comparisons within our data timeframe of 2010-2014. The same applies to most state policies that became effective either before or after the time limits of our dataset. The analysis would have benefited from a larger dataset covering more than 10 years of physician movements.

The quantitative analysis of SB 894, which encouraged physician employment in small counties (population ≤ 50,000), did not reveal any significant changes in the physician movements before and after the bill was enacted. This could be reflective of a true absence of any policy effect. Alternatively, it could be explained by the short time period for the baseline group covering only 15 months before SB 894 was enacted, which might not be representative of physician moves in earlier years.

As for the SB189/SB949 analysis on IMGs, the difference between the three groups of movements (pre-SB 189, during SB189, and post-SB949) was not significant in terms of the destination county status. While a statistically significant difference was detected for the origin county status. More specifically, we detected a higher percentage of IMG moves from the "outside" (52.68%) and "non-shortage" (38.34%) counties during the time SB 189 was effective. Compared to a higher percentage of moves originating from "shortage" (43.40%) counties before SB 189 was enacted. Since our dataset did not include a specific variable on physicians with an H-1B visa status, we used information on IMGs as a proxy measure. This could have possibly introduced bias, since not all IMGs are on H-1B visas. Accordingly, our findings are inconclusive given the possible interference from different factors. A multivariate analysis would be a more appropriate tool to identify whether these policies had any impact on physician movements.

Conclusion

We aimed to understand the intricate relationship between policies and physician movements in Texas. Our desk review revealed that federal policies were stable, compared to a more dynamic policy scene at the state level. We focused our quantitative analysis on three bills enacted by the Texas legislature. Only one bill, requiring international physicians to work in underserved areas, revealed a statistically significant difference in terms of the origin county status. Additional research is needed to identify whether an association between policy and physician movements persists, when accounting for different person- and place-specific factors.

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CONCLUSION

To the researcher's knowledge, this is the largest study analyzing PC physician movements at a state level. Aim 1 and Aim 2, intended to get a better understanding of the different person- and place-specific factors that could possibly influence those moves. Findings showed that the majority of PC physicians are stable, and when they decide to move, their outflow is greater than their influx to the state of Texas. Moreover, physicians' gender, age, medical school (public vs. private), medical degree (DO vs. MD), and Medicaid enrollment status, all had a significant association with their movement patterns. As for counties, the results were in line with the general perceptions of shortage counties being smaller and less populous. In terms of place-specific factors, a population of 50,000 or more, and the presence of FQHCs increased the odds of a PC physician moving to a shortage county.

For Aim 3, the researcher sought to understand the intricate relationship between policies and PC physician movements in Texas. A desk review revealed that federal policies were stable, compared to a more dynamic policy scene at the state level. The researcher then conducted comparative analyses on three bills enacted by the Texas legislature within the study timeframe (2010-2014). Only one bill, requiring international physicians to work in underserved areas, revealed a statistically significant difference in terms of the origin county status.

One major strength of this study lies in using combined quantitative and qualitative approaches. Hence, the findings constitute a comprehensive evaluation of the PC physician shortage in Texas, covering the three layers of person, place, and policy factors. Another advantage was tracking physician movements on a monthly basis, while previous methods only measured the net movements between two points in time. The third and final strength is related to the use of the Texas Medical Board database, which is more up-to-date and reliable compared to the non-mandatory self-reported data in the American Medical Association Masterfile, usually used for studies on physicians.

The analyses were limited by the inherent biases and limitations of a large secondary data analysis, including the missing information on exiting physicians and other important personal factors (i.e. family ties, receipt of financial incentives, and career aspirations). Accordingly, there is a need for research involving primary data collection from physicians to improve our understanding of person- and place-specific factors affecting their movement decisions, especially their motives to move to shortage counties. The study was also restricted by the five-year timeframe, which proved to be too short for reliably observing associations between policies and physician movements. Additional research is needed covering at least ten years of observation to identify policy effects while accounting for different person- and place-specific factors.

APPENDICES

Appendix A: Summary Tables for Texas Legislature Bills (2007-2015)

Table III-A-1: Bills on Physician Employment in Texas (2007-2015)

