Midwives as prenatal care providers in the United States

Dissertation

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By

Jiska Loewenberg Weisband, MPH

Graduate Program in Public Health

The Ohio State University

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Dissertation Committee:

Professor Alison H. Norris, Advisor

Professor Maria Gallo

Professor Mark Klebanoff

Professor Abigail Shoben
Abstract

Introduction: Nearly one-third of births in the United States (US) are Cesarean sections (C-sections); more than double the World Health Organization’s optimal C-section rate. In addition, vaginal births frequently include various interventions, including labor induction, labor augmentation, and epidural analgesia. Births in the US are also more expensive than in other high-income countries. Despite the copious amounts of money and care involved in births, maternal and neonatal mortality in the US are among the highest in high-income countries. One substantial difference between the US and other high-income countries is the infrequent use of midwives in the US. Our study aimed to assess whether women who used midwives in the US were different from women who used a physician. Second, we examined the progression of care among midwife patients, to understand when women leave midwife care and to assess correlates of transfers of care to a physician. Finally, we compared birth interventions, maternal outcomes and neonatal outcomes of low-risk women who used a midwife for prenatal care and those who used a physician.

Methods: We used the Listening to Mothers III survey to assess the equivalence of women who used a midwife and those who used a physician. We also obtained a retrospective cohort of women who delivered at The Ohio State University Wexner Medical Center (OSUWMC), and had at least one prenatal care appointment in the...
OSUWMC network. We used logistic regression with Firth’s bias correction as necessary to obtain correlates of transfers from midwife to physician care. We assessed risk ratios and odds ratios of birth interventions, maternal outcomes and neonatal outcomes using modified Poisson regression or logistic regression with Firth’s bias correction as appropriate.

Results: We found that nationally, women who use a midwife were similar in most aspects to women who used a physician for prenatal care or as a birth attendant. However, the percentage of white and married women was greater among women who used a midwife for prenatal care, and the percentage of women over age 35 was lower among women who used a midwife as a birth attendant. In our second analysis, we found that less than 5% of women transferred to a physician during prenatal care and 21% transferred during delivery. Our final analysis found that women who used a midwife for prenatal care had reduced risks of having a C-section and preterm birth, without increased odds of severe maternal or neonatal outcomes. Midwife patients had a significant increase in excessive bleeding during labor, although the absolute risk was small.

Conclusions: Women who use midwives for prenatal care are similar to those who use physicians. Our findings also indicate that as most women remained in midwife-care throughout their pregnancy and delivery, initiating prenatal care with a midwife is likely to lead to continuity of care for women with low-risk pregnancies. Finally, we found that for women with low-risk pregnancies, midwives provide a safe alternative to physician care, and midwife care is associated with substantially fewer preterm births and C-sections.
Dedication

To Shaul, I couldn’t have done this without you by my side. And to our fantastic four: Ariel, Talya, Gefen and Roni, for keeping me focused on the truly important things in life.
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Vita

2003 ................................................. B.Sc Computer Science and Math, The Hebrew University

2011-2012 ....................................... Graduate Research Assistant, National Program for Quality indicators in community healthcare, The Hebrew University

2012 .................................................. Master of Public Health, The Hebrew University

2016 .................................................. Senior Research Associate, Center for Perinatal Research, Nationwide Children’s Hospital

2012-2017 ......................................... Graduate Research/Teaching Assistant, Division of Epidemiology, College of Public Health, The Ohio State University
Publications


Fields of Study

Major Field: Public Health
Epidemiology
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Chapter 1: Introduction

