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Distribution and Adequacy of Delivery Care Providers in the United States

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Abstract

Distribution and Adequacy of Delivery Care Providers in the United States
By Jennifer Vanderlaan

Obstetrician benchmarks have been used to measure maternity care workforce adequacy in the United States since 1981. These measures are not precise enough to capture evolving differences in non-physician workforce, nor do they allow for regional differences in fertility rates. Using GIS technology to compare the distribution of areas with adequate workforce reveals differences between obstetrician to population measures and obstetrician equivalent to birth measures. Using a measure of adequacy that includes a count of midwives reveals associations between policies regulating midwifery practice and proportion of areas with adequate delivery workforce.

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Part One: Introduction

Introduction and Rationale

Maternal health care is an important expense in the United States. Childbirth is the leading reason for hospitalization, accounting for 4.2 million hospital stays in 2009 (Wier et al., 2011) and maternity care is the fourth leading reason for an outpatient visit (Sakala & Corry, 2008). Delivery care accounted for 23% of all Medicaid paid hospital stays in 2009. The three most common conditions paid for by Medicaid are related to childbirth and together accounted for 30% of all Medicaid billed stays. Additionally, the most commonly performed operating procedure is cesarean section (Wier et al., 2011). Average estimated costs for maternity care range from $7,000 for an uncomplicated vaginal birth to $16,000 for a cesarean surgery (Sakala & Corry, 2008). The total costs for live births in 2009 was $11.6 billion (Wier et al., 2011).

In the World Health Organization publication, Trends in maternal mortality: 1990 to 2010, the authors estimate maternal mortality in the United States increased 65% between 1990 and 2010 (World Health Organization, 2012c). In some literature, the increase is attributed to a 2007 vital statistics system change to track late maternal deaths (Hogan et al., 2010). Other studies indicate an increase in maternal age with a resultant increase in cardiovascular and CNS disorders (Rossi & Mullin, 2012). Whether the measure represents a change in health outcome or simply improved monitoring, the United States ranks 47th internationally for maternal mortality, tied with Iran and Hungary (World Health Organization, 2012b).

Within the United States, disparities in maternal outcomes vary on geographic, racial or ethnic and socioeconomic characteristics. In 2007 the maternal mortality rate for black women was 2.7 times higher than the rate for white women. Women living in areas of middle poverty have 58% higher rates of maternal mortality than women not living in areas of poverty. Women living in areas of high poverty have 102% higher rates of maternal mortality than women not living in areas of poverty (Singh, 2010). Upcoming changes in health care financing will help lessen disparities of access by reducing the number of uninsured women and making maternity care part of all essential care packages (King, 2012). However structural barriers to health care access will continue to include availability of health care providers.

The 2011World Health Organization estimates of infant mortality rank the United States at 40th internationally with a rate of 6 infant deaths per 1000 live births (World Health Organization, 2012a). A major contributor to infant mortality in the United States is preterm birth (Spong, Iams, Goldenberg, Hauck, & Willinger, 2011). The Center for Disease Control estimates the preterm birth rate for 2011 is 11.72, with a low birth weight rate of 8.10 (Hamilton, Martin, & Ventura, 2012). Healthy People 2020 aims for a 10% reduction in premature birth, from 12.7% to 11.4% (Miller, 2011). Objective MCH-1.3 aims for a 10% improvement in infant deaths, from 6.7 per 1,000 live births to 6.0 per 1,000 live births (Miller, 2011).

As the United States works to improve maternal health outcomes, ongoing changes in the healthcare workforce are causing projected shortages of maternity care workers (Anderson, Hale, Salsberg, & Schulkin, 2008; Loafman & Nanda, 2009; Rayburn, Klagholz, Murray-Krezan, Dowell, & Strunk, 2012). Studies have documented

an overall decrease in the number of obstetricians and family practitioners providing maternity care (Cohen & Coco, 2009; Loafman & Nanda, 2009). A 2006 study in Oregon found only 36.6% of trained maternity care providers were delivering babies in their practice. Of those providing maternity care, 21.5% planned to stop providing delivery services within five years (Smits, King, Rdesinski, Dodson, & Saultz, 2009). Additional limitations of access may occur for women based on factors such as Medicaid status or assumed pregnancy risk. A survey of obstetricians in southern Florida found 14% would refuse to care for a woman during pregnancy based on arbitrary maternal weight cut-offs (McGee, 2011).

Fewer medical students choose a career in obstetrics, and those who choose obstetrics retire earlier than other physicians (Anderson et al., 2008). Demographic changes in the obstetrical workforce and practice characteristics of obstetricians have lead HRSA to estimate that although the total obstetrician/gynecologist workforce is projected to increase 19% by 2020, it will actually only be an increase in full time equivalents of 15%. Despite these change, HRSA reports only geographic pockets of undersupply without any serious evidence of national imbalance (Bureau of Health Professions, 2008).

Adequate prenatal care decreases disparities of birth outcomes for high risk groups (Rabin, Weinstein, Seltzer, Langer, & Kohn, 2009). Prenatal care may be a cost effective way to decrease the rates of low birth weight deliveries as well as neonatal and perinatal mortality (Rosenthal, Li, Robertson, & Milstein, 2009; Vidal, Samico, Frias, & Hartz, 2011). A 2005 enquiry into the preventability of pregnancy-related deaths found 40% of the deaths were potentially preventable during pregnancy, and preconception care

could potentially have prevented more than half the deaths (Berg et al., 2005). Similarly, the risk of a woman having a potentially avoidable maternity complication if she receives adequate care is only 43% the risk for a woman who receives inadequate prenatal care (Laditka, Laditka, Mastanduno, Lauria, & Foster, 2005). These economic and health benefits of prenatal care led to the Healthy People 2020 goal of a 10% increase in the proportions of women receiving early and adequate prenatal care.

In the United States 70.5% of women receive early and adequate prenatal care (Miller, 2011). However, the percentage of prenatal outpatient visits occurring in hospitals rather than physician offices is increasing. Between 1997 and 2004, the proportion of complicated prenatal visits occurring in hospitals increased 83%, from 22.7% to 41.6% in states with high medical liability costs. During this same time period, the proportion of complicated prenatal visits occurring in hospitals decreased by 43% in low medical liability cost states (Coco, Cohen, Horst, & Gambler, 2009). This disparate shift in point of care may be a sign of changes in access to maternity care.

In 2009, 98.9% of births occurred in hospitals where a woman may be attended by a midwife or physician (Martin et al., 2012). Although this indicates a high rate of skilled birth attendance, questions of quality of the care women receive arise due to the methods used during labor. For example, in 2008, 23.1% of labors were induced (U.S. Census Bureau, 2012). The rate of induction rose faster than changes in maternal characteristics that indicate a need for induction, causing the Agency for Healthcare Research and Quality (AHRQ) to investigate evidence for the use of the procedure. AHRQ found a lack of evidence to support elective induction before 41 weeks (Coughey et al., 2009). The

increasing use of induction may indicate a growing need for maternity care workers to manage an overwhelming workload.

In 2011, 32.8% of births in the United States were by cesarean section (Hamilton et al., 2012), with state rates varying from a low of 23% in Utah to a high of 40% in New Jersey (Martin et al., 2012). Health status of the woman and events occurring during labor explain only some of the large geographic variation in cesarean section. In one study, 40.5% of the variation in cesarean section rate is explained by what the researchers call “practice style” of the geographic region (Baicker, Buckles, & Chandra, 2006). If cesarean section is a tool used to help manage overwhelming workloads, its use may be found to be closely tied to lack of access to maternity care. This may be cause for concern. States with the highest rates of cesarean section also have the highest rate of maternal mortality (Singh, 2010). Similarly, elective cesarean section deliveries are associated with higher rates of maternal morbidity than vaginal deliveries (Bodner, Wierrani, Grunberger, & Bodner-Adler, 2011). The World Health Organization maintains an appropriate cesarean section rate should be between 5 and 15% (World Health Organization, 1985).

Postpartum care includes the immediate care women receive in hospital and a follow-up within two months. The follow-up visit helps to ensure the mother is transitioning well to motherhood and addresses pain or breastfeeding problems. Although the United States has no national tracking of postpartum care, Healthy People 2020 includes increasing rates of postpartum care as an objective (Miller, 2011). In one review of women enrolled in Medicaid in Massachusetts, about 60% of women received a postpartum care visit (Weir et al., 2011).

Problem Statement

The National Prevention Council has defined reproductive and sexual health as a priority need, with a goal to increase preconception and prenatal care, and to support reproductive and sexual health services for pregnant and parenting women (National Prevention Council, 2011). While changes in health care financing will remove some barriers to access, data from the Massachusetts implementation of health care reform legislation demonstrate additional barriers to care exist for many women (Weir et al., 2011). One of these barriers is the capacity of the existing maternity care provider workforce.

At a presentation at the Minnesota Rural Health Conference, the Rural Obstetrics Work Group reported the unexpected finding of a higher rate of cesarean section for women living in rural areas. This was attributed to a shortage in the delivery care workforce. To ensure safe delivery, all deliveries were scheduled on specific days when the delivery provider would be available, a large proportion as cesarean section. (The Minnesota Rural Health Advisory Committee's Rural Obstetrics Work Group, 2012). Similarly, a study of U.S. Military Hospitals reported unexplained high rates of cesarean sections for small hospitals and teaching hospitals. Small hospitals had the least complex patient case mix but the highest rate of cesarean (Linton, Peterson, & Williams, 2005).

A 2001 study comparing provider distribution to statewide cesarean section rate found no association between maternity care provider workforce and cesarean section rates (Hueston & Lewis-Stevenson, 2001). The Bureau of Health Professions found markers of imbalance in the physician supply and demand, but no evidence of a shortage of obstetrician-gynecologists (Bureau of Health Professions, 2008). These reports do not

provide a precise description of the maternity care provider workforce because the benchmark lacks a precise definition of maternity care provider.

The benchmark of maternity care provider workforce in the United States is the number of obstetricians per population. The GMENAC Report on U.S. Physician Manpower Policies set the standard of 9.9 providers per 100,000 population in 1981 (Peterson & Rodin, 1983). This benchmark has been reevaluated several times, with recommendations varying from 8.8 to 11.2 obstetrician-gynecologists per 100,000 population (McClendon, Politzer, Christian, & Fernandez, 1997).While this benchmark can provide a reference for the number of women's health specialist surgeons per population, it may not provide an accurate reflection of the maternity care work force for several reasons.

The first problem with obstetrician-gynecologist benchmarking by population is that not all obstetricians provide general maternity care, and those who do may not provide it in equal amounts. Obstetricians are increasingly sub-specializing in areas such as gynecology or maternal-fetal medicine. These obstetricians are not available for general maternity visits or for birth attendance (Bureau of Health Professions, 2008; Loafman & Nanda, 2009). Physicians in less populated areas spend more work hours in general patient care than physicians in more populated areas, leaving less time for delivery attendance (Bureau of Health Professions, 2008). As the population continues to age, the estimated time obstetrician/gynecologists spend caring for women 65 and older will increase from 5% to 7% (Bureau of Health Professions, 2008).

A second problem with assessing maternity care provider workforce adequacy by obstetrician per population is the tendency to group large geographical areas with

significant differences in provider volume. After closure of an obstetrical hospital in rural Missouri, the rate of low birth rate infants increased by 18.2% while the state rate remained between 7.1 and 7.8%. During this transition there were no changes noted in utilization of prenatal care (Sontheimer, Halverson, Bell, Ellis, & Bunting, 2008). Similarly, a study rural Canada found travel distance from residence to birth site is associated with an increase in NICU days. Increases in NICU days were found at the 1-2 hour distance from birth site and again at 2-4 hours distance. Women who needed to travel more than four hours for delivery had a perinatal mortality OR of 3.17 (Grzybowski, Stoll, & Kornelsen, 2011).

During a study of obstetrical hospitals, the authors reported some low-volume hospitals in the United States had stopped providing obstetrical services between 2008 and 2010 due to lack of physician coverage and cost (Simpson, 2011). In a study using GIS to map the distance from residence to hospital in rural Nebraska, researchers found 18% of women giving birth needed to travel more than 40 miles to arrive at that birth site (Gjesfjeld & Jung, 2011). These differences can be masked when adequacy of care is based on population to physician ratio for large areas, or when residency categories combine women who live near and far from sources of care.

The third problem with the current measure is the difference between population and fertility rate. Fertility rate varies across age, race, and ethnicity, which can lead to differences in fertility rates in regions. Pregnancy rates for non-Hispanic black and Hispanic women are nearly 60 percent higher than the rate for non-Hispanic white women (Stephanie J Ventura, Curtin, Abma, & Henshaw, 2012). Birth rates vary from 9.8 per 1,000 women in Maine and New Hampshire to the nearly doubled 18.9 per 1,000

women in Utah (Martin et al., 2012). Determining the need for maternity care based on the total population misses this variation in need.

Measures of obstetrician to population also miss the variations in non-obstetrical delivery care providers. In Michigan, 80% of rural physicians who practice obstetrics are family physicians (Xu et al., 2009). In the state of Washington, about one third of rural family physicians perform cesareans while none of the urban family physicians perform cesareans (Dresden, Baldwin, Andrilla, Skillman, & Benedetti, 2008). (Tong et al., 2012). In 2007, percent of total deliveries attended by midwives ranged from 0.6% in Arkansas to 28.5% in New Mexico (Declercq, 2011).

Reports of family practice physicians indicate about a 20% decrease in the number of physicians providing delivery services between 1998-2003 (Chen, Huntington, Kim, Phillips, & Stevens, 2006). There has been a 50% decline in the number of prenatal visits to family physicians in the past ten years (Cohen & Coco, 2009). The number of family physicians who report providing maternity care decreased from 23.3% in 2000 to 9.7% in 2010. Family physicians who work in a rural areas were four times more likely to stop providing obstetrical care than those who worked in urban areas (Xu et al., 2009). Fewer medical students plan to practice family medicine. Only 42% of family practice residencies were matched in 2009, compared with 75% in 1996 (The National Advisory Committee on Rural Health and Human Services, 2010). A survey of family practice physicians who completed obstetrics fellowships between 1992 – 2000 found 88% were providing prenatal care, while 66% had privileges to perform cesarean delivery (Chang Pecci, Leeman, & Wilkinson, 2008).

The changing delivery care workforce could increase the rural urban health disparities. One study found the loss of one family physician in a rural area predicted the increase of infant mortality by 9.6% (Larimore & Davis, 1995). Another study found a 2.5% reduction in infant mortality and a 3.2% reduction in low birth weight for every increase of one primary care doctor per 10,000 population (Shi et al., 2004). Interestingly, a study of provider distribution found each 1% increase in the percentage of family physicians providing obstetrical care lead to a 0.08% drop in the statewide cesarean rate (Hueston & Lewis-Stevenson, 2001). Vital statistics records at the time the GMEAC benchmark was created did not distinguish between obstetrician and non-obstetrician physician birth attendants, making adjustments to the benchmark for changing family practice population characteristics impossible. Changes in the practice characteristics of family physicians may change availability of maternity care without changing adequacy based on the obstetrician benchmark for an area.

According to the National Center for Vital Statistics, midwives were responsible for attending over 8% of deliveries in 2010 (Martin et al., 2012). This estimate may be low. Birth certificate data has been shown to underreporting of midwife attended births by as much as 10.9% (Walker, Schmunk, & Summers, 2004). In a review of births in Washington State, it was revealed that nurse midwives attended about 10% of all births, with the rate of nurse midwife births in high volume hospitals doubling over the ten year review period (Bussey, Bell, & Lydon-Rochelle, 2007). When the benchmark of 9.9 obstetricians per 100,000 population was calculated, midwives attended 1.9% of all births (Feinleib, 1985).