No.	Legislature Year	Bill	Author(s)	Effective	Statute	Caption
1	80th 2007	SB 1107	Watson	9/1/2007	Government Code Health and Safety Code Occupations Code	Relating to the powers and duties of the **Travis** County Healthcare District. [a hospital district created in a county with a population of more than 800,000 may employ physicians] (Watson, 2007)
2	81st 2009	SB 1705	West	6/19/2009	Health and Safety Code	Relating to the authority and policies and procedures of the **Dallas** County Hospital District with regard to appointing, contracting for, or employing physicians, dentists, and other health care providers. [allowing the employment of approximately 145 primary care physicians] (West, 2009a, 2009b)
3	81st 2009	HB 3485	Coleman	Vetoed	Health and Safety Code	Relating to certain county, municipal, district, and other governmental functions, procedures, powers, duties, and services, including certain criminal procedures. [an amendment was added late in the session introducing a liability cap for physicians at $250,000 leading the governor to veto this bill] (Coleman, 2009; Perry, 2009)
4	81st 2009	HB 4730	Craddick	6/19/2009	Acts of the 60th Legislature	Relating to the **Martin** County Hospital District. (Craddick, 2009b)
5	82nd 2011	HB 1566	Coleman	6/17/2011	Local Government Code	Relating to the authority of counties to appoint, contract for, or employ physicians, dentists, or other health care providers for county jails. (Coleman, 2011a)
6	82nd 2011	HB 1567	Coleman	6/17/2011	Local Government Code	Relating to the authority of certain counties to appoint, contract for, or employ physicians, dentists, or other health care providers for county jails. (Coleman, 2011b)
7	82nd 2011	HB 1568	Coleman	6/17/2011	Health and Safety Code Local Government Code	Relating to the authority of certain local governmental entities in certain populous counties to appoint, contract for, or employ physicians. [specifically related to **Harris** County Hospital District Sec. 281.0283 of Subchapter B, Chapter 281, Health and Safety Code] (Coleman, 2011c, 2011d)

No.	Legislature Year	Bill	Author(s)	Effective	Statute	Caption
8	82nd 2011	SB 310	Seliger	6/17/2011	Special District Local Laws Code	Relating to the **Dallam-Hartley** Counties Hospital District. (Seliger, 2011a, 2011c)
9	82nd 2011	SB 311	Seliger	6/17/2011	Special District Local Laws Code	Relating to the authority of the board of directors of the **Ochiltree** County Hospital District to employ physicians and other health care providers. (Seliger, 2011b, 2011d)
10	82nd 2011	SB 860	Rodriguez	6/17/2011	Health and Safety Code	Relating to the authority of the **El Paso** County Hospital District to appoint, contract for, or employ physicians, dentists, and other health care providers. (A. Rodriguez, 2011; Rodriguez, 2011)
11	82nd 2011	HB 2351	McClendon	6/17/2011	Health and Safety Code	Relating to the authority of the **Bexar** County Hospital District to employ physicians. (McClendon, 2011a, 2011b)
12	82nd 2011	SB 303	Nichols	9/1/2011	Health and Safety Code	Relating to health care services provided or paid by certain hospital districts. [authorizes the board of the **Tarrant** County Hospital District to appoint, contract for, or employ physicians] (Nichols, 2011a, 2011b)
13	82nd 2011	SB 894	Duncan et al.	5/12/2011	Health and Safety Code	Relating to employment of physicians by certain hospitals. [applicable to any hospital located in **a county with a population of 50,000 or less**] (Duncan et al., 2011a, 2011b)
14	82nd 2011	SB 761	West	6/17/2011	Health and Safety Code	Relating to the employment of physicians by certain hospitals associated with nonprofit fraternal organizations. (West, 2011a, 2011b)
15	83rd 2013	HB 3905	Bonnen, Dennis	6/14/2013	Special District Local Laws Code	Relating to the Angleton-Danbury Hospital District of **Brazoria** County, Texas. (Bonnen and Dennis, 2013a, 2013b)
16	83rd 2013	SB 1861	Taylor	6/14/2013	Special District Local Laws Code	Relating to the Angleton-Danbury Hospital District of **Brazoria** County, Texas. (Taylor, 2013a, 2013b)
17	83rd 2013	HB 1247	Clardy	6/14/2013	Special District Local Laws Code	Relating to the authority of the board of directors of the **Nacogdoches** County Hospital District to employ physicians. (Clardy, 2013a, 2013b)
18	84th 2015	HB 3433	Sheffield et al.	6/16/2015	Health and Safety Code	Relating to level of care designations for hospitals that provide neonatal and maternal care. [allowing to hire two physicians (instead of one) at a hospital that has 50 or fewer patient beds located in a county with a population of 60,000 or less] (Sheffield et al., 2015a, 2015b)

Table III-A-2: Bills on Loan Repayment in Texas (2007-2015)