1.1 Description of the problem

As the 7th wealthiest country in the world, and as a leader in innovation and technology, we might expect the United States to have some of the best birth outcomes in the developed world. However, this is far from the situation. Consider, for example neonatal and maternal deaths. One of the goals of the Organization for Economic Co-operation and Development (OECD), a forum of 34 of the world’s most advanced and emerging countries, is to develop reliable statistics of health system performance and to assess how each of these countries compare to other developed countries. The US infant mortality rate is well above the OECD’s average rate (1) and US maternal mortality rates have been increasing in the past 20 years, in contrast to the trends in other developed countries (2). All of this comes during a period of consistent and ongoing increases in the cost of birth in the US (3). One major difference between the US and other developed countries is the use of midwives for prenatal care and delivery. While midwives commonly attend births in other developed countries, in the US, midwives attend only 8% of all births (4). In the UK, Australia and Canada, midwives provide care with fewer interventions while having similar or less adverse outcomes when compared to the care of physicians. In addition, midwife-care in these countries is less costly compared to physician care (5,6). However, very little research has been done on midwife care in the US (7).
As the US health care system differs tremendously from those in other countries, it is important to understand more about the current state of midwife-led care in the US. This will allow us to assess whether integrating midwives more commonly into routine prenatal and intrapartum care in the US can lower costs of births without increasing adverse birth outcomes. In order to do so I propose a multi-faceted approach: to understand the characteristics of women who use midwives for prenatal care, to evaluate the characteristics of women who remain in midwife care, and to assess whether birth outcomes of women who used a midwife for prenatal care differ from those who used a physician.

First I describe which factors uniquely characterize women who choose to use midwives, thereby identifying whether women who currently use midwives are different in some way from women who use physicians. If there are differences it will be important to be aware of them when interpreting differences in birth outcomes. Second, I will be able to understand the transitions between the care of midwives and physicians. This, together with the understanding of differences in birth outcomes between provider types, will allow us to find the optimal way for midwives and physicians to work harmoniously to ensure optimal outcomes.

These outcomes are expected to have an important positive impact because they can illuminate a cadre of professional providers who can provide high quality prenatal care while lowering costs, and in addition this may lead to an improvement in access to care for women living in medically underserved areas.
1.2 Specific aims and associated research questions

1. To describe women who use a midwife for prenatal care (PNC) and to compare them to women who use a physician for prenatal care.

   Research Questions: What proportion of women use a midwife for prenatal care? What proportion of women use a midwife as a birth attendant? What proportion of women use midwives for prenatal care and as a birth attendant? How do the socio-demographic characteristics of women who use a midwife as a prenatal care provider differ from those of women who use a physician as a prenatal care provider? How do the health history characteristics of women who use a midwife as a prenatal care provider differ from those of women who use a physician as a prenatal care provider? How do assessments of interpersonal quality of care compare between women who use a midwife for prenatal care and those who use a physician for prenatal care?

Hypotheses:

1. There are no differences in socio-demographic characteristics between midwife and physician patients.

2. There are no differences in health history characteristics between midwife and physician patients.

3. Women assess the quality of prenatal care provided by midwives to be similar to that of physicians.
2. To evaluate the progression of care among women with a low-risk pregnancy who initiate prenatal care with midwives and deliver at a large Midwestern hospital.

Research Questions: What proportion of women with low-risk pregnancies initiate prenatal care with a midwife? What proportion of these women transfer to physician care during prenatal care? What proportion of these women transfer to physician care during delivery? What are the reasons women transfer to physician care throughout their pregnancy and delivery, and are these reasons different for transfers during prenatal care and during delivery?

Hypothesis:

1. Most of the women who attend a midwife for prenatal care will remain with a midwife throughout delivery.

2. Most of the women who transfer to the care of a physician will do so for delivery, with fewer transferring during prenatal care.

3. To compare birth outcomes between women with a low-risk pregnancy who use midwives for prenatal care and those who use physicians for prenatal care.

Research questions: Do the following outcomes differ between women with low-risk pregnancies who use a midwife for prenatal care and women with low-risk pregnancies who use a physician for prenatal care: labor augmentation, labor induction, Cesarean section (C-section), preterm birth, episiotomy, severe maternal morbidity, third and fourth degree perineal lacerations, excessive bleeding during labor, shoulder dystocia, admission to level 3 or 4 NICU, low Apgar score rate, stillbirth or neonatal death?
Hypothesis:

1. The proportion of women who experience interventions during labor, including: labor augmentation, induction, C-section, and episiotomy will be lower in women with low risk pregnancies who use a midwife for prenatal care compared to women with low risk pregnancies who use a physician for prenatal care.