In the United States, midwives are categorized by professional training and practice as direct entry midwives or nurse midwives. Although midwives have been legally licensed to attend births in all states since 1984, their distribution is not uniform (Avery, Germano, & Camune, 2010). Proportion of births attended by midwives ranges from less than 2% in Louisiana and Arkansas to 28.5% in New Mexico (Declercq, 2011). Variations in state policies contribute to variations in the role and contribution of midwives between states.

Some states require midwives to enter into written contracts with a physician to practice before being allowed to provide care they that is legally within their scope. Termed Written Practice Agreements (WPAs), these requirements can create an economic disadvantage for midwives and restrict their ability to practice. For example, in New York City, seven midwives were unable to practice when they were unable to obtain a WPA after the closure of the hospital which had been their WPA collaborator. In California, of 111 midwives licensed under the California Licenses Midwifery Act of 1993, only one could obtain a WPA to provide services (Carrasco, 2011). Similarly, wording in the laws can make it difficult for midwives to obtain full medical staff privileges and independently admit patients (Reed & Roberts, 2000).

Other difficulty with midwifery variations between states are prescribing laws and insurance reimbursement. Some states require midwives to enter an agreement with a physician to perform prescriptive activities, making this part of midwifery care a "delegated medical act." Some states limit insurance payments to midwives for services the midwife is legally authorized to perform. In other states, insurance companies are allowed to restrict payments to midwives despite the services being within the legal scope

of midwifery. Additionally, malpractice insurance surcharges may be imposed on physicians who collaborate with midwives, despite data that physicians working with midwives have fewer claims (Reed & Roberts, 2000).

The availability of midwives affects the total number of obstetricians necessary to ensure adequate maternity care. However, the availability of midwives between states is highly varied, and within states may vary geographically based on the distribution of physicians (Carrasco, 2011). The obstetrician to population benchmark lacks precision with such wide variation in midwifery practice, and may hide the impact of restrictive midwifery policies on the adequacy of the delivery workforce.

This highly varied workforce makes measurement of the adequacy of the workforce difficult. The obstetrician to population benchmark lacks the precision necessary to identify the true maternity health care capacity of a region or state. Without an accurate count of maternity health care providers and understanding their distribution in the United States, it is impossible to identify the true need for increased workforce. Although preconception, prenatal, postpartum and termination of pregnancy care are important aspects to achieving maternal health, calculation of adequacy of this full range of services involves including additional practitioners (physicians assistants, nurse practitioners and public health nurses) and is beyond the scope of this paper. For that reason, this paper will use the proxy of delivery care providers to estimate the distribution of all maternity care services.

Purpose Statement

The purpose of this paper is to describe the distribution of the delivery care provider workforce in the United States using, identifying regions without an adequate

delivery care provider workforce. Two measures of adequate delivery care will be compared. This paper will also examine how midwifery practice acts affect the adequacy of delivery care workers.

Research Questions

To achieve this purpose, this paper will attempt to answer these questions.

Question 1: Are the obstetrician per population benchmarks for adequacy of health care associated with adequacy of delivery care providers?

Null Hypothesis: The obstetrician per population benchmarks for adequacy of health care are not associated with adequacy of delivery care providers.

Question 2: Are the written practice agreements required by states for legal midwifery practice associated with adequacy of delivery care providers?

Null Hypothesis 2: The written practice agreements required by states for legal midwifery practice are not associated with adequacy of delivery care providers.

Question 3: Is the licensing of direct entry midwives by states associated with the adequacy of the delivery care provider workforce.

Null Hypothesis 3: The licensing of direct entry midwives by states is not associated with the adequacy of the delivery care provider workforce.

Significance Statement

An accurate count of the delivery care workforce and its distribution is needed to allow incentives to be targeted to the areas most in need of delivery care workforce help. Achieving an accurate count requires the inclusion of all types of delivery care providers. This preliminary research can help define a new standard to measure the delivery care provider workforce.

Once an accurate measure of provider adequacy is achieved, research can begin to determine if provider density impacts outcomes not only for individual practitioners who operate in a variety of practice settings, but at the community level. Understanding the impact of provider workforce adequacy on outcomes will allow the creation of policies that support building an appropriate delivery care provider workload.

Understanding how midwifery practice acts impact delivery care provider workforce is a necessary first step to identifying policies that support appropriate workforce. If policies with the potential to restrict midwifery practice are found to significantly decrease the likelihood of having an appropriate delivery care provider workforce, these policies should be reviewed to determine the overall value they provide to maternal health.

Definition of Terms

A **nurse-midwife** is a registered nurse with additional training in the advanced practice of midwifery. Nurse-midwifery is legal in all states; however the degree of independence of a nurse-midwife varies by state to state.

A **direct entry midwife** is a midwife not trained as a nurse. States have a variety of ways of regulating direct entry midwifery, from licensing based on minimum certification standards to prohibition of practice. In some states direct entry midwifery is unregulated.

Delivery Care Providers are the physicians, whether MD, DO, obstetrician-gynecologist or family practitioner; and midwives, whether direct entry or nurse, who are currently attending women during delivery.

Health Service Areas are population groupings based on travel patterns between counties for routine hospital care**.**

Delivery Care is attendance at delivery by a recognized skilled provider.

A Written Practice Agreement is part of a midwifery practice act that requires a midwife to have a formal and signed contract with a physician before she is legally able to provide some or all midwifery services. Requirements vary by state.

Chapter Two: Literature Review

Existing standards for maternity coverage are reviewed to determine estimations of an adequate workforce. Available literature is also reviewed to determine the actual number of births generally attended by each type of practitioner. Finally, geographic studies on access to care are reviewed to determine methods of assessing distribution.

Delivery Care Provider Workforce Benchmarking

In 1983, the Graduate Medical Education National Advisory Committee (GMENAC) recommended minimum physician to population proportions to ensure for the public health. At the time, the benchmark for obstetrician/gynecologists was 9.9 per 100,000 population and had built in assumptions about non-physician providers (Graduate Medical Education National Advisory Committee, 1980). GMENAC recommended health manpower shortage areas should be determined by the physician to population ratio (Peterson & Rodin, 1983). At the time, the crude birth rate in the United States was 16 births per 1,000 population, or 1600 births per 100,000 population (The World Bank, 2012). Dividing the births per population by the GMENAC physician benchmark, the average births per obstetrician should be no more than 162 per year.

However it should be noted this number was calculated before the change to managed care in the United States, and during a time when midwives contributed with only 1.8% of births (Feinleib, 1985). Changes in the maternity care provider workforce and the overall health delivery system may mean this number no longer defines an adequate workforce.

Obstetricians

One paper reported on an attempt to reach expert consensus about optimal numbers of procedures to perform annually for a physician to maintain competence. The expert panel included physicians from various parts of Asia and Africa anonymously completing a Delphi exercise independently. The final consensus for normal deliveries was that 100 per year was optimal, with 300 being the maximum and 50 being the minimum a physician should perform. Final consensus for cesarean deliveries was an optimal number of 68 with a maximum of 175 and a minimum of 25 per year. A final consensus on optimal delivery attendance of all types was 168 per year (Scotland & Bullough, 2004). Two weaknesses of this paper are its reliance on expert consensus rather than actual outcome data, and that its experts work in health care systems that may not be equivalent to the system in the United States. Additionally, the investigators noted disagreement about what “attendance” at a birth meant, with some experts believing a physician could be considered to attend to a woman if the physician was in the hospital able to be called if the nurses, midwives or medical students needed assistance. However, it is interesting to note the similarity between the consensus number and GMENAC’s number.

This number is also similar to the benchmarking set by the United Nations Population Fund in the State of the World's Midwifery 2011 Report. In this report, the benchmark for a health district of 100,000 – 120,000 population with 3,000-3,600 births per year is 20 midwives with three part time obstetrician backup for the 60-110 anticipated surgical births needed for safety (Day-Stirk & Fauveau, 2012). Subtracting the anticipated surgical births leaves a range of 2890 – 3440 births for 20 midwives, or 145-175 births per midwife per year as the upper limit of safe care.

The Indian Health Service mandates minimum staffing levels for safe care at Indian Health Service Hospitals. The minimum obstetrical staffing is 1.5 FTE for any facility with a minimum 200 births with an additional 1 FTE for every 210 births beyond 200 births. Included in the minimum staffing is 1 FTE certified nurse midwife for every 200 deliveries in every facility with a minimum of 125 deliveries per year. Using this minimum, a facility with 410 – 619 births per year will have a staff of 2.5 FTE obstetricians and 2 FTE certified nurse midwives. Assuming midwife delivery attendance will be 0.75 that of obstetricians due to cesareans, each obstetrical provider will on average attend 102-155 deliveries per year (RRM Technical Advisory Committee, 2012).

A review of the obstetrical workforce from 1994 examined the changing health care system on the requirements for physicians. Using data from health maintenance organizations serving over 7 million Americans, they found the average supply in HMOs was 10.28 obstetrician/gynecologists per 100,000 population (Weiner, 1994). In 1994 the crude birth rate in the US was 15 per 1,000 population for an average annual obstetrician birth workload of 146 deliveries. Within the health care systems included in this study, there were an estimated 23 non-physician providers per 100,000 population, and one site

had already transitioned to non-physician providers performing up to 56% of all ambulatory obstetrical contacts. At the time of this study, the national average supply of obstetrician-gynecologists was 11.4 per 100,000, which means an average 132 deliveries per obstetrician (Steinwachs et al., 1986). In 1994, midwives provided care for 5.5% of births (Stephanie J Ventura, Martin, Mathews, & Clark, 1996). If these 82.5 deliveries are deducted, the1417.5 deliveries are distributed between 11.4 obstetricians, for 124 deliveries per obstetrician on average. However, this does not account for births attended by family practice physicians which mean the obstetrician average is over-estimated.

During a 1997 review of the needs in staffing obstetrics and gynecology, the researchers compared the number of new physicians being certified with the number needed to sustain the current standard. Using four different models of staffing, they found the average requirement of obstetricians is 11.2 per 100,000 population (McClendon et al., 1997). While this cannot give precise details, it can help estimate the appropriate maternity care provider workforce. In 1997, the crude birth rate in the US was 15 per 1,000 population or 1500 per 100,000 (The World Bank, 2012). Dividing this by the average obstetrician workforce provides an estimation of 134 births per obstetrician per year. In 1997 midwives provided care for 7% of births (Stephanie J. Ventura, Martin, Curtin, & Mathews, 1999). If this is factored into the equation, midwives provided care for 105 births per 1,000 population, leaving 1395 births for 11.2 obstetricians, or 124.5 births per obstetrician. This measurement is also unable to determine the impact of family practice physicians, and will over-estimate the average deliveries per obstetrician.

Some studies have recommended the benchmark be lower than GMENAC's 9.9 per 100,000, with recommendations between 8.0 and 8.4. This translates to 166-175

births per obstetrician if non-obstetrician providers are not counted. Other studies, such as one performed by Solucient in 2003, recommend a benchmark higher than GMENAC's. At 10.7 obstetricians per 100,000 population, Solucient sets the benchmark at 138 births per obstetrician when not counting non-physician providers (Hawkins).

The Georgia Physician Workforce used various national standards of adequate physician per population to compare the workforce in each Georgia County. The ten measures found for obstetrician/gynecologists ranged from 8.0 to 14.1 per population, which equates to a range from 99.3 to 175 births per physician per year if non-obstetrician providers are excluded from the equation. The average requirement was 10.2, which is equivalent to an average of 137.2 births per obstetrician per year (Georgia Board for Physician Workforce, n.d.).

The U.S. Department of Health and Human Services measures the supply of obstetricians/gynecologists as a whole but not specifically those involved in delivery care. Estimations on supply and demand are measured in full time equivalents. This is due to differences in practice style for different physicians. For example, females and older obstetricians typically work fewer hours than their colleagues. Using a stratified random sample of ACOG members completing surveys, researchers attempted to determine if differences in income between males and females were due to differences in productivity. The survey was distributed to 1200 members, with a 49% response rate. They found female obstetricians saw 8-9% fewer patients per week, working 5% fewer hours per week. Younger female obstetricians worked 10% fewer hours per week (Reyes, 2007). The low response rate may bias these results, however understanding that female obstetricians currently represent 40% of the workforce, but 76% of the residents in

obstetrics, the differences in work patterns may become significant when determining the future needed size of a workforce.

In contrast, a survey of 92% of all obstetricians in Washington State found no differences between males and females in terms of total patients seen. The researchers cited only two workload statistical differences; lower weekly inpatient visits for women and lower proportion of women working 60 hours per week or more (Benedetti, Baldwin, Andrilla, & Hart, 2004). However, both of these studies relied on obstetrician self-reported data, which may not be an accurate reflection of total patients seen or hours providing care.

Family Practice Physicians

Studies on average birth workload for family physicians focused on identifying lower limits of safe rather than defining an appropriate maximum workload. A study in British Columbia Women's Hospital and Health Center compared 444 singleton births attended by 152 family physicians by physician annual birth attendance. Defining low volume as fewer than 12 births a year, medium volume as 12-24 and high volume as 25 or more, the researchers found no statistical differences in complex maternal morbidity, 5 minute APGAR less than seven or admission to NICU. There were 72 low volume providers, however the average volume was 29 births in 16 months – or 22 births per year (Klein, Spence, Kaczorowski, Kelly, & Grzybowski, 2002). This study was conducted in Canada, so the outcomes may not be generalizable to the American health care system

A study of low provider volume in US hospitals used a 2007 nationwide inpatient sample from the Healthcare Cost and Utilization Project to determine if an association exists between outcomes for low volume providers or low volume hospitals. Using a

retrospective cohort study of women admitted for care in 2007 and analyzing the provider and hospital separately, the researchers found no consistent relationship between rates of complications and hospital volume. However, they did find providers in the lowest quartile of provider volume (less than seven deliveries per year) had a 50% higher odds of having a complication than high volume providers (more than 90 deliveries per year) (Janakiraman, Lazar, Joynt, & Jha, 2011). This study was not able to identify the background of the physician, and provider volume in the study ranged from 1 delivery per year to 1731 deliveries per year--a number that would equate to 6 or 7 deliveries a day, every business day and is therefore most likely the total for a group rather than one provider.

It is interesting to note that although these studies found different outcomes, both identified large numbers of (presumably) family physicians providing very low volume birth attendance. In the second study, 50% of the practitioners were attending no more than 31 births a year (only 2-3 per month). This is similar to the results of a Survey of obstetrician / gynecologists and family physicians in Washington State which revealed both urban and rural family physicians attended on average 2 birth per month, while their obstetrician/gynecologist colleagues attended 10 births per month (Dresden et al., 2008). This was a self-report survey; however the researchers found sufficient similarity to the vital statistics total births to feel confident in the survey estimates.

Midwives

A retrospective study of Washington State live birth certificate data from 1995 to 2004 was performed to identify trends in certified nurse midwife attended deliveries. The investigators limited the data to singleton vaginal births, and excluded any births missing

delivery type or attendant. They found nurse midwives attended about 10% of deliveries, with midwife attended deliveries doubling in high volume hospitals (more than 2000 births per year) over the ten year period. More than 50% of the nurse midwife births occurred in high volume hospitals. They found midwives were providing care to women who would be considered high risk due to socio-economic and health indicators, with midwives more likely to provide care than physicians for some risk factors (Bussey et al., 2007). This study did not determine the average birth attendance per nurse midwife.