No.	**Legislature Year**	**Bill**	**Author(s)**	**Effective**	**Statute**	**Caption**	**Topic**
19	81st 2009	HB 2154	Edwards	9/1/2009	Education Code	Relating to the physician education loan repayment program. [decreased the number of years for which a physician is allowed to receive assistance (from 5 to 4 years)] (Edwards, 2009a, 2009b)	Loan repayment
20	81st 2009	HB 3456	Branch et al.	5/19/2009	Education Code	Relating to the education and preparation of resident physicians. (Branch et al., 2009a, 2009b)	Medical Education
21	82nd 2011	HB 1908	Madden	6/17/2011	Education Code	Relating to student loan repayment assistance for certain providers of correctional health care. [allows physicians working in correctional facilities to receive loan repayment assistance for up to four years; limited for the first ten physicians each year] (Madden, 2011a, 2011b)	Loan repayment
22	82nd 2011	HB 3579	Gonzales, Larry	6/17/2011	Education Code	Relating to repayment assistance for certain physician education loans. [repealed Section 61.535(b) of the Education Code which was about authorizing a repayment to be applied only to the principal amount of the loan] (Gonzales and Larry, 2011a, 2011b)	Loan repayment
23	82nd 2011	HB 2908	Branch et al.	9/1/2011	Education Code	Relating to providing graduate medical education positions for Texas medical school graduates. (Branch and Davis, 2011a, 2011b)	Medical Education
24	83rd 2013	HB 2550	Patrick, Diane	9/1/2013	Education Code	Relating to the consolidation of the Higher Education Enrollment Assistance Program and the Higher Education Assistance Plan and the transfer of certain enrollment assistance duties to institutions of higher education and to measures to enhance medical education. (Patrick and Diane, 2013a, 2013b)	Medical Education
25	83rd 2013	SB 24	Hinojosa et al.	6/14/2013	Education Code	Relating to the creation of a new university in South Texas within The University of Texas System. (Hinojosa et al., 2013a, 2013b)	Medical Education
26	84th 2015	SB 18	Nelson et al.	9/1/2015	Education Code Health and	Relating to measures to support or enhance graduate medical education in this state, including the transfer of certain assets from the Texas Medical Liability Insurance Underwriting	Medical Education

No.	Legislature Year	Bill	Author(s)	Effective	Statute	Caption	Topic
					Safety Insurance Code	Association to the permanent fund supporting graduate medical education and the authority of the association to issue new policies. (Nelson et al., 2015a, 2015b)	
27	84th 2015	HB 2396	Howard et al.	06/20/2015	Education Code	Relating to eliminating requirements that certain public institutions of higher education set aside portions of tuition for student loan repayment programs for certain physicians and state attorneys. (Howard et al., 2015a, 2015b)	Loan repayment
28	84th 2015	SB 317	Hinojosa et al.	5/23/2015	Education Code	Relating to The University of Texas Rio Grande Valley. (Hinojosa et al., 2015a, 2015b)	Medical Education

Table III-A-3: Bills on Physician Licensing in Texas (2007-2015)

No.	Legislature Year	Bill	Author(s)	Effective	Statute	Caption
29	80th 2007	SB 36	Nelson et al.	6/15/2007	Occupations Code	Relating to the examination of certain applicants for a license to practice medicine. (Nelson and Van de Putte, 2007a, 2007b)
30	81st 2009	SB 202	Shapleigh et al.	9/1/2009	Occupations Code	Relating to provisional licensing of physicians to practice in underserved areas. (Shapleigh and Uresti, 2009a, 2009b)
31	82nd 2011	SB 189	Nelson	9/1/2011	Occupations Code	Relating to the eligibility of certain aliens for a license to practice medicine in this state. (Nelson, 2011a, 2011c)
32	83rd 2013	SB 336	Rodríguez	9/1/2013	Code of Criminal Procedure	Relating to the qualifications for appointment as a medical examiner. (Rodríguez, 2013a, 2013b)
33	83rd 2013	SB 949	Nelson	6/14/2013	Occupations Code	Relating to licensing under the Medical Practice Act. [repeals amendments made by SB 189] (Nelson, 2013a, 2013b)

Table III-A-4: Bills on Telemedicine in Texas (2007-2015)

No.	**Legislature Year**	**Bill**	**Author(s)**	**Effective**	**Statute**	**Caption**
34	80th 2007	SB 24	Nelson	6/15/2007	Government Code	Relating to certain health care services provided through telemedicine or telehealth under the state **Medicaid** program. (Nelson, 2007a, 2007b)
35	80th 2007	SB 760	Nelson	9/1/2007	Government Code	Relating to participation and reimbursement of telemedicine medical service providers under the **Medicaid** program. (Nelson, 2007c, 2007f)
36	82nd 2011	SB 219	Nelson	9/1/2011	Government Code	Relating to health and mental health services for children in foster care and kinship care. (Nelson and Van de Putte, 2011a, 2011b)
37	82nd	SB 293	Watson et al.	9/1/2011	Government Code	Relating to telemedicine medical services, telehealth services, and home telemonitoring services provided to certain **Medicaid** recipients. (Watson and Nelson, 2011a, 2011b)
38	84th 2015	HB 1878	Laubenberg et al.	9/1/2015	Government Code	Relating to the provision of telemedicine medical services in a school-based setting, including the reimbursement of providers under the **Medicaid** program for those services. (Laubenberg et al., 2015a, 2015b)
39	84th 2015	HB 479	Bell et al.	9/1/2015	Health and Safety Code	Relating to the transfer of the regional emergency medical dispatch resource centers program to the Commission on State Emergency Communications and a pilot project to provide emergency telemedicine medical services in rural areas. (Bell et al., 2015a, 2015b)