2. The proportion of women who experience adverse maternal outcomes including: severe maternal morbidity, third and fourth degree perineal lacerations, excessive bleeding during labor, and shoulder dystocia will not differ between women with low risk pregnancies who use a midwife for prenatal care and women with low risk pregnancies who use a physician for prenatal care.

3. The proportion of infants who experience adverse neonatal outcomes including: admission to level 3 or 4 NICU, low Apgar score, stillbirth or neonatal death will not differ between women with low risk pregnancies who use a midwife for prenatal care and women with low risk pregnancies who use a physician for prenatal care.
Chapter 2: Background and significance

2.1 Midwife care in the US

The vast majority of births in the U.S occur within a hospital. In 2015, 98.5% of all births occurred in a hospital, and only 1.5% of births occurred out-of-hospital. Physicians attended 91% of hospital births while certified nurse midwives attended 8.1% of hospital births (1). Between 1975-2015 there has been a consistent increase in midwife-attended births, from less than 1% to over 8% (1,2). Nearly all midwives in the US are certified nurse-midwives (CNM). CNMs are licensed and have prescriptive authority in every state. According to the American Midwifery Certification Board, as of January 2012 there were 12,622 CNMs in the United States (3). Midwives attend births wherever women deliver: in hospitals, birth centers and at women’s homes. Overall, 95% of births attended by midwives occur in the hospital (4).

2.2 Midwife scope of practice

Midwives provide care for women with low-risk pregnancies, as well as for women with certain medium-risk pregnancies. Women are considered to have a low-risk pregnancy if they don’t have the following pre-existing and antepartum conditions: cardiac disease, renal disease with failure, insulin-dependent diabetes mellitus, uncontrolled asthma, or maternal HIV infection, persistent hypertension, gestational
diabetes requiring management with medication, and known fetal anomalies. These conditions may make a woman an unsuitable candidate for a midwife-led birth.

In addition, there are conditions in which a woman’s care is usually transferred for delivery. These conditions include: non-cephalic fetal presentation and placenta previa at term. Finally, during delivery, there are numerous conditions, which may require the transfer of care to a physician, including: persistent non-reassuring fetal heart rate pattern, maternal fever, and thick meconium (11,12).

2.3 High-risk pregnancy and other counter-indications for midwife care

Despite the long list of potential factors that can prevent a woman from having midwife-led birth, the vast majority of births are in fact low risk births which can be attended by either a midwife or a physician. High-risk complications are estimated to occur in 6%-8% of pregnancies (5). However, there is some variation in the estimation of different indications for high-risk pregnancies. For example, an estimated 0.3% of pregnancies occur in women with pre-existing diabetes mellitus (6), and an additional 4.6% - 9.2% of pregnancies are complicated with gestational diabetes (7,8). Some proportion of these women will require management with medication, and these women will not be able to be cared for by midwives.

According to the National Heart, Lung and Blood Institute (NHLBI), 6%-8% of pregnant women have high blood pressure (9), preeclampsia occurs in 2.7% and gestational hypertension occurs in 2.1% of pregnancies (10). Multiple gestation also increases the risks to the pregnancy. Twin births occur in about 3% of pregnancies. Some of these high-risk pregnancies can have severe complications and require the care of
trained specialists to ensure the best possible outcome, and are therefore not suitable for midwifery care (5).

In addition to these pre-existing conditions, there are several indications that may lead to the transfer of care from a midwife to a physician, prior to labor. These indications include fetal breech position and complications that occur during pregnancy. No studies that have assessed the proportion of women who transfer from midwife to physician care, however, from my personal communication with a midwife, we estimate that approximately 10% of women have a pre-existing condition that make them unsuitable candidates for midwife care, and 5% of pregnancies are transferred from midwife to physician care during pregnancy, before labor (11). An additional 15% of births are transferred from midwife to physician care during labor, most often due to the need for a C-section or a vacuum delivery (11).

When we take into account all of the possible reasons that would preclude women from being treated by midwives, we are still left with at least 60% of women who have low-risk pregnancies whose births could have been attended by midwives. Despite this fact, midwives attend just 7.9% of all births, and 11.9% of all vaginal births in the US (12).