Two case reports of collaborative practices involving obstetricians and midwives were found. The first, at Bronx-Lebanon Hospital Center, serves an urban community of 762,600 people with approximately 2708 deliveries in 2009 and approximately 70,000 outpatient visits. The service employs 20 physicians, 17 residents, 17 midwives and 3 physician assistants. The cesarean rate was 34.5% and the midwives attend 18% of all vaginal deliveries (Marshall, Flores, & Mankoff, 2012). This equates to 1774 vaginal births, with 319 attended by midwives for an average of 18 births per midwife per year. However, this number may be underestimated due to the full scope of the program. Some obstetricians and midwives may work specifically in gynecology and not provide obstetrical services. Additionally, this program provides education for medical and midwifery students. It is unclear if 18% is the total of deliveries where a midwife is staff in charge, or if a birth with a midwife and medical student is coded as a physician birth.

A collaborative practice in Boston provides obstetrical coverage with a combination of obstetricians, midwives and family practice physicians. In 2010, the service had 2500 deliveries, of which the midwives provided care for 44% of the vaginal births, but does not give the numbers of staff or the percentage of births that were vaginal

(C. C. Pecci, Mottle-Santiago, Culpepper, Heffner, & McMahan, 2012). In an email from the author, the practice was described as having 14 staff on duty at all times (including residents), and again not all obstetricians or midwives on the service are involved in the labor and birth (C. Pecci, 2012). These case studies provide information about models that are currently working in high volume health systems, but not necessarily the most cost effective or appropriate birth per practitioner ratio for every area.

A report from the American College of Nurse-Midwives described a variety of midwifery practice models in use at federally qualified health centers (T. Johnson, 2010). Based on data provided from the centers in this report, midwives who provide delivery care may be attending as few as 50 -80 births per year, or as high as 143 per year. Minimum staffing requirements from the Indian Health Service reviewed previously can also be used to determine anticipated average delivery attendance for certified nurse midwives. Using the staffing standard and assuming a midwife will attend .75 the number of deliveries attended by an obstetrician, a midwife in a facility with 410-619 deliveries per year can expect to attend 77 – 116 of those deliveries ("Resource Requirements Methodology (RRM) Staffing Standards Reference Model," 2012).

A 2002 study into the practice characteristics of midwives found 60% of nurse midwives work in private offices, 14% in public clinics and 10% in Managed Care Organizations (McCloskey, Kennedy, Declercq, & Williams, 2002). A survey of nurse midwives in Connecticut explored practice characteristics in 2004. At that time Connecticut midwives had prescriptive privileges but were required to obtain a written practice agreement to provide care, and attended 10% of the births in the state. Of those nurse midwives responding, 64% worked through physician-owned practices, 17%

worked in community health centers and 13% in hospital clinics. They found the typical midwife worked two 24 hour call days per week in addition to three 7-hour office days, but did not determine the volume of births attended during the on-call time (Holland & Holland, 2007). However, both studies had low response rates and there was no attempt to validate the survey responses.

In contrast, direct entry midwives often work independently and follow a caseload model. Caseload midwifery is a practice model matching a woman to one midwife who provides her care and attends her delivery. In the clinical redesign of the Australian maternity system, caseload midwifery was built in with the limitation of no more than 35-40 births per annum per midwife (Hartz et al., 2012). This upper limit for a caseload practice seems verified in a study of the outcomes of planned homebirths in the United States. In 2000, the certifying organization for direct entry midwives made participation in a study mandatory for recertification. The database from the birth surveys provided information about 7623 women seen by 409 unique direct entry midwives in the United States and Canada. This means the average client load for a direct entry midwife was 18.6 births per year (K. C. Johnson & Daviss, 2005). This should be an accurate estimation given the mandatory reporting, however the survey was only mandatory for midwives desiring recertification with the North American Registry of Midwives. Direct entry midwives who do not participate in this certification process were not included in the analysis. These are likely to be midwives who reside in states without legal protection for direct entry midwives, or who require direct entry midwives to certify through a different organization. These midwives may have a smaller or larger client load.

Birth certificate data from 2008 was available for each state from the National Center for Vital Statistics website. This data can be compared to the number of delivery care providers in each state in 2008 from the Area Resource File ("Area Resource File (ARF)," 2012) to get an average birth attendance per type of provider. Of the 51 observations of births to MD obstetricians (50 states and Washington DC), the mean average births in 2008 was 122 (95% CI 112.3 – 131.8) per obstetrician (excluding residents). The true mean births per annum per MD obstetrician is likely lower, as the total count of MDs did not include the number of family practice MDs who attend deliveries. Using similar strategy, the mean average births in 2008 for DO obstetricians was 148.9 (95% CI 126-171.8). Data on number of nurse midwives in four states was missing from the Area Resource file. Of the 46 observations available, the mean average births in 2008 for nurse midwives was 59.8 with a 95% CI of 42.5 – 77 births per year.

Geographic Studies

In a recent review of the distribution of obstetricians, counties were mapped as either no American Congress of Obstetricians and Gynecologists (ACOG) members or 1 or more ACOG member. They found nearly half (1,550, 49%) of the total 3,143 counties in the United States did not have an ACOG member, and these counties were home to 8.2% of the adult female population (10.1 million women) (Rayburn et al., 2012). This dichotomous mapping did not take into account the distribution of births, or the presence of other delivery care providers. This analysis was only performed at the county level, with no indication of adequacy at a larger community level. County boundaries are not impermeable, and available resources in a county may include those of surrounding

counties. Looking only at county data will create the appearance of shortages where none occur.

One paper discussed using GIS technology to assign catchment areas based on travel distance (Luo, 2004). This method allows measurement based on issues of distance and travel, understanding that arbitrary government boundaries are not impermeable. While this method does allow for the measurement of both revealed and potential access, this method is impractical for country-wide comparisons.

Health Service Areas were created in 1991 to help assess community access to care. Each Health Service Area is a self-contained hospital service area, meaning residents within that area remain within that area when seeking health care. To determine these areas, researchers at the National Center for Health Statistics analyzed patterns of hospital use and county of residence (Makuc, Haglund, Ingram, Kleinman, & Feldman, 1991). Combining county analysis with health service area analysis will provide a more complete picture of geographic access to maternity care.

Summary of Current Problem and Relevance

While a wide variety of benchmark estimates can be used to estimate the delivery care workforce, the literature reveals a lack of a measure of the delivery care workforce which is precise for all delivery care providers. While the available measures attempt to ensure an adequate workforce for obstetrical and gynecological surgical needs, the lack of identifying which providers are attending deliveries can result in an overestimation of the delivery care workforce. The available research does attempt to define a minimum standard of deliveries attended per year required to remain competent, but does not define

an upper limit of number of deliveries attended per year to maintain patient safety or to optimize delivery health outcomes.

The available literature demonstrates significant changes in the delivery care workforce, not only the increase in births attended by nurse midwives, but also the decrease of family physicians providing delivery care services. There appears to be wide variation in the number non-obstetricians providing delivery care. Strong evidence exists for this variation, but little evidence exists for the impact state level midwifery policies may have on the variation in midwifery workforce. Without accounting for family practice physicians and midwives who are attending births, this measure may underestimate the current delivery workforce.

The literature review also reveals the currently used measure of delivery care adequacy does not reflect differences in fertility rate between geographical regions of the country. These differences are as important as the distribution of women of reproductive age in determining the delivery workforce needs. Measures based on population lack precision in ensuring an adequate delivery workforce.

This study will provide a preliminary look at the delivery care workforce distribution, and the ratio of delivery care providers to deliveries within counties and health service areas. This study will also begin to explore the association between policies governing midwifery practice and the capacity of the maternity care workforce. This will allow a comparison of the measures of adequacy to determine if a new measure of delivery care provider workforce is needed.

Chapter Three: Methodology

Introduction

This is non-human subject research. IRB approval is not needed.

This research will describe the distribution of the delivery care workforce by comparing publicly available lists of providers to publicly available counts of deliveries at the county and health service area level. This distribution will then be compared to a standard of "adequacy" based on existing obstetrician to population benchmarks, and a standard of adequacy based on delivery care provider to deliveries benchmarks.

Finally, the study will assess the association of laws governing midwifery practice and workforce adequacy by comparing state specific policies licensing of direct entry midwives and requirements for a written practice agreement. Proportion of counties and health service areas with adequate delivery workforce will then be compared between states which license direct entry midwives, and those that do not.

Population and Sample

The main data source for this study is the Area Resource File, a public database released by the U.S. Department of Health and Human Services containing county specific information aggregated from a variety of sources. Information on obstetrician distribution was taken from the Health Professions 2010 non-federal MDs, specialty obstetrics in direct patient care. Additional obstetricians were counted from Health Professions 2010 non-federal DOs, specialty obstetrics in direct patient care. This data originates from the American Medical Association Physician Masterfile and are considered accurate as of December 31, 2010. The number of residents was subtracted

from total patient care to account for the differentiation of the resident role. This listing did not differentiate between those providing delivery care and those who do not, so will likely overestimate the total delivery care workforce.

Information for certified nurse midwives and certified midwives was taken from the Area Resource File Health Professions: Certified Nurse Midwives. This information was collected from the American College of Nurse Midwives (ACNM) and is considered an accurate count of active nurse midwives in the year 2011. The listing contains all nurse midwives, and direct entry midwives who obtain the certified midwife designation. Certified midwives can legally practice in five states. It is not possible to analyze certified midwives with the other direct entry midwives. However, the practice patterns of certified midwives, who are trained to work in hospitals, are similar to the nurse midwife.

Data on direct entry midwives is publically available from the state governmental departments responsible for their licensing. Data was available for 23 states (See Appendix A). To prevent double counting, only direct entry midwives who resided in the state of license will be examined. An additional 14 states allow direct entry midwifery, however lack of regulation and licensing. The lack of a list of practicing direct entry midwives prevents the inclusion of those midwives in this analysis.

The Area Resource File includes counts of total primary care physicians, both MDs and DOs, but does not differentiate between family practice physicians who do or do not provide delivery care. Use of this data set for family practice physicians would likely overestimate the total number of delivery care providers. Inquiries about a publicly available count of family practice physicians who provide delivery care were made to

both the American Medical Association and the American Academy of Family Physicians; however no public use dataset is available. Due to these limitations, family physicians will be excluded from the analysis. This will underestimate the total delivery care workforce.

Counts of population and births are taken from the Area Resource File. The most current population estimate available is 2009 the Bureau of the Census and is considered accurate as of July 1, 2009. Total births data is from the Bureau of the Census based on place of residence for calendar year 2008.

Data on states requirements for a written practice agreement were obtained from the American College of Nurse Midwifery, and verified by reviewing the state specific statute. In cases where statues changed between the year of nurse midwife data availability and the date of writing, the state was coded to reflect the status of laws in 2011 (See Appendix B).

Data on state licensing of direct entry midwives was obtained from Citizens for Midwifery and verified by reviewing the state specific statute. The lack of available data on direct entry midwives in states that do not offer licensing prevents the analysis of association for this policy and adequacy of care.

Research Design

This will be an observational, cross-sectional descriptive analysis of the delivery care health workforce in the United States by both county and health service area performed with public use data.

Procedures

Data will be analyzed using STATA statistical software and mapped using ARCGIS

Distribution of obstetricians, nurse midwives and direct entry midwives will be described in terms of county and health service area. Data will be mapped by both county and health service area to identify patterns in distribution.

The workforce will be analyzed for adequacy at county and the health service area level. To determine adequacy of an area, each obstetrician will be assumed to safely manage 140 deliveries per year; each certified nurse midwife will be assumed to safely manage 110 deliveries per year; each licensed direct entry midwife will be assumed to safely manage 35 deliveries per year. Obstetrician equivalents will be calculated based on the number of deliveries each practitioner is considered safe to manage, with nurse midwives counted as 0.79 obstetrical equivalents and direct entry midwives counted as 0.25 obstetrical equivalents. Counties and health service areas with 140 or less births per obstetrical equivalent will be counted as having adequate coverage. Counties with greater than 140, but less than or equal to 166 births per obstetrical equivalent will be counted as at risk. Counties with greater than 166 births per obstetrical equivalent will be counted as not adequate.

The measure of adequacy by 140 births per obstetrical equivalent will be compared to the standard measure of adequacy of 9.9 obstetricians per 100,000 population for each state, and for major United States regions. A proportion test using 95% significance will be used in each state to assess the difference.

The distribution of average deliveries to obstetrician will be mapped by both county and health service area to identify distribution of average delivery workload. The distribution of average deliveries to obstetrical equivalent will be mapped for comparison.

To determine the impact of written practice agreements and direct entry midwife licensing on the delivery care workforce, the measure of adequacy by delivery workforce capacity will be compared for states with and without each policy using a chi-square test at 95% significance. States will then be given a score for midwife friendly policies: 0 for no policies, 1 for one of the policies or 2 if the state has both policies. Association between adequacy of the delivery workforce and number of midwife friendly policies will be measured with a chi-square test at 95% significance.

Limitations and Delimitations

This study is limited by the available data on delivery providers. Although the Area Resource File does provide a count of obstetrician/gynecologists, midwives and family physicians by county, it does not distinguish between those who provide delivery care and those who do not. In the case of obstetrician/gynecologists, the decision was made to count all non-resident obstetricians/gynecologists included in total patient care knowing this would over-estimate the total workforce. Similarly, the study uses all certified nurse midwives. In the case of family physicians, the decision was made to exclude all family physicians from the analysis. This decision is reasonable given that data suggests those who do are attending on average 2 deliveries per month. However, this exclusion will underestimate the delivery workforce, which may cause the appearance of shortages where none exist.

This study is also limited by a lack of data on direct entry midwives. Regulations and licensing vary from state to state. Fourteen states have no licensing available for direct entry midwifery, although the practice is not explicitly prohibited. Obtaining information for midwives from public use lists in these states was not possible. This prevents a thorough description of the direct entry midwifery workforce, and will cause underestimates of the total delivery workforce in those fourteen states.

This study is delimited to describe the delivery workforce at the county and health service area levels. While the use of geopolitical boundaries allows easy description of services due to available data, these boundaries do not limit population health-seeking behavior across borders. The health service area level describes access in terms of existing health service delivery, but depends on county boundaries which will not accurately describe differences in ease of access throughout the health service area. To allow comparison between states, modified health service areas that do not cross state lines will be used. This may cause some border areas to have underestimates of available care. The county level is not precise enough to describe differences in access within densely populated urban centers.

Chapter Three: Results

Findings

Distribution of Delivery Care Providers at the County Level

In 2010, 34,078 obstetricians were in 1688 counties in the United States (See Figure 1). The women living in those counties had 4,005,576 live births in 2010. This represents 94% of all live births in the United States in 2008. There are 1452 counties

with no obstetricians. Women living in those counties had 257,324 live births. A total of 504 counties have at least one obstetrician but no certified nurse midwives while 1381 counties have at least one obstetrician but no licensed direct entry midwives.

There are 12,383 nurse midwives in 1380 counties in the United States (see Figure 2). The women living in those counties had 3,796,572 live births in 2008. This represents 89.1% of all live births in the United States. There are 1760 counties with no nurse midwives. Women living in those counties had 466,328 live births in 2010. A total of 196 counties have at least one nurse midwife but no obstetrician while 1093 counties have at least one nurse midwife but no direct entry licensed midwives.

There are 1249 direct entry midwives in 360 counties in the United States (See Figure 3). The women living in those counties had 1,679,323 live births in 2008. This represents 39.4% of all live births in the United States. There are 2780 counties with no direct entry midwives. Women living in those counties had 2,583,577 live births in 2008. At least one direct entry midwife provides care to women in 43 counties that have neither a certified nurse midwife nor an obstetrician.