Table III-A-5: Bills on Alternative Health Providers (Nurses and Physician Assistants) in Texas (2007-2015)

No.	**Legislature Year**	**Bill**	**Author(s)**	**Effective**	**Statute**	**Caption**
40	80th 2007	SB 289	Nelson	6/15/2007	Education Code	Relating to the use of professional **nursing shortage reduction** program grants to encourage clinical nursing instruction by part-time faculty at public or private institutions of higher education. (Nelson, 2007d, 2007g)
41	81st 2009	HB 4471	Kolkhorst et al.	6/19/2009	Education Code	Relating to the professional nursing shortage reduction program. (Kolkhorst et al., 2009a, 2009b)
42	81st 2009	SB 1984	Uresti et al.	6/19/2009	Transportation Code	Relating to certification of a person in certain counties as eligible for disabled parking privileges. (Uresti and Hegar, 2009a, 2009b)
43	82nd 2011	HB 2080	King, Tracy O.	6/17/2011	Transportation Code	Relating to certification of a person as eligible for disabled parking privileges. (King, 2011a, 2011b)
44	83rd 2013	SB 406	Nelson et al.	11/1/2013	Occupations Code Government Code Health and Safety Code Human Resources Code	Relating to the practice of advanced practice registered nurses and physician assistants and the delegation of prescriptive authority by physicians to and the supervision by physicians of certain advanced practice registered nurses and physician assistants. (Nelson et al., 2013a, 2013b)

Table III-A-6: Bills on Miscellaneous Topics related to Rural and Studying Physician Shortage in Texas (2007-2015)

No.	Legislature Year	Bill	Author(s)	Effective	Statute	Caption	Topic
45	80th 2007	SB 10	Nelson et al.	9/1/2007	Government Code Human Resources Code	Relating to the operation and financing of the medical assistance program and other programs to provide health care benefits and services to persons in this state; providing penalties [requiring recipients of assistance programs to designate a primary care provider; commissions a study on increasing the number of medical residents and residency programs] (Nelson et al., 2007a, 2007b)	Primary Care Studying physician shortage
46	80th 2007	SB 29	Nelson	6/15/2007	Health and Safety Code	Relating to the creation of a minimum data set for the collection of information on health professionals by the statewide health coordinating council [including physicians]. (Nelson, 2007e, 2007h)	Studying physician shortage
47	81st 2009	HB 1684	Brown, Betty et al.	8/31/2009	Government Code	Relating to the creation and administration of the rural veterinarian loan repayment program. (Brown et al., 2009a, 2009b)	Rural
48	81st 2009	SB 1016	Estes et al.	9/1/2009	Agriculture Code	Relating to the continuation and functions of the Department of Agriculture and the Prescribed Burning Board, the creation of the Texas Bioenergy Policy Council and Texas Bioenergy Research Committee, and the abolition of the Texas-Israel Exchange Fund Board; providing penalties. [created the Texas Rural Investment Fund] (Estes and Hegar, 2009a, 2009b)	Rural
49	82nd 2011	SB 74	Nelson	6/17/2011	Government Code	Relating to the disposition of surplus or salvage data processing equipment of a university system or an institution or agency of higher education. (Nelson, 2011b, 2011d)	Rural
50	83rd 2013	HB 1023	Burkett et al.	6/14/2013	Not Applicable	Relating to recommendations by the Health and Human Services Commission or a designated health and human services agency regarding mental health	Studying physician shortage

No.	Legislature Year	Bill	Author(s)	Effective	Statute	Caption	Topic
						workforce shortages. (Burkett and Alvarado, 2013; Schwertner and Perry, 2017b)	
51	83rd 2013	HB 1493	King, Tracy O.	9/1/2013	Education Code Government Code	Relating to the transfer of programs from the Texas Department of Rural Affairs to the Department of Agriculture. [Texas Department of Rural Health closed and was assimilated as an office within Texas Department of Agriculture] (King, 2013a, 2013b)	Rural
52	84th 2015	HB 74	González	9/1/2015	Government Code	Relating to certain financial assistance administered by the Texas Department of Housing and Community Affairs in certain rural areas. [designation of certain areas as rural] (González, 2015a, 2015b)	Rural
53	84th 2015	SB 1305	Menéndez et al.	6/19/2015	Health and Safety Code	Relating to the creation of a rural veterans mental health initiative within the mental health intervention program for veterans.(Menéndez et al., 2015a, 2015b)	Rural

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