2.4 Birth outcomes in the US: C-section rates

The norm in the United States is for physicians to attend birth. Births are treated as a medical event, which needs to be “treated.” As a result, births turn into highly medicalized events. The US C-section rate of 32.7% is more than double the rate recommended by the WHO(13,14). At the population level, the WHO’s systematic
review found that C-section rates higher than 10-15% are not associated with reductions in maternal and neonatal morbidity rates. One of the factors that contribute to the US’ high rate of C-sections, is what is referred to as the “cascade of interventions”, where one intervention increases the likelihood of other interventions (15). A nationally representative survey of childbearing women found that among first time mothers who were not planning to have a C-section, 47% experienced an induction. Of those having an induction, 78% had an epidural, and of those mothers who had both an attempted induction and an epidural, the unplanned C-section rate was 31%. Those who experienced either labor induction or an epidural, but not both, had C-section rates of 19% to 20%. For those first-time mothers whom neither experienced attempted induction nor epidural, the unplanned C-section rate was 5% (see figure 2.1) (15).
2.4.1 Complications of C-sections

C-sections are effective in saving maternal and infant lives, but only when they are necessary for medically indicated reasons (13). It is important to weigh the costs of C-sections along with the benefits. C-sections are a major abdominal surgery, which can cause significant complications, some of which are permanent, as well as disability or death. C-sections are associated with increased use of antibiotics postpartum, greater severe maternal morbidity and mortality, and higher fetal and neonatal morbidity. These
results remain even after adjusting for demographic characteristics, risk factors, general and pregnancy associated complications (16).

In addition to the risk associated with the initial C-section, subsequent pregnancies and repeat C-sections are associated with additional increased risks. The risks of placenta accreta, cystotomy, bowel injury, ureteral injury, and ileus, the need for postoperative ventilation, intensive care unit admission, hysterectomy, blood transfusions, and the duration of operative time and hospital stay significantly increased with increasing number of cesarean deliveries (17).

2.5 Birth outcomes in the US: Infant mortality rates

Had increased interventions in US births led to improved birth outcomes, perhaps there would be no room for concern. However, the US has relatively poor outcomes when compared to other developed countries. The US infant mortality rate in 2013 was almost 6.0 per 1,000 live births, which is well above the OECD average rate of just over 4.0 per 1,000 live births. Put into historical context, all OECD countries have achieved remarkable progress in reducing infant mortality rates from the levels of 1970, when the average was close to 30.0 deaths per 1,000 live births, to the current average of just over 4.0. By contrast, in the United States, the reduction in infant mortality has been slower than in most other OECD countries. In 1970, the US infant mortality rate was well below the OECD average but it is currently well above (18).

It is important to note that infant mortality is not homogenous across the US, and even within states there are large differences between cities. Infant mortality rates are higher in several cities in the US compared to cities in other OECD countries. For
example, Washington DC has an infant mortality rate of 7.9 per 1,000 live births. This is by far the highest infant mortality rate when compared to the infant mortality rate in the 25 capital cities of the other OECD countries (19).

The US has the highest first-day neonatal death rate in the developed world, with 3 per 1,000 live births. Annually, an estimated 11,300 newborns die on the same day they were born (20). This is 50% more than all of the other developed countries combined. The top cause for the high neonatal death rate in the US is preterm birth, which is the direct cause of 34% of all newborn deaths (21). In addition, the US has the highest adolescent birth rate of any developed country. Teenage mothers tend to receive less prenatal care, and are poorer and less educated compared to older mothers, leading to increased adverse pregnancy outcomes (22).