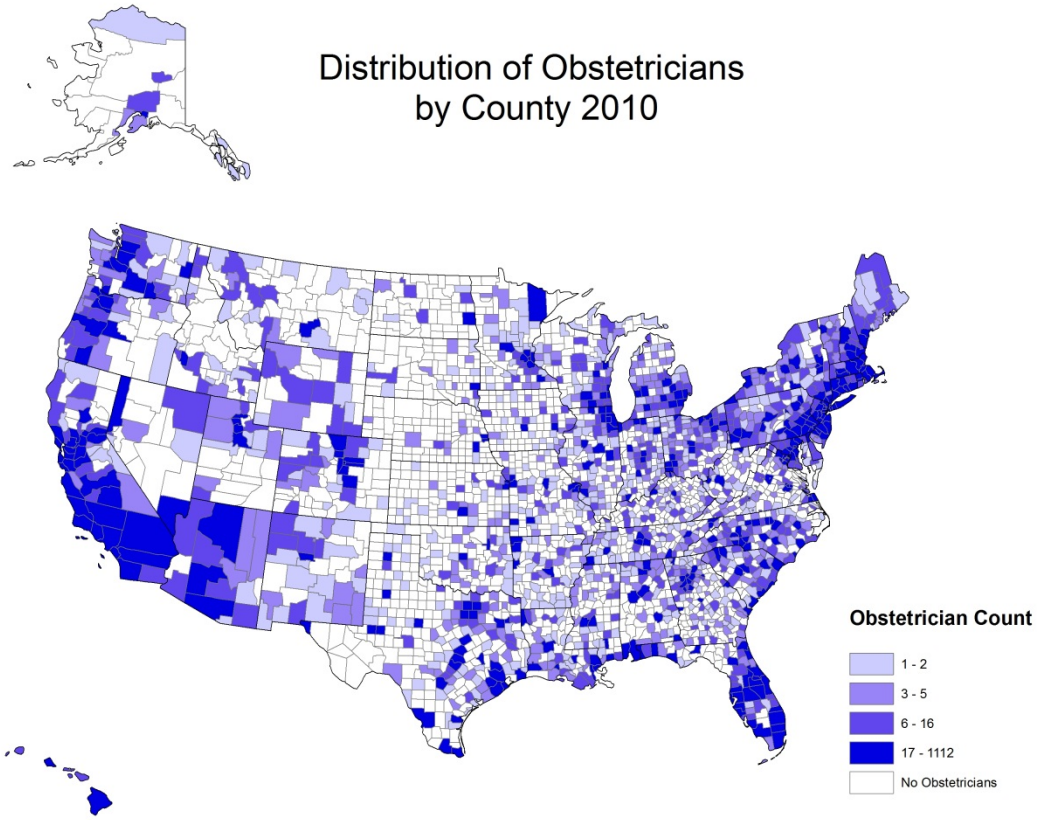

Figure 1: Distribution of Obstetricians by County 2010

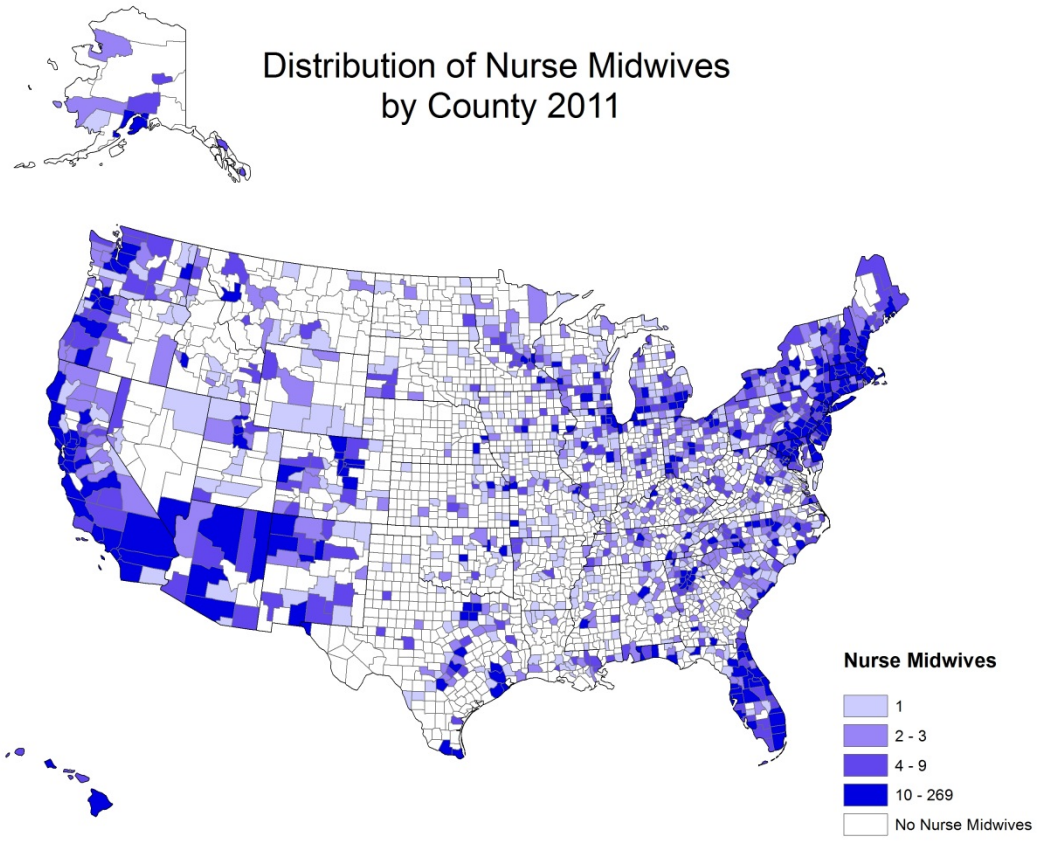

Figure 2: Distribution of Nurse Midwives by County 2011

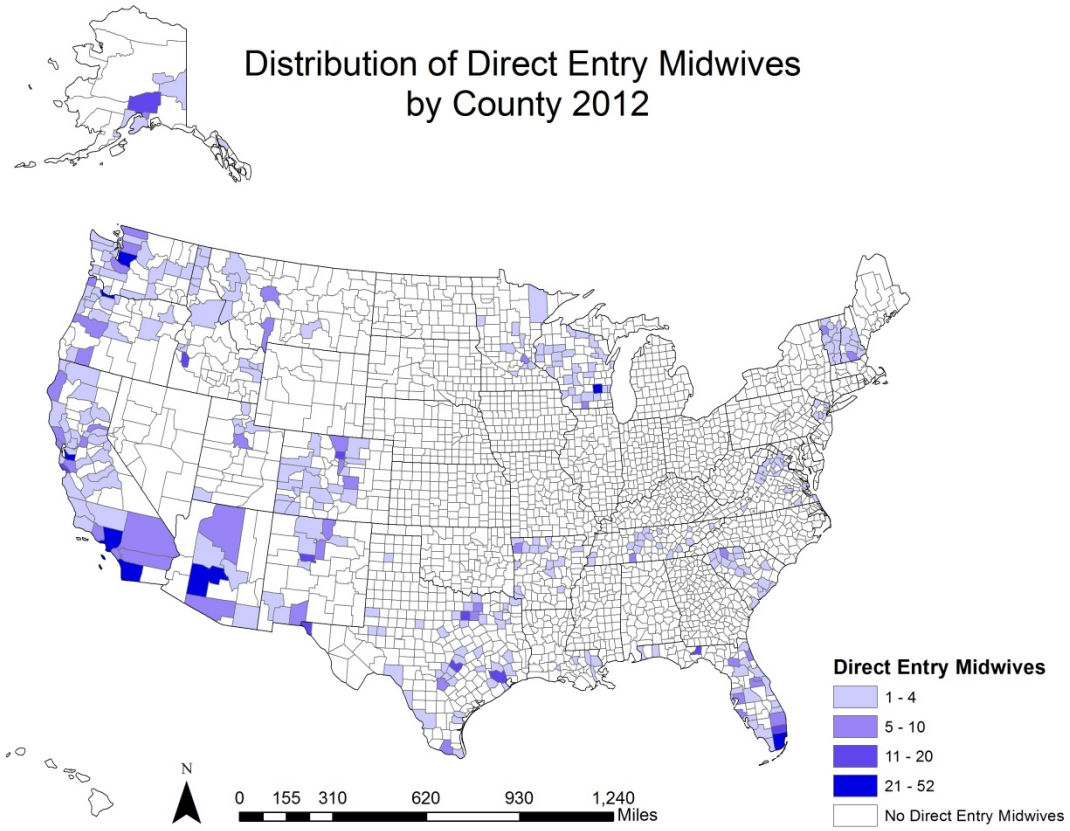

Figure 3: Distribution of Direct Entry Midwives by County 2012

A total of 1213 counties have no obstetricians, nurse midwives or direct entry midwives, while 317 counties have all three types of delivery care providers. The counties without any providers had 192,272 live births in 2008, which is 4.5% of live births.

Adequacy of the workforce at the County Level

Using the measure of 9.9 obstetrician/gynecologists to 100,000 population, 695 counties (22%) have an adequate delivery care workforce (See Figure 4). These counties represent 2,323,965 births which is 54.5% of births in the US for 2008. An additional 2,445 counties had a workforce that is not adequate. There are 1213 counties without workforce which represent 192,272 births, 4.5% of all births in 2008. Of those counties, 541 had more than 140 births.

Using 140 births per obstetrical equivalent measure, 1,100 counties (35%) had adequate delivery care workforce ($p<.01$) (see Figure 5). These counties represent 3,090370 births which is 72.5% of all births in the US in 2008. An additional 188 counties (6%) could be counted as adequate if the upper limit were set to 166 births per obstetrical equivalent. This represents 309,641 births, 7.3% of all births in 2008. There were 640 counties with delivery care providers, but not an adequate supply.

Using the 9.9 obstetricians per 100,000 population measure, only one state and the District of Columbia had an adequate delivery workforce in all counties (See Table 1). Using the 140 births to obstetrical equivalent measure, six states and the District of Columbia had an adequate delivery workforce in all counties. A total of 17 states had statistically significant changes in the number of counties with an adequate delivery workforce.

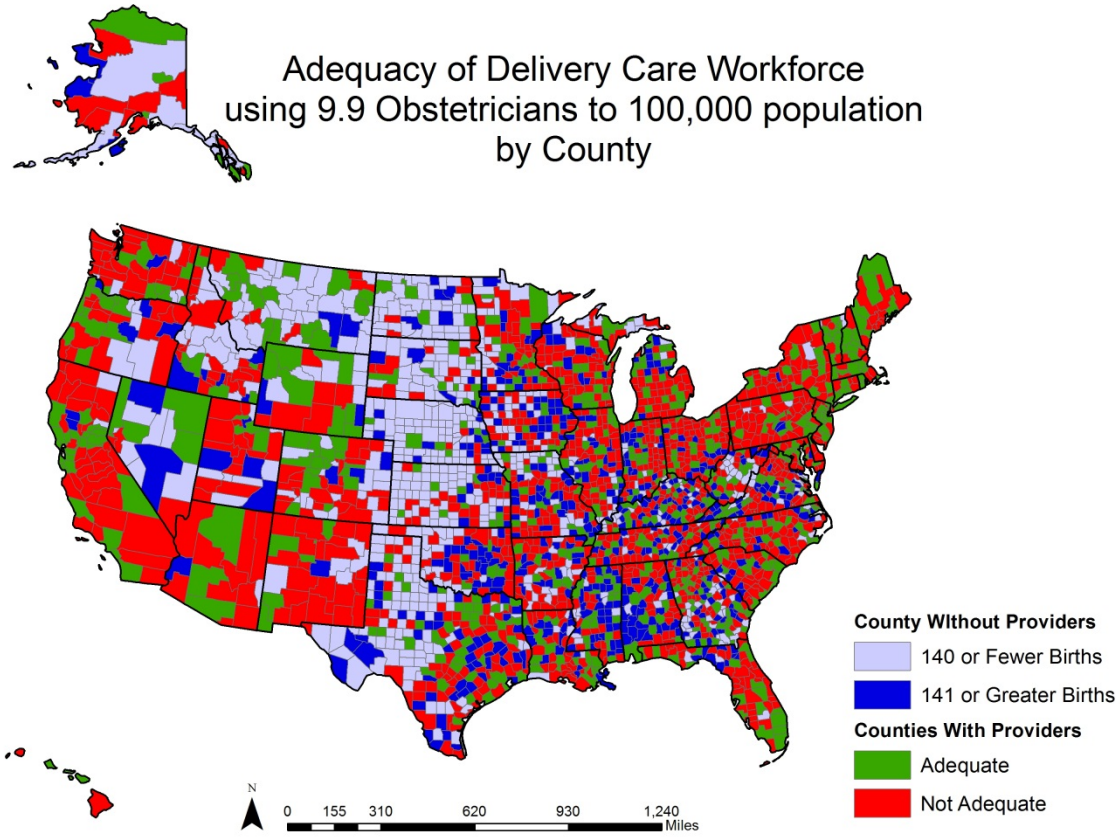

Figure 4 Adequacy of Delivery Care Workforce using 9.9 Obstetricians per 100,000 Population

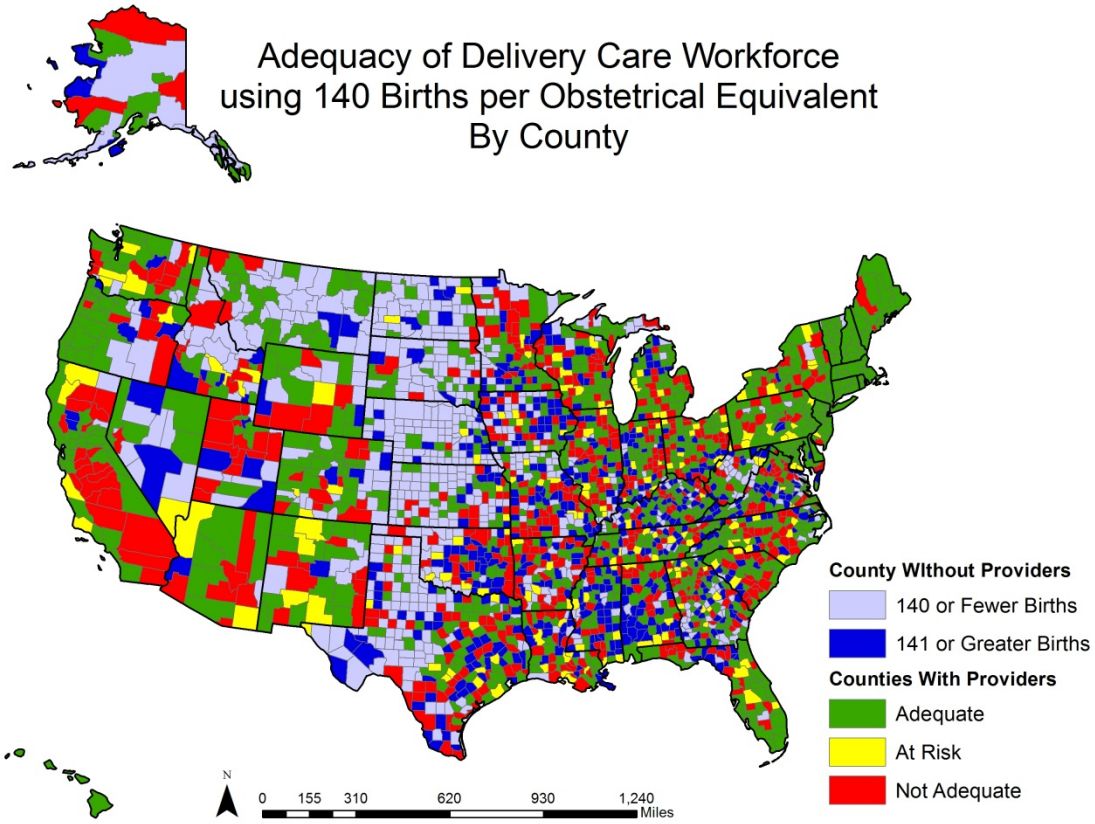

Figure 5 Adequacy of Delivery Care Workforce 140 Births to Obstetrical Equivalent