Still, 30.5% of all infant deaths occur in full-term infants (23). One indicator that reflects the quality of intrapartum care for fetuses and newborns delivered at facilities is the “intrapartum and very early neonatal death rate”. The rate is defined as the proportion of births weighing $\geq 2.5$ kg during a specified time period that result in an intrapartum death (fresh stillbirth) or very early neonatal death within the first 24 hours during a specified time period (24). Asphyxia is one of the major causes of intrapartum or early very neonatal death, and can result from poorly managed obstetric complications and from the absence of neonatal resuscitation. Good quality intrapartum care is crucial for both mothers and their infants, and when appropriate high quality care is provided, most maternal and neonatal deaths can be prevented (25). Therefore, this is an important indicator to measure. This is an especially important measure to assess when we are comparing the care of midwives to that of physicians, in order to ensure that a potential
decrease in C-section rates associated with midwife-care does not come with an increase in adverse outcomes such as neonatal deaths.

2.6 Birth outcomes in the US: Neonatal intensive care unit (NICU) admission rates

In addition to infant mortality, it is also important to assess infant morbidity. However, trends in neonatal morbidity are difficult to assess, since there are many different factors that can be associated with infant morbidity. NICU admission rates are often used as a proxy for infant morbidity. Although NICU admission rates are not a perfect proxy for morbidity, NICU admission data is often the most readily available measure and is therefore still one of the most common measures used to assess neonatal morbidity (26,27).

Neonatal intensive care units provide highly effective care, improving outcomes for the smallest and sickest newborns. However, the care provided in the NICU is very expensive and carries inherent risks, such as infections and increased stress to the families. NICU admission rates have been rising steadily from 2007 to 2012, from 64.0 to 77.9 per 1000 live births. In addition to the increasing rates of NICU admission, newborns admitted to NICUs are also more likely to be at term and not low birth weight. This raises the question of whether changes in NICU settings, such as de-regionalization, may have also affected the care received by larger newborns. It is possible that the development of transitional care areas within level III NICUs has led to more low- and moderate-risk newborns being admitted for short periods of observation only. Despite the fact that these infants would be exposed to fewer interventions and invasive procedures than other NICU infants, this level of care may still be unnecessary, with the potential for
negative effects. Spending unnecessary time in a NICU can contribute to increased costs, family distress, and the heightened medicalization of a generally healthy birth (28). In addition, the inherent separation of the mother and infant when an infant is hospitalized in the NICU may in itself have adverse effects on the infant (29). As such, it is still an important outcome to measure when assessing birth outcomes.

2.7 Birth outcomes in the US: Maternal mortality rates

Accompanying the concerning infant morbidity and mortality rates are increasingly high maternal mortality rates. While in 1987 7.2 women died per 100,000 births, in 2011 the rate increased to 17.8 deaths per 100,000 live births (30). This increase occurred even as maternal mortality dropped in less-developed countries around the world. The reason for this disturbing upward trend is unclear. It is possible that some of the increase seen in maternal mortality is due to the change in the ICD9 codes to ICD10, with an addition of a check box for maternal mortality on birth records, but this cannot be the only explanation. While it is unclear how much of the increase is due to reporting, these changes alone do not adequately explain the near doubling of maternal deaths. The rise in maternal mortality rates has caused sufficient alarm that the Joint Commission, an independent, not-for-profit organization, issued a Sentinel Alert on the topic (31).

2.8 Birth outcomes in the US: Maternal morbidity rates

Maternal mortality is not only devastating in itself, but it is also concerning since maternal mortality is considered to be the tip of the iceberg, which represents many more cases of near-misses which did not end in death but very well could have. For every woman who dies of pregnancy-related causes, 20 to 30 others experience acute or chronic
morbidity, often with permanent sequelae that undermine their normal functioning. These ramifications can affect women’s mental, physical, or sexual health, their cognitive ability, mobility, body image and their social and economic status (32).

2.8.1 Defining severe maternal morbidity

Maternal morbidity is defined as physical and psychological conditions that are a result from or are aggravated by pregnancy and have an adverse effect on a woman’s health. The most severe cases, which have a more significant effect on the woman's health and pose exceeding risks to her immediate and lifelong well-being, are referred to as severe maternal morbidity. Severe maternal morbidity affects more than 50,000 women in the United States annually, and the rate of severe maternal morbidity is increasing steadily (33). Most studies that assess severe maternal morbidity identify cases based on a list of ICD-9 diagnosis and procedure codes. Some of these studies also include a minimum length of stay to ensure the identification of the most severe cases of maternal morbidity (34,35).