State	Total Counties	Number of Counties Adequate by Measure		p
		9.9 Obstetrician to 100,000 population	140 Births to Obstetrical Equivalent	
Alabama	67	12	18	.21
Alaska	26	5	10	.13
Arizona	15	3	5	.41
Arkansas	75	10	14	.37
California	58	22	30	.14
Colorado	64	17	28	.04
Connecticut	8	4	8	.07*
Delaware	3	1	3	.37*
District of Columbia	1	1	1	N/A
Florida	67	19	35	.01
Georgia	159	41	54	.11
Hawaii	5	2	5	.16*
Idaho	44	6	11	.18
Illinois	102	20	29	.14
Indiana	92	19	30	.07
Iowa	99	9	19	.04
Kansas	105	12	21	.09
Kentucky	120	27	42	.03
Louisiana	64	16	16	N/A
Maine	16	6	14	<.01
Maryland	24	10	18	.02
Massachusetts	14	8	14	.02*
Michigan	83	24	42	<.01
Minnesota	87	16	27	.05
Mississippi	87	20	21	.86
Missouri	115	21	26	.51
Montana	56	13	18	.21
Nebraska	93	8	9	.80
Nevada	17	5	6	.71
New Hampshire	10	7	10	.20*
New Jersey	21	12	18	.04
New Mexico	33	6	15	.02
New York	62	19	40	<.01
North Carolina	100	23	47	<.01
North Dakota	53	5	7	.54
Ohio	88	19	38	<.01
Oklahoma	77	5	7	.56
Oregon	36	13	21	.06
Pennsylvania	67	18	44	<.01
Rhode Island	5	5	5	N/A
South Carolina	46	12	19	.12
South Dakota	66	10	17	.19
Tennessee	95	16	30	.02
Texas	254	45	54	.37
Utah	29	4	5	.72
Vermont	14	8	12	.21*
Virginia	135	47	64	.04
Washington	39	8	20	.01
West Virginia	55	11	18	.13
Wisconsin	72	17	27	.07
Wyoming	23	8	8	N/A

Table 1: Difference in Adequacy Measure, 9.9 Obstetricians per 100,000 Population and 140 Births per Obstetrical Equivalent

*Fisher Exact Test

Comparing the proportion of adequate delivery care per county using the two measures provides a different ranking of need at the regional level. All regions increased the proportion of adequately covered counties (See Table 2). The 9.9 obstetrician per 100,000 population benchmark measures the Pacific region as in need with only 16.1% of counties adequately covered. However the 140 births to obstetrical equivalent benchmark measures the Pacific region as 48.4% of counties adequately covered.

The average number of births per obstetrician at the county level ranges from 11.2 to 2145 (See Figure 6). The interquartile range of births to obstetrician is 103.2 to 231.6. The average number of births per obstetrical equivalent at the county level ranges from 0.5 to 1198 (See Figure 7). The interquartile range is 60.5 to 177.5.

Region	Total Counties	Number of Counties Adequate by Measure: 9.9 Obstetrician to 100,000 population	Number of Counties Adequate by Measure: 140 Births to Obstetrical Equivalent	p
Midwest	1055	192 (18.2%)	292 (27.7%)	<.01
Northeast	217	113 (52.1%)	165 (76%)	<.01
Pacific	31	5 (16.1%)	15 (48.4%)	<.01
South	1423	331 (23.3%)	461 (32.4%)	<.01
West	414	106 (25.6%)	167 (40.1%)	<.01

Table 2 Difference in Proportion of Counties Covered by Adequacy Measure, 9.9 Obstetricians per 100,000 Population and 140 Births per Obstetrical Equivalent

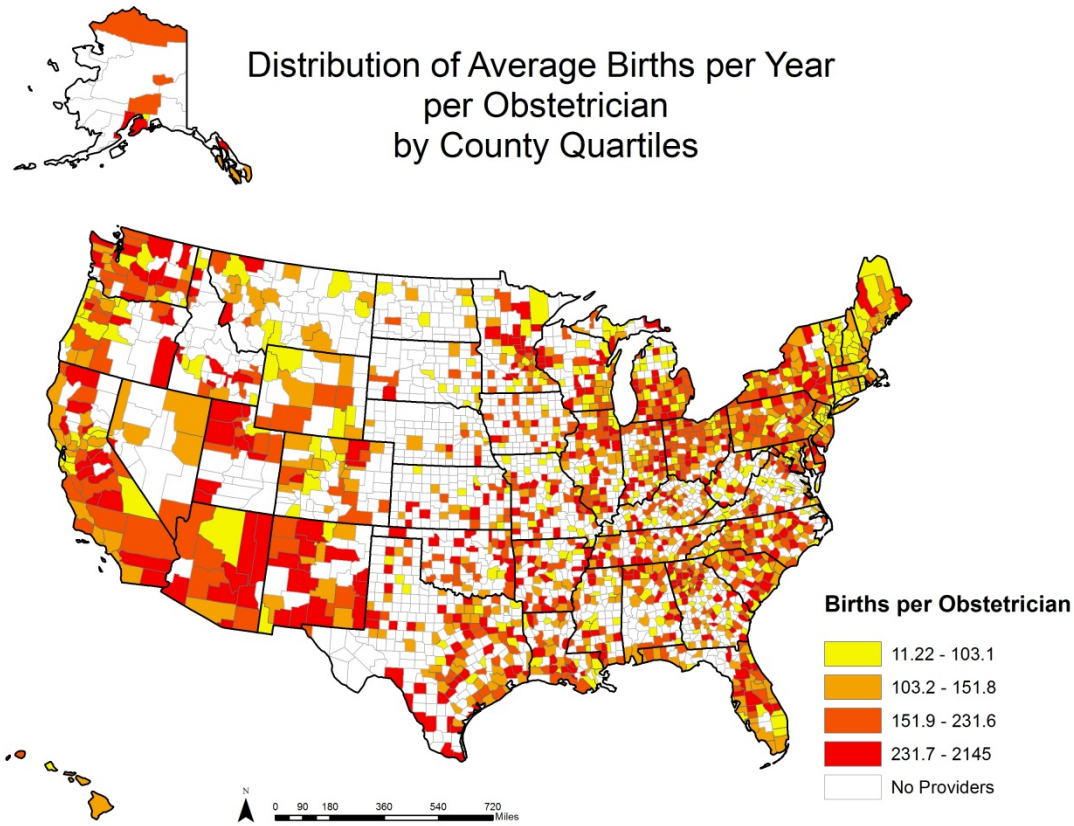

Figure 6 Average Births per Year per Obstetrician by County Quartiles

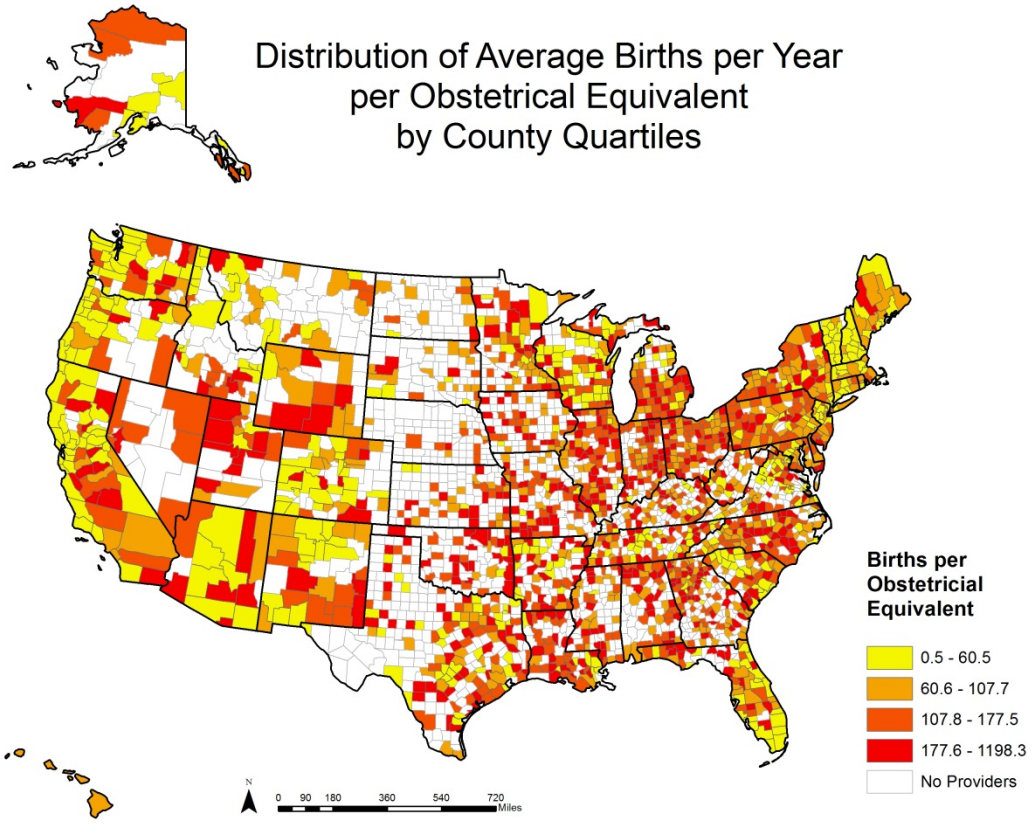

Figure 7 Average Births per Obstetrical Equivalent per Year by County

Distribution of Delivery Care Providers at the Health Service Area Level

There are 34,078 obstetricians in 816 health service areas in the United States (See Figure 8). There were 4,234,622 live births in those health service areas in 2008. This represents 99.3% of all live births in the United States in 2008. There are 133 health service areas with no obstetricians. There were 28,278 live births in health service areas without an obstetrician in 2008.

There are 12,383 nurse midwives in 692 health service areas in the United States (See Figure 9). There were 4,113,068 births in those health service areas in 2008. This represents 96.4% of all live births in the United States in 2008. There are 257 health service areas with no nurse midwives. There were 149,832 live births in health service areas without certified nurse midwives in 2008.

There are 1,249 direct entry midwives in 213 health service areas in the United States (See Figure 10). There were 2,004,644 births in those health service areas in 2008. This represents 47% of all live births in the United States in 2008. There are 736 health service areas with no direct entry midwives. There were 2,258,256 births in health service areas without direct entry midwives in 2008.

Direct entry midwives provide care in five health service areas without obstetricians. Direct entry midwives provide care in fourteen health service areas without nurse midwives. Overall, licensed direct entry midwives provide care in two health service areas that do not have at least one obstetrician or one nurse midwife.