2.9 Cost of birth in the US

Childbirth in the US is more expensive than it is in any other country in the world (36). The average price of a normal delivery in the US is $10,002, whereas the price ranges from $2,237 in Argentina to $8,307 in Switzerland. The difference is even larger in cesarean section deliveries, with an average price of $15,240 in the US compared to $2,844 (Spain) - $10,681 (Switzerland).

Between 2004 and 2010, average allowed payments for maternal care increased by 49% for vaginal childbirths and 41% for cesarean childbirths (figure 2.2). In addition,
out-of-pocket payments for women with both vaginal and cesarean births increased nearly fourfold over the six-year period (37).

In 2008, childbirth and newborn care were the most frequent reasons for hospitalization, accounting for nearly a quarter of all discharges from all US hospitals. Due to the high volume of births that occur annually, the facility charges for these hospital stays total $111 billion for “mother’s pregnancy and delivery” and “newborn infants” in 2010 (35).

Figure 2.2 Average total maternal health care payments by payment source and delivery type, 2004-2010

Figure originally published in http://transform.childbirthconnection.org/wp-content/uploads/2013/01/Cost-of-Having-a-Baby1.pdf

2.10 Potential solution - increased midwife care?

The increasing maternal morbidity and mortality rates in the US, combined with the high rates of infant mortality and morbidity, at a time when the costs of delivery care
are skyrocketing, are all indicative of a failing system. It seems as though something is
not working as well as it should. I suggest that we should look at other models of care
from countries around the world, which seem to have equal or better birth outcomes than
we do in the US, at lower costs. Midwife care is common in the UK, Australia and other
European countries. Could midwife-care become more common in the US, and if so,
what would the implications be?

2.11 Midwife-led care birth outcomes (Outside the US)

In countries where midwife care is more common, there have been numerous
studies comparing birth outcomes among women who use midwives to women who use
physicians for prenatal care and delivery. A recent Cochrane review compared the
outcomes of midwife-led care models (care led by a midwife) to physician-led models of
care as well as shared-care (care led by a physician with some of the care being done by a
midwife). The review included 15 RCTs from Canada, UK, Australia and Ireland. The
review found that midwife-led care was associated with several benefits for mothers and
infants, and identified no adverse effects compared with models of physician-led care and
shared care. Specifically, the review found the following benefits for midwife-led care: a
reduction in the use of epidural analgesia, fewer episiotomies, and fewer instrumental
births. In addition, women in the midwife-led care model were more likely to deliver with
a provider whom they knew in advance, and more likely to have a spontaneous vaginal
birth. There was no significant difference in the rate of C-sections between the groups
(38).
The UK’s National Institute for Health and Care Excellence (NICE) reviewed their recommendations regarding intrapartum care in 2014, and found that for low-risk nulliparous and multiparous women, delivery in a midwifery-led unit (freestanding or alongside) had lower rates of interventions and the outcome for the baby was no different compared with an obstetric unit. As a result of their findings they advised low-risk women to choose midwife-led care instead of obstetric led care (39).

These reviews did not include any studies from the US. As there are substantial differences between the health system in the US and those in other western countries, it is important to understand the impact midwives have in US births.

2.12 Midwife-led care birth outcomes (US)

The topic of midwife births and the outcomes associated with them is not frequently studied in the US. A recent systematic review of studies that were done in the US between 1990 and 2008 found that women who used midwives had lower rates of C-sections, fewer interventions during birth, higher rates of vaginal births after C-sections (VBACs), and had equally good maternal and neonatal outcomes (40). However, it is important to note that some of the studies included in the review did not account for the fact that some women may have transferred from midwife care to the care of a physician. In addition, only five of the studies were published since 2000, of which only three were studies that used data collected in the past 20 years. The first study was an unpublished dissertation paper that compared birth outcomes for moderate-risk women. The study included women who enrolled for prenatal care with either a midwife (n=822) or physician (n=351) at 2 sites. The results of the study have not been published in a peer-
reviewed journal and attempts to receive additional information regarding the study from the authors were unsuccessful (41). An additional study by Cragin et al compared a convenience sample of women who chose midwives (n = 196) with those who chose physician care (n = 179). The study found that women in the midwife group had less use of technology and interventions with no difference in neonatal outcomes, even when preexisting risk was taken into account. (42) The main limitation of this study is that it only included a small convenience sample, which may not have very good external validity. The final study by Sze et al assessed risk factors associated with anal sphincter tear difference among midwife, private obstetrician, and resident deliveries. The study found that after adjusting for risk factors, private obstetricians and residents had a higher rate of anal sphincter tears during vaginal delivery than midwives (43). Finally, one additional study from 2013 found that women who delivered with a midwife were less likely to have a C-section, and were less likely to have a preterm birth (44). However, this study compared women who delivered with a midwife in a birth center to women who delivered with a physician in a hospital, and therefore the results do not provide a direct comparison of differences by provider type.