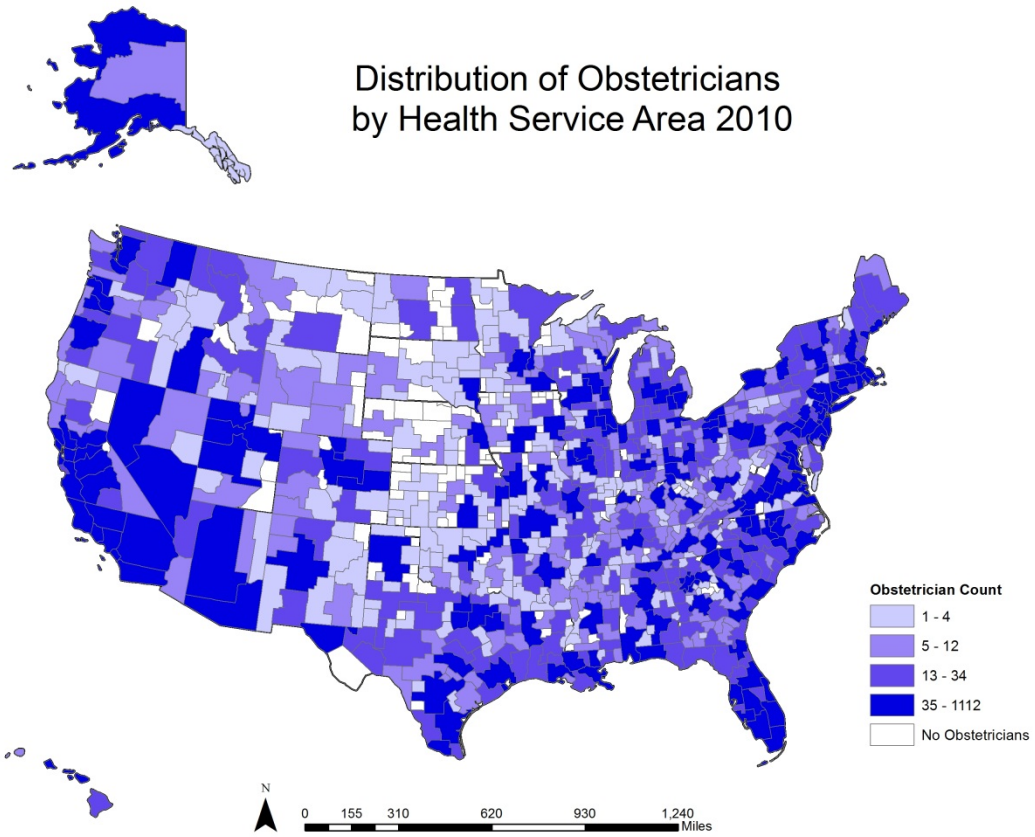

Figure 8 Distribution of Obstetricians by Health Service Area 2010

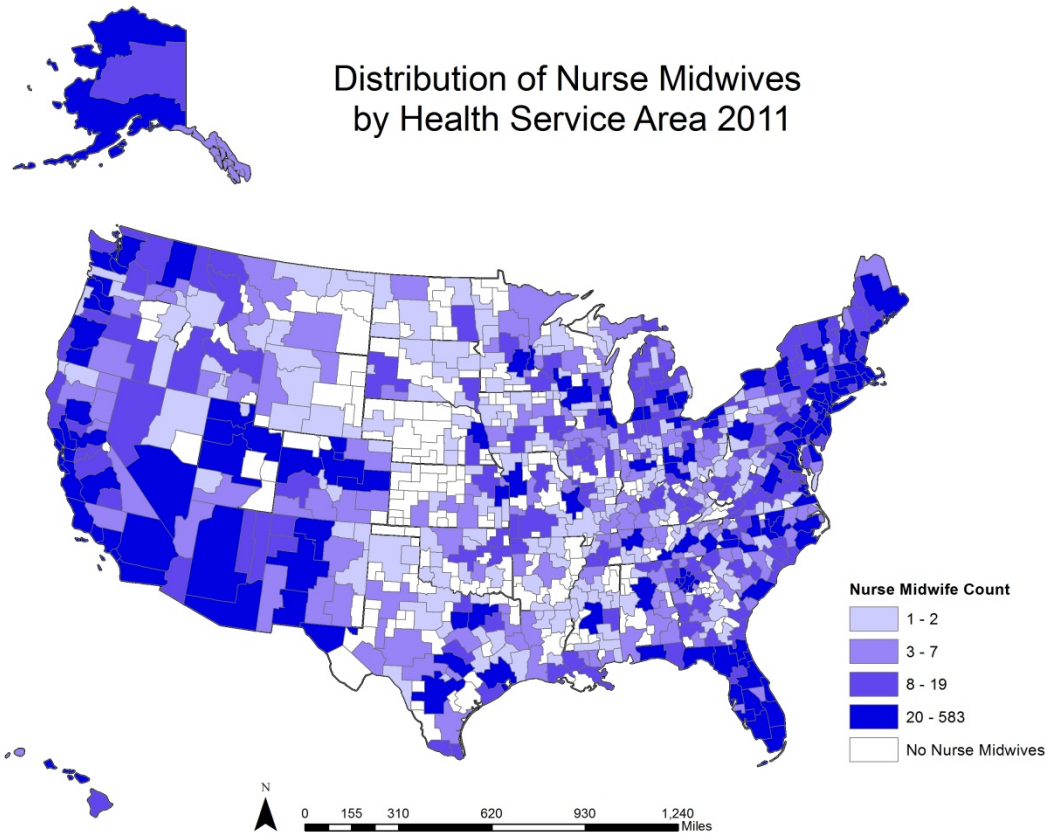

Figure 9 Distribution of Nurse Midwives by Health Service Area 2011

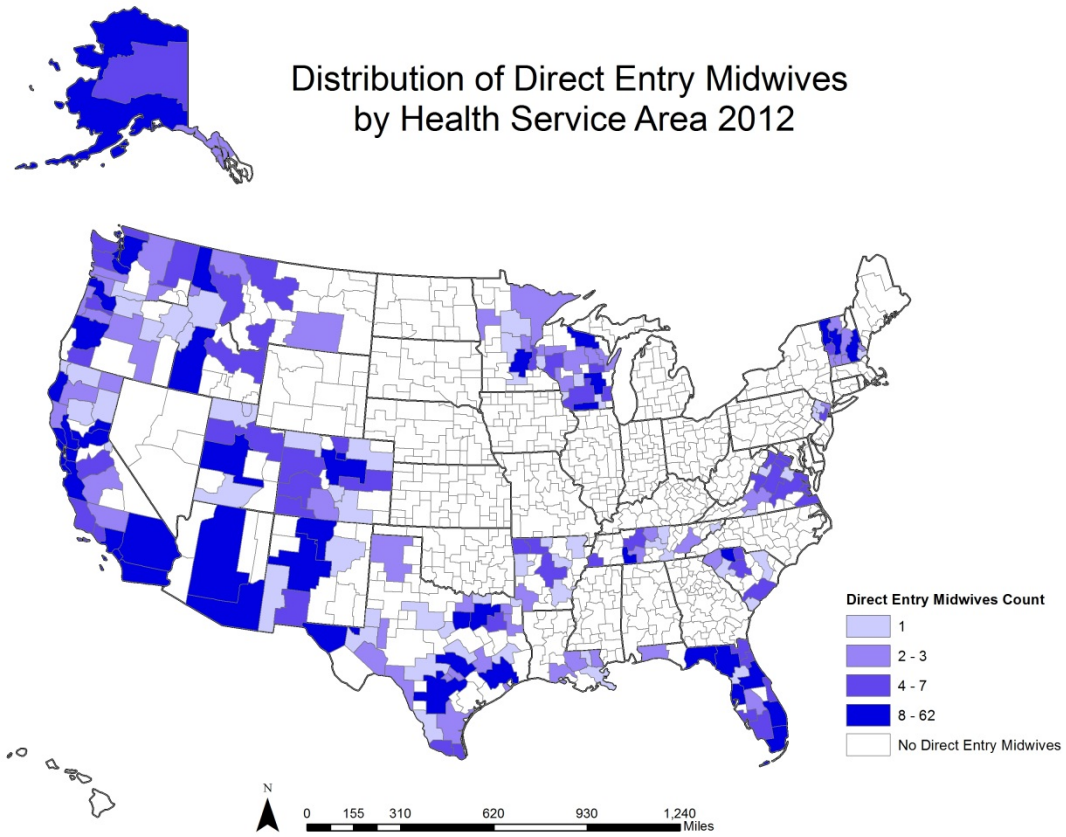

Figure 10 Distribution of Direct Entry Midwives by Health Service Area 2012

Adequacy of the workforce at the Health Service Area Level

Using the measure of 9.9 obstetrician/gynecologists to 100,000 population, 257 health service areas (27.1%) have an adequate delivery care workforce (See Figure 11). These health service areas represent 2,633,246 births, or 61.8% of all births in 2008. An additional 589 (62%) have obstetricians but do not meet the adequacy benchmark. There were 103 health service areas without workforce representing 19,727 live births, which is 0.5% of live births in 2008. Of those, 62 (60%) had more than 140 births.

Using 140 births per obstetrical equivalent measure, 498 health service areas (52.5%) had adequate delivery care workforce ($p<.01$) (See Figure 12). These health service areas represent 3,389,793 births, or 79.5% of all births in 2008. An additional 100 health service areas (10.5%) could be counted as adequate if the upper limit were set to 166 births per obstetrical equivalent. These health service areas represent 305,070 births, or 7.2% of the total births in 2008. There were 248 health service areas with delivery care providers, but not an adequate supply.

Using the 9.9 obstetricians per 100,000 population measure, only one state and the District of Columbia had an adequate delivery workforce in all health service areas (See Table 3). Using the 140 births to obstetrical equivalent measure, seven states and the District of Columbia had an adequate delivery workforce in all health service areas. A total of 14 states had statistically significant changes in the number of health service areas with an adequate delivery workforce.

Comparing the proportion of adequate delivery care per health service area using the two measures provides a different ranking of need at the regional level (See Table 4).

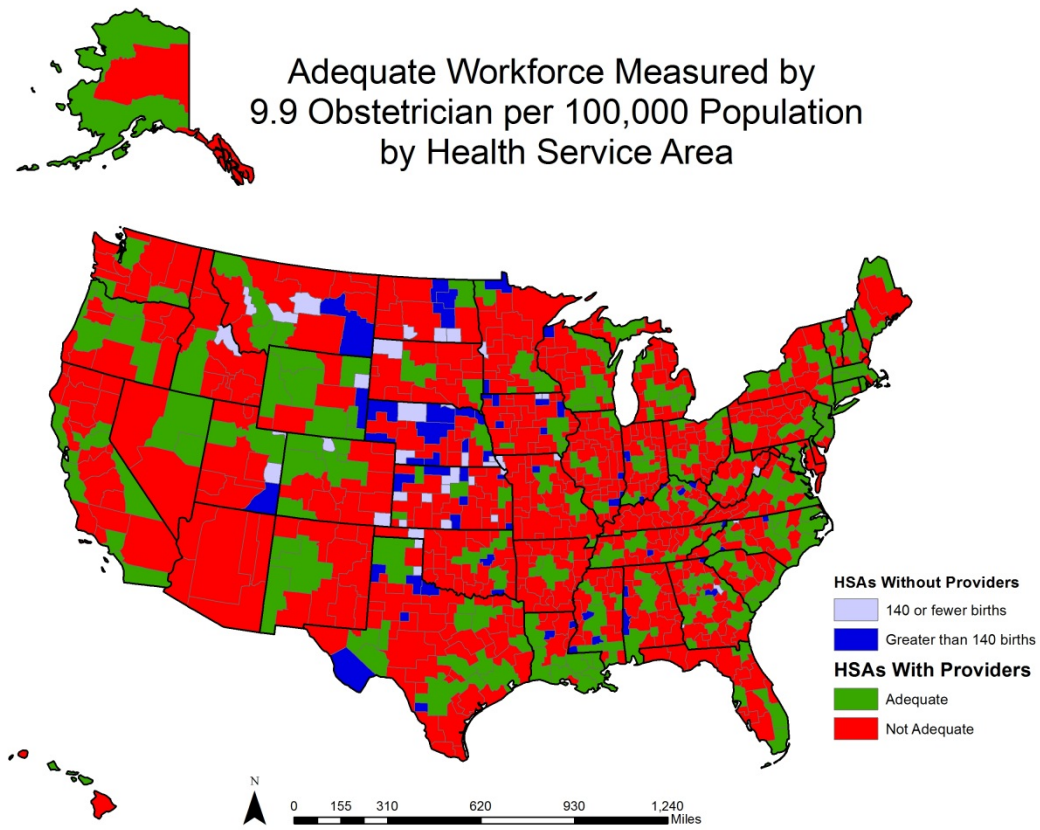

Figure 11 Adequate Workforce as Measured by 9.9 Obstetrician per 100,000 Population by Health Service Area

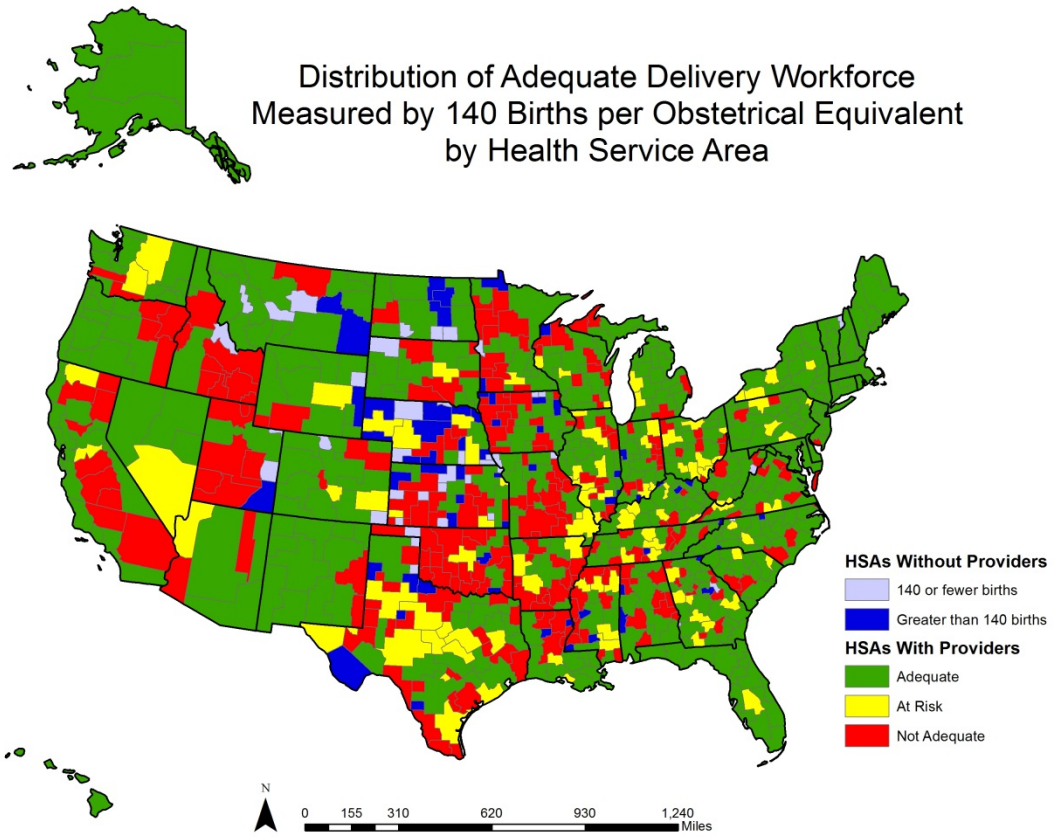

Figure 12 Distribution of Adequate Delivery Workforce Measured by 140 Births per Obstetrical Equivalent by Health Service Area

State	Total Health Service Areas	Health Service Areas Adequate by Measure: 9.9 Obstetrician to 100,000 population	Health Service Areas Adequate by Measure: 140 Births per Obstetrical Equivalent	p
Alabama	20	4	9	.09
Alaska	4	1	4	.13*
Arizona	6	0	3	.17*
Arkansas	22	3	7	.21*
California	30	13	20	.07
Colorado	17	6	11	.09
Connecticut	4	3	4	.96*
Delaware	2	1	2	.95*
District of Columbia	1	1	1	N/A
Florida	17	5	16	<.01
Georgia	42	14	23	.048
Hawaii	3	1	3	.37*.
Idaho	12	1	3	.59*
Illinois	35	3	15	<.01
Indiana	29	7	15	.03
Iowa	34	4	11	.04
Kansas	37	4	7	.33
Kentucky	31	7	20	<.01
Louisiana	17	9	8	.73
Maine	6	3	6	.17
Maryland	9	4	9	<.01
Massachusetts	6	4	6	.43*
Michigan	25	8	19	<.01
Minnesota	26	6	11	.14
Mississippi	25	7	6	.75
Missouri	27	5	11	.07
Montana	16	4	11	.01
Nebraska	25	1	2	.99*
Nevada	4	2	3	.99*
New Hampshire	6	3	6	.17*
New Jersey	9	7	8	.99*
New Mexico	13	3	11	<.01
New York	21	8	17	<.01
North Carolina	32	14	24	.01
North Dakota	13	1	6	.07
Ohio	28	7	13	.09
Oklahoma	26	3	2	.99*
Oregon	14	5	10	0.06
Pennsylvania	26	6	20	<.01
Rhode Island	2	2	2	N/A
South Carolina	14	6	10	.13
South Dakota	15	2	8	.02
Tennessee	28	7	14	.053
Texas	61	14	18	.41
Utah	10	1	1	N/A
Vermont	7	3	6	.27*
Virginia	23	9	13	.24
Washington	15	5	11	.06*
West Virginia	16	5	11	.08*
Wisconsin	25	8	12	.25
Wyoming	13	7	8	.99*

Table 3 Differences in Proportion of Health Service Areas Covered by Adequacy Measure, 9.9 Obstetricians per 100,000 Population and 140 Births per Obstetrical Equivalent

*Fisher Exact Test

Region	Total Health Service Areas	Number of Counties Adequate by Measure		p
		9.9 Obstetrician to 100,000 population	140 Births to Obstetrical Equivalent	
Midwest	319	56 (17%)	131 (41.1%)	<.01
Northeast	87	39 (44.8%)	75 (86.2%)	<.01
Pacific	7	2 (28.6%)	7 (100%)	<.01
South	386	113 (29.3%)	193 (50%)	<.01
West	150	47 (31.3%)	92 (61.3%)	<.01

Table 4 Difference in Proportion of Health Service Areas Covered by Adequacy Measure, 9.9 Obstetricians per 100,000 Population and 140 Births per Obstetrical Equivalent

All regions increased the proportion of adequately covered health service areas. The 9.9 obstetrician per 100,000 population benchmark measures the Pacific region as in need with only 28.6% of health service areas adequately covered. However the 140 births to obstetrical equivalent benchmark measures the Pacific region as highest coverage with 100% of health service areas adequately covered.

The average number of births per obstetrician at the health service area level ranges from 45.2 to 937 (See Figure 13). The interquartile rate of births to obstetrician is 118.6 to 217. The number of births per obstetrical equivalent at the health service area level ranges from 0.1 to 937 (See Figure 14). The interquartile range is 68.6 to 166.5.