The above-mentioned studies do not provide us with the answers we are seeking. These studies do not provide us with definitive findings regarding how birth outcomes compare between women in the US who choose midwives compared to those who choose physicians for care. In addition, none of these studies provide the profile of women who choose the care of midwives. Based on these limitations, there is a clear need for well-designed, larger scale, current research on this topic.
2.13 Midwife-led care – which women use midwives in the US?

There is a widespread perception that women who choose midwives are more highly educated, healthy and wealthy compared to women who chose a physician. However, few studies have assessed the differences in women who choose a midwife over a physician as their primary birth attendant. One study from Northfield, Minnesota found that women who choose midwives do not differ from women who do not in terms of their education, income, experience with childbirth, age or religious affiliation, or even birth order. However, these women reported a greater feeling of knowledge about birth attendants, and reported being more in control over a variety of pregnancy decisions (45). An additional study found that women with Medicaid were actually 3.5 times more likely to use a certified nurse-midwife compared to those with private insurance (46).

2.14 Cost of care by birth attendant

The cost of care for prenatal care and delivery varies greatly based on the provider type of the birth attendant. A Cochrane review found five randomized trials that performed economic analyses comparing different birth attendant settings (38). Three of the studies were from Australia and two were from the UK. Each study used different economic evaluation methods. All five studies found a cost-saving effect in intra-partum care; however, the results regarding post-natal care were inconsistent. There does seem to be a trend towards the cost-saving effect of midwife-led care in comparison with medical-led care.
In the US, a study comparing the cost of birth for women with Medicaid in a midwife-led care at a freestanding birth center, with those who receive obstetrical care in a hospital found that birth center care was an average of $1,163 cheaper per birth (47).

2.15 Practicing at the top of one’s license

Practicing at the top of one’s license means that every worker should practice to the full extent of his or her education and training, instead of spending time doing something that could be effectively done by someone else, at a lower cost. The recent 2010 institute of medicine’s report: “future of nursing” encourages nurses, and particularly advanced practice nurses such as midwives, to practice at the “top of their license” (48). The report found that enabling nurses to practice to the full extent of their education and training could be a major step forward in meeting the challenges that come with the changing health care system in recent years. These challenges include increased patient-centered care, delivering more primary care (as opposed to specialty care), and more care in the community rather than in an acute setting.

2.15.1 Practicing at the top of one’s license: an example from abortion literature

The abortion literature provides us with a model in which physicians historically were the sole providers of care, and research has shown that mid-level providers can provide abortion care with similar outcomes to that provided by physicians, at lower costs.

Abortions used to be considered a highly complex procedure, but are currently one of the safest and most frequent clinical procedures used by women. Surgical methods of abortion are safe up to 15 weeks using aspiration techniques, as is dilation and
evacuation in the second trimester. In addition, medical abortion using a combination of the drugs mifepristone and misoprostol has changed the way abortions are performed as well as how women experience them (49). Several US studies comparing abortions performed by physicians and those performed by mid-level providers including nurse-midwives and physicians assistants, found no differences in the safety and the complication rates between the two groups (50,51). More recent studies from around the world confirm these results (52–54). Based on all of these studies, WHO’s 2012 policy guidelines for safe abortion recommend that abortion services be provided at the lowest appropriate