Association of state midwifery policy with adequacy of the workforce

A total of 35 states required some form of written agreement with a physician or hospital for a midwife to provide services within the midwifery scope of practice in 2011 (See Figure 15). States requiring a written practice agreement for midwives had a smaller proportion of adequate delivery coverage at both the county and health service area levels. At the county level, states with written practice agreement policies had 32.8% of counties adequately covered compared to 44.7% for states without written practice agreement policies (OR 1.651; CI 1.374-1.983; $p<.01$). At the health service area level, states with written practice agreement policies had 49.1% of health services adequately covered compared to 64.6% for states without written practice agreement policies (OR 1.89; CI 1.37-2.63 $p<.01$). There was no association between written practice agreement and proportion of areas with adequate care when adequacy was measured by 9.9 obstetricians per 100,000 population.

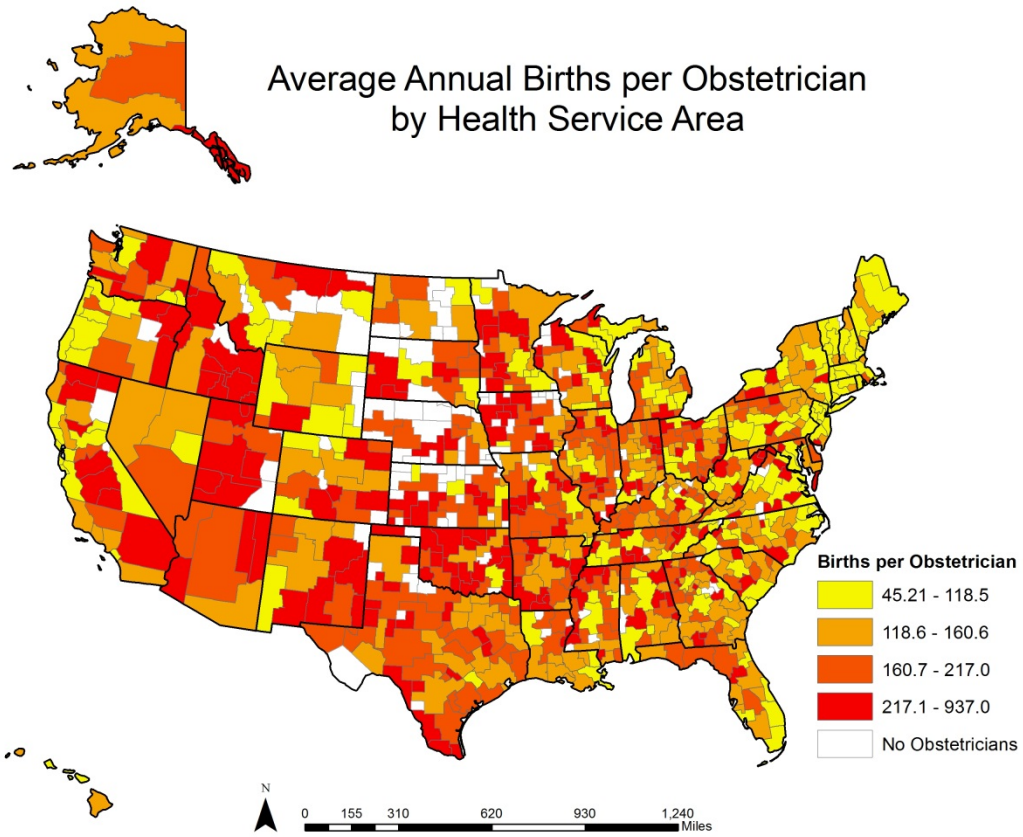

Figure 13 Average Annual Births per Obstetrician by Health Service Area

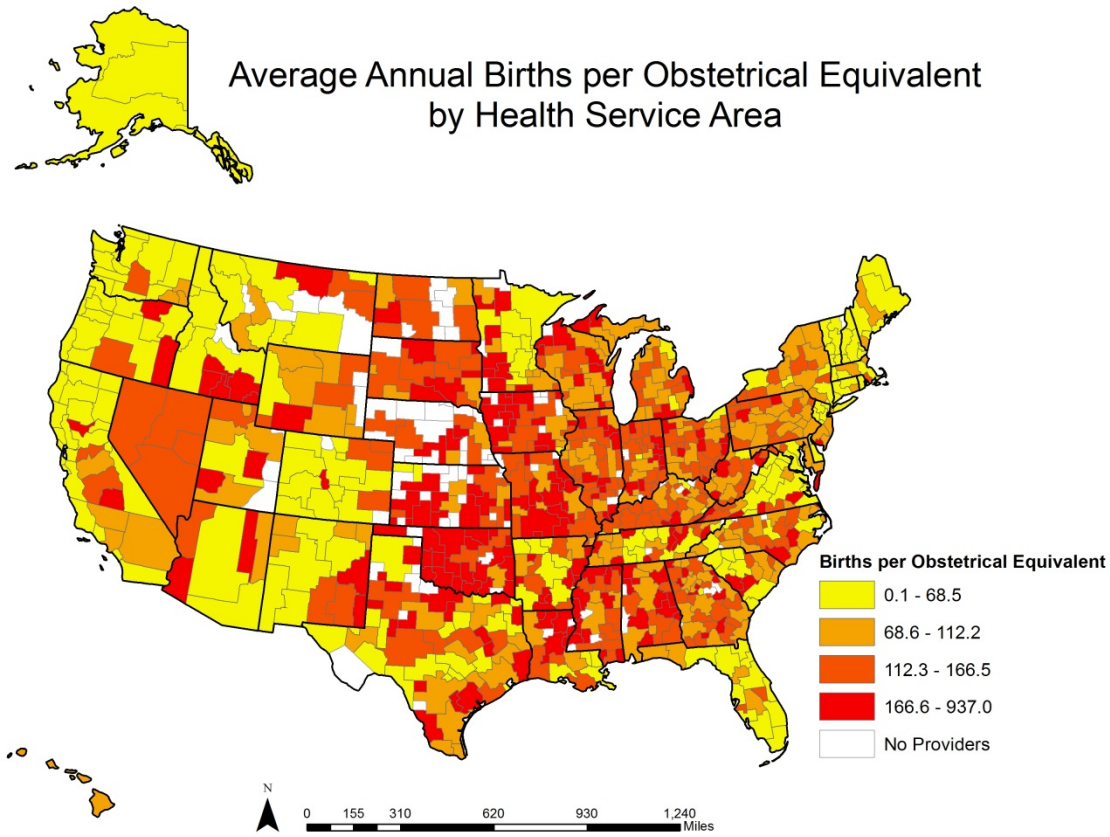

Figure 14 Average Annual Births per Obstetrical Equivalent by Health Service Area

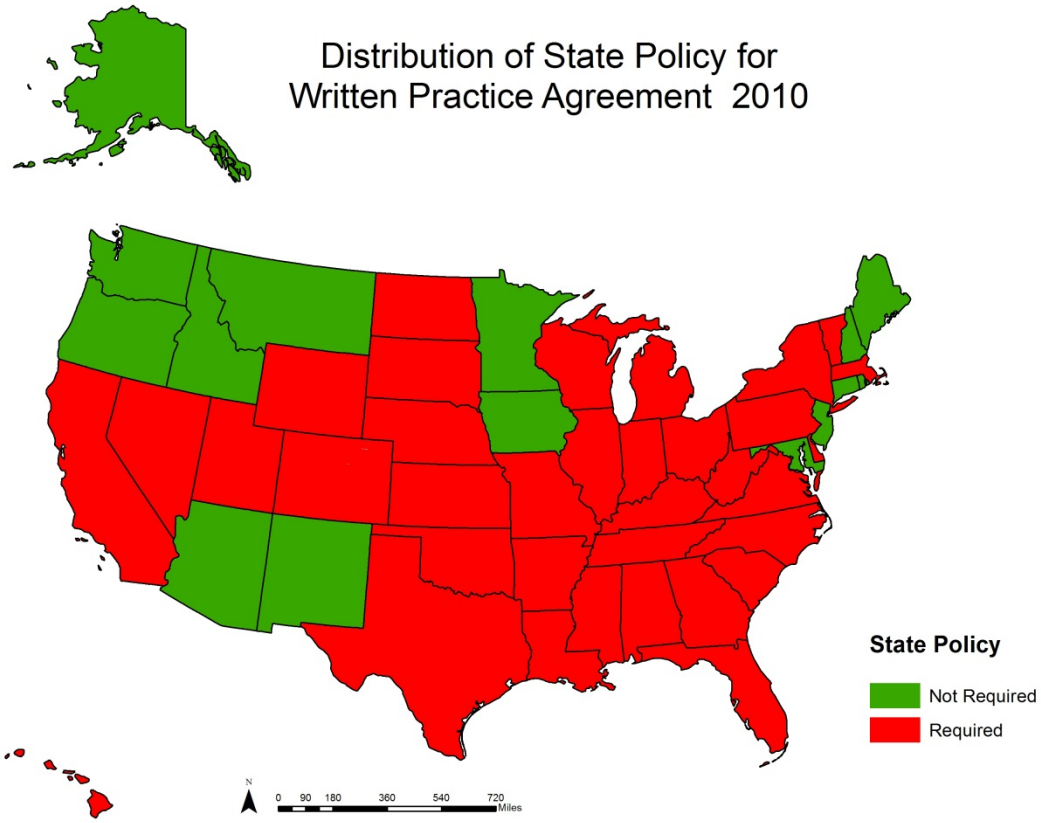

Figure 15 Distribution of State Policy for Written Practice Agreement 2010

A total of 26 states provided a mechanism for direct entry midwives to become licensed or registered to practice in 2012 (See Figure 16). States allowing the licensing of direct entry midwifery are more likely to have adequate delivery coverage at both the county and health service area levels, although the difference is only significant at the health service area level. At the county level, states with policies supporting legal practice of direct entry midwifery have 36.6% of counties adequately covered compared to 34.1% for states without policies supporting licensing of direct entry midwifery, but this was not significant (OR 1.114; CI 0.958-1.295 ; p=.16). At the health service area level, states with policies supporting legal practice of direct entry midwifery have 56.5% of health services adequately covered compared to 48.9% for states without policies supporting legal practice of direct entry midwifery (OR 1.4; CI 1.1-1.8 p=.02). The increased proportion of adequately covered health service areas was also associated with an increased adequacy using the 9.9 obstetrician per 100,000 population measure (OR 1.6; CI 1.2-2.1 p<.01)

A total of 22 states that had neither a policy supporting direct entry midwifery nor a policy allowing midwives to practice without written consent of a physician, 17 states that had only one of the two policies, and 11 states that had both policies. States which had both policies supportive of midwifery practice were more likely to have adequate delivery care coverage at both the county and the health service area levels. At the county level, 45.6% of counties were adequately covered for states that had both policies, compared to 33.5% for either one or neither policy (OR 1.66; CI 1.341-2.055 p<0.001). At the health service area level, 67.4% of health service areas in states with both policies have adequate coverage compared to 49.7% of health service areas in states with either

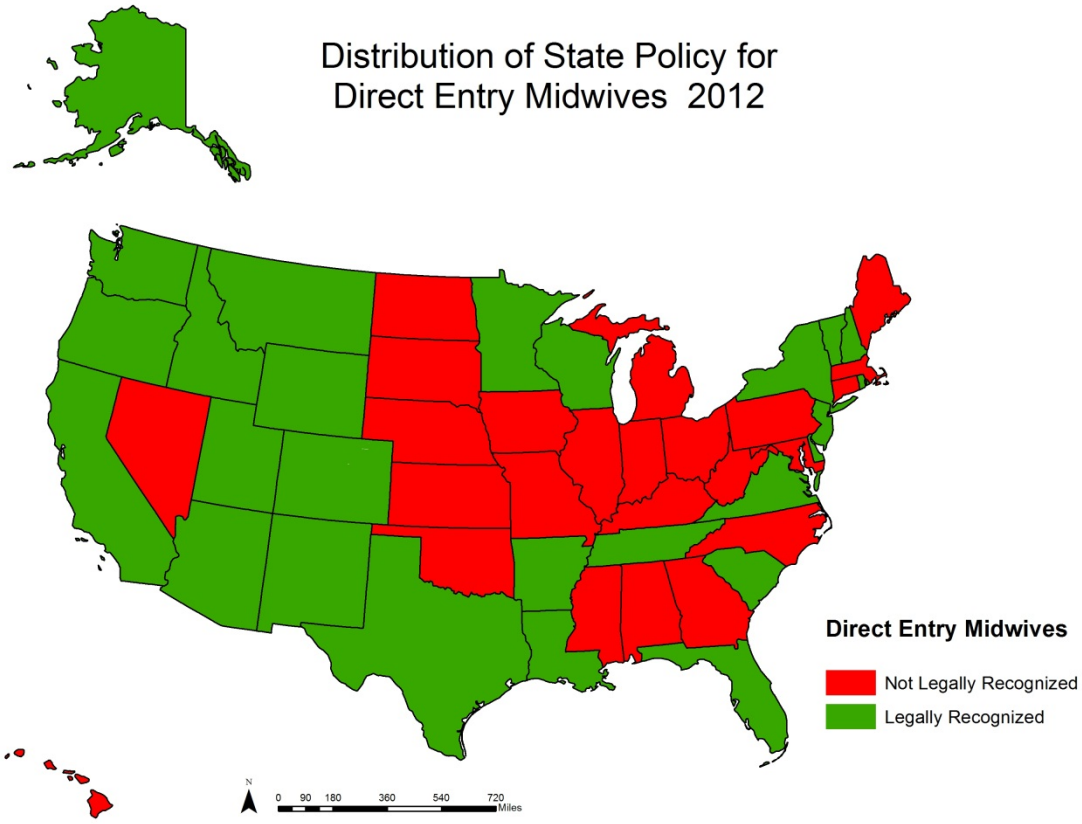

Figure 16 Distribution of State Policy for Legal Recognition of Direct Entry Midwives 2012

one or neither of the policies (OR 2.088; CI 1.44-3.056 p<.01). There was no association found for both policies and the measure of 9.9 obstetricians per 100,000 population (p=.22).

Other Findings

The effect of changing the benchmark from 9.9 obstetricians per 100,000 population to a benchmark of 140 births per obstetrician was calculated while building the equation for obstetrical equivalent. At the county level, measuring 140 births per obstetrician decreased the number of adequately covered counties in 6 states, maintained the count in 7 states and increased the count in the remaining states. At the health service area level, measuring 140 births per obstetrician decreased the number of adequately covered health service areas in 9 states, maintained the count in 16 states and increased the count in the remaining states. None of the differences in adequately covered counties or health service areas were significant. A comparison table can be found in Appendix C.

The average birth attendance per state by certified nurse midwives in 2008 was lower than the upper limit of capacity determined by the analysis. Given the World Health Organization upper limit of annual births attended per midwife (Day-Stirk & Fauveau, 2012), this likely represents an under-utilization of the active midwives in the United States.

The data maps indicate a clustering of direct entry midwives near urban areas with high concentrations of obstetricians and nurse midwives. Analysis of the impact of adding certified professional midwives to the adequacy equation revealed almost no difference in the number of counties or health service areas that could be counted as having adequate care by counting only obstetricians and certified nurse midwives.

Summary

This study provides evidence that the 9.9 obstetrician per 100,000 population is not an accurate estimate of the adequacy of delivery care in a region. Measuring the number of deliveries per obstetrical equivalent revealed a different distribution of average workload per delivery care provider, and a different distribution of regions with adequate and inadequate delivery care provider workforce.

Chapter Five: Discussion

Based on this study, the 9.9 obstetrician to 100,000 population benchmark does not accurately estimate the adequacy of the delivery care workforce. Statistically significant differences in the proportion of health service areas with adequate delivery care existed in 14 states. Accounting for all delivery care providers increased the proportion of births in adequately covered areas from 54.5% to 72.5% at the county level and 61.8% to 79.5% at the health service area level.

In addition to differences in overall adequacy of delivery care, differences in the distribution of adequate delivery care were revealed through the mapping. Mapping adequacy based on 9.9 obstetricians per 100,000 population at the health service area revealed a pattern of even distribution of adequate and not adequate health service areas between states. However, mapping adequacy based on 140 births per obstetrical equivalent revealed a concentration of not adequate health service areas in the Midwest and South. Similarly, mapping of birth to obstetrical equivalent quartiles revealed a heavy burden on Midwestern and Southern states that is not revealed in the average delivery to obstetrician quartile map.

The counts used in this study are the best case scenario. In reality not every nurse midwife or obstetrician will be providing delivery care, nor will the care be provided to the same number of patients. I family physicians were able to be included it is possible the maps would show a different picture of adequately covered rural areas. Based on the delivery attendance used in this study, areas without providers with greater than 140 births per year would need at least six family physicians attending delivery to become "adequate."

The estimates made in this study assume every woman has equal access to every delivery care provider. However, physicians employed through managed care organizations may only be available to patients enrolled in their program. Additionally, studies indicate approximately 85% of physicians accept Medicaid (Public Sector Consultants Inc., 2009) while use of Medicaid as payer source for delivery is increasing with rates in 2009 ranging from 27% of births in Virginia to 64% of births in Oklahoma and Arkansas (Marks, 2011). This may mean providers accepting Medicaid must carry delivery loads above a safe threshold even if overall numbers for an area indicate adequate care.

This study identified wide variation in the workload of delivery care providers. Of the health service areas with at least one delivery care provider, one quarter have fewer than 90 births per provider and one quarter have over 173 births per provider. It is possible these differences in workload result in differences in outcomes. To date research on the effect of heavy delivery provider workload on outcomes is not available. Studies on this upper limit are necessary to set a delivery care workforce benchmark.

Adequacy equations were calculated both with and without including direct entry midwives; however the effect of including direct entry midwives was minimal. A total of 10 counties and 7 health service areas measured as adequately covered only after the inclusion of direct entry midwives. Based on the mapping of midwives, it would seem this lack of effect is due to the clustering of direct entry midwives in areas with high obstetrician and midwife populations. It is also likely the low volume of births attributed to direct entry midwives keeps the total effect small. No data supported using a higher estimation for average births per annum.

This study has provided evidence that policies requiring a written practice agreement for midwives are associated with the adequacy of delivery care. States that do not require a written practice agreement have a statistically significant higher proportion of both counties and health service areas with an adequate supply of delivery care providers. This study has provided evidence that policies supporting the legal recognition of direct entry midwifery are associated with the adequacy of delivery care at the health service area level, but not at the county level. This association is increased for states with both midwife friendly policies.

Knowing the addition of direct entry midwives to the adequacy equation only increased the number of health service areas considered adequate by seven, it is interesting that having a policy supporting the legal recognition of direct entry midwives is associated with a higher rate of adequately covered health service areas. The association cannot be attributed to the actual count of direct entry midwives and must be related to the overall friendliness of a state's policies to midwives and other providers.

Chapter Six: Implications/Recommendations

Several research needs were identified by this study. First, the United States lacks an accurate count of delivery care providers. Counts used are based on identification of primary practice specialty, which may or may not include delivery care. Estimations of family physicians providing delivery care include those who may only provide gynecological care. Because of this, an accurate description of the distribution of delivery care providers was not possible. A mandatory registration of delivery care providers should be considered to allow more accurate estimation of shortage areas.

In nine states, direct entry midwives are not prohibited from practicing but are not regulated. It is impossible to estimate the total impact of direct entry midwifery in states without a system allowing direct entry midwives to register and be counted. Failure to count these providers makes it impossible to estimate the true delivery workforce and to identify shortage areas. States which allow but do not regulate direct entry midwives should find an accurate way to count these providers.

Research should begin to identify the safe upper-limit of deliveries attended per year, and expected health outcome changes when providers are made to practice above this level. Although surgical outcomes improve with increased frequency of performing procedure, it cannot be assumed this is true with vaginal delivery which has different demands on the time and skill of a health care provider than a planned cesarean. The safe upper limit may be different for different types of providers or different practice models. This recommendation agrees with the World Health Organization's identified need to validate maternal health care provider benchmarks in the State of the World's Midwifery publication in 2011 (Day-Stirk & Fauveau, 2012).

The rate of deliveries covered by Medicaid varies by state, and within states. It is possible the number of delivery care providers who accept Medicaid payments will also vary by state and within states. It is necessary to investigate the adequacy of care for Medicaid populations comparing the number of deliveries covered by Medicaid to the number of providers who accept Medicaid. In this way, the adequacy of the delivery workforce for Medicaid participants will not be masked by the adequacy measure for the region as a whole.

Policies which restrict midwifery practice have not been shown to improve patient outcomes, but in this analysis are associated with adequate delivery workforce. This study looked at two policies, the requirement for a written practice agreement and legal recognition of direct entry midwifery. Other policies regulating midwifery practice such as those that affect insurance reimbursement rates and ability for hospitals to deny privileges to independent midwives may also be associated with the overall adequacy of the delivery care workforce. These policies should be studied to determine the overall effect on workforce adequacy.

Appendix A: Summary of Direct Entry Midwifery Laws with Sources for Direct Entry Midwifery Data

State	Source
Alabama	Direct entry midwifery prohibited
Alaska	Division of Corporations Business and Professional Licensing (2012). "Professional License Search." Retrieved March 20, 2012, from http://www.commerce.state.ak.us/occ/search3.htm.
Arizona	Arizona Department of Health Services (2012). "AZ Care Check." Retrieved 3, 20, 2012, from http://www.azdhs.gov/als/search/index.htm.
Arkansas	Health, A. D. o. (2012). "Lay Midwifery." Retrieved March 20, 2012, from http://www.healthy.arkansas.gov/programsServices/familyHealth/WomensHealth/Pages/LayMidwifery.aspx.
California	The Medical Board of California (2012). "License Search for Midwives." Retrieved March 20, 2012, from http://www2.dca.ca.gov/pls/wllpub/wllqryna$lcev2.startup?p_qte_code=LM&p_qte_pgm_code=6200.
Colorado	Colorado Department of Regulatory Agencies (2012). "Lookup a Colorado Credential." Retrieved March 20, 2012, from https://www.colorado.gov/dora/licensing/Lookup/LicenseLookup.aspx.
Connecticut	Direct Entry Midwifery is not licensed
Delaware	Non-licensed, permit only - Division of Public Health, Family Health – Bureau of Maternal and Child Health (302) – 744-4553
District of Columbia	Prohibited
Florida	Florida Department of Health (2012). "License Verification." Retrieved March 3, 2012, from http://ww2.doh.state.fl.us/IRM00PRAES/PRASLIST.ASP.
Georgia	Licensing Not Available
Hawaii	Licensing Not Available
Idaho	Bureau of Occupational Licenses (2012). "Public Record Registration & License Search." Retrieved March 20, 2012, from http://www.ibol.idaho.gov/IBOL/AgencyAdditional.aspx?Agency=427&AgencyLinkID=30.
Illinois	Prohibited
Indiana	Prohibited
Iowa	Prohibited
Kansas	Unregulated
Kentucky	Prohibited
Louisiana	Louisiana State Board of Medical Examiners (2012). "Licensure Verifications." Retrieved October 14, 2012, from http://www.lsbme.louisiana.gov/apps/verifications/lookup.aspx.
Maine	Unregulated
Maryland	Prohibited
Massachusetts	Prohibited
Michigan	Prohibited

State	Source
Minnesota	Minnesota Board of Medical Practice (2012). "AIM Docfinder." Retrieved August 23, 2012, from http://mn.gov/health-licensing-boards/medical-practice/public/find-practitioner/docfinder.jsp.
Mississippi	Unregulated
Missouri	Unregulated
Montana	Montana Department of Labor And Industry (2012). "eBiz.mt.gov Search for Licensee." Retrieved August 23, 2012, from https://ebiz.mt.gov/pol/default.aspx.
Nebraska	Unregulated
Nevada	Unregulated
New Hampshire	Requested from New Hampshire Midwives Association http://www.nhmidwives.org, received October 10, 2012
New Jersey	Certified Midwives are included in the Certified Nurse Midwife list. Certified Professional Midwives were retrieved from Division of Consumer Affairs (2012). "Division of Consumer Affairs License Verification System." Retrieved March 20, 2012, from https://newjersey.mylicense.com/verification/.
New Mexico	New Mexico Department of Health (2012). "Certified Nurse Midwives and Licensed Midwives ". Retrieved March 20, 2012, from http://www.health.state.nm.us/PHD/midwife_roster.shtml.
New York	Direct Entry Midwives are Certified Midwives licensed with Certified Nurse Midwives and in the ARF
North Carolina	Prohibited
North Dakota	Unregulated
Ohio	Unregulated
Oklahoma	Unregulated
Oregon	State of Oregon (2012). "Public Record Information Record Finder." Retrieved March 20, 2012, from https://elite.hlo.state.or.us/elitepublic/LPRBrowser.aspx.
Pennsylvania	Prohibited
Rhode Island	Direct Entry Midwives are Certified Midwives licensed with Certified Nurse Midwives and in the ARF
South Carolina	South Carolina Department of Health and Environmental Control (2012). "Health Licensing." Retrieved March 20, 2012, from http://www.scdhec.gov/health/licen/hrlicmw.htm.
South Dakota	Prohibited
Tennessee	Department of Health (2012). "License Verification." Retrieved March 20, 2012, from http://health.state.tn.us/Licensure/default.aspx.
Texas	Texas Midwifery Board (2012). "Find a Midwife - Live Online Search Verification." Retrieved March 20, 2012, from http://www.dshs.state.tx.us/midwife/mw_search.shtm.
Utah	Utah Division of Occupational and Professional Licensing (2012). "Licensee Lookup & Verification System." Retrieved March 30, 2012, from https://secure.utah.gov/llv/search/index.html.
Vermont	State of Vermont (2012). "State of Vermont eLicense System." Retrieved March 20, 2012, from https://secure.vtprofessionals.org/.

State	Source
Virginia	Virginia Department of Health Professions (2012). "Public Information System." Retrieved March 20, 2012, from https://secure01.virginiainteractive.org/dhp/cgi-bin/search_publicdb.cgi.
Washington	Washington State Department of Health (2012). "Provider Credential Search." Retrieved March 20, 2012, from http://www.doh.wa.gov/LicensesPermitsandCertificates/ProviderCredentialSearch.aspx.
West Virginia	Unregulated
Wisconsin	Requested from Wisconsin Department of Safety and Professional Services http://online.drl.wi.gov/LicenseLookup/LicenseLookup.aspx
Wyoming	Wyoming Board of Midwifery (2012). "License Directory." Retrieved March 20, 2012, from http://plboards.state.wy.us/midwifery/ApplicationInstructionsForms.aspx.

Appendix B: Summary of Midwifery Written Practice Agreement Laws by State(ACNM, 2011)

State	Law
Alabama	Requires written practice agreement
Alaska	No written practice agreement
Arizona	No written practice agreement
Arkansas	Requires written practice agreement
California	No specific written agreement, but requires physician supervision
Colorado	Requires written practice agreement
Connecticut	No written practice agreement
Delaware	Requires written practice agreement
District of Columbia	No written practice agreement
Florida	Requires written practice agreement
Georgia	Written agreement required to prescribe medications
Hawaii	Written agreement required to prescribe medications
Idaho	No written practice agreement
Illinois	Requires written practice agreement
Indiana	Requires written practice agreement
Iowa	No written practice agreement
Kansas	Requires written practice agreement
Kentucky	Written agreement required to prescribe medications
Louisiana	Requires written practice agreement
Maine	No written practice agreement
Maryland	No written practice agreement
Massachusetts	Required written practice agreement in 2010; no longer required
Michigan	Written agreement required to prescribe medications
Minnesota	No written practice agreement
Mississippi	Requires written practice agreement
Missouri	Requires written practice agreement
Montana	No written practice agreement
Nebraska	Requires written practice agreement
Nevada	Requires written practice agreement
New Hampshire	No written practice agreement
New Jersey	No written practice agreement
New Mexico	No written practice agreement
New York	Required written practice agreement in 2010; no longer required
North Carolina	Requires written practice agreement
North Dakota	Required written practice agreement in 2010; no longer required
Ohio	Requires written practice agreement
Oklahoma	Written agreement required to prescribe medications
Oregon	No written practice agreement
Pennsylvania	Requires written practice agreement
Rhode Island	No written practice agreement
South Carolina	Requires written practice agreement
South Dakota	Requires written practice agreement
Tennessee	Written agreement required to prescribe medications

State	Law
Texas	Requires physician review of practice guidelines
Utah	Required written practice agreement in 2010; no longer required
Vermont	Required written practice agreement in 2010; no longer required
Virginia	Requires written practice agreement
Washington	No written practice agreement
West Virginia	Requires written practice agreement
Wisconsin	Requires written practice agreement
Wyoming	Requires written practice agreement

Appendix C: Difference between Obstetrician to Population and Obstetrician to D Measures of Adequacy

	Number of Counties Adequate by Measure			Health Service Areas Adequate by Measure		
State	Total Counties	9.9 Obstetricians to 100,000 Population	140 Births per Obstetrician	Total Health Service Areas	9.9 Obstetricians to 100,000 Population	140 Births per Obstetrician
Alabama	67	12	16	20	4	8
Alaska	26	5	3	4	1	1
Arizona	15	3	2	6	0	0
Arkansas	75	10	13	22	3	3
California	58	22	25	30	13	13
Colorado	64	17	20	17	6	5
Connecticut	8	4	7	4	3	4
Delaware	3	1	1	2	1	1
District of Columbia	1	1	1	1	1	1
Florida	67	19	28	17	5	9
Georgia	159	41	46	42	14	12
Hawaii	5	2	3	3	1	1
Idaho	44	6	4	12	1	1
Illinois	102	20	23	35	3	6
Indiana	92	19	25	29	7	9
Iowa	99	9	12	34	4	4
Kansas	105	12	13	37	4	4
Kentucky	120	27	31	31	7	7
Louisiana	64	16	16	17	9	7
Maine	16	6	13	6	3	5
Maryland	24	10	13	9	4	5
Massachusetts	14	8	11	6	4	4
Michigan	83	24	31	25	8	12
Minnesota	87	16	18	26	6	7
Mississippi	87	20	21	25	7	4
Missouri	115	21	20	27	5	7
Montana	56	13	14	16	4	5
Nebraska	93	8	7	25	1	1
Nevada	17	5	5	4	2	1
New Hampshire	10	7	10	6	3	5
New Jersey	21	12	13	9	7	8
New Mexico	33	6	8	13	3	4
New York	62	19	27	21	8	12
North Carolina	100	23	28	32	14	15
North Dakota	53	5	6	13	1	3
Ohio	88	19	23	28	7	9
Oklahoma	77	5	7	26	3	2
Oregon	36	13	14	14	5	8
Pennsylvania	67	18	30	26	6	12
Rhode Island	5	5	5	2	2	2
South Carolina	46	12	16	14	6	8
South Dakota	66	10	10	15	2	2
Tennessee	95	16	19	28	7	8
Texas	254	45	49	61	14	9
Utah	29	4	1	10	1	0
Vermont	14	8	11	7	3	5
Virginia	135	47	52	23	9	12
Washington	39	8	12	15	5	4
West Virginia	55	11	13	16	5	7
Wisconsin	72	17	20	25	8	9
Wyoming	23	8	8	13	7	7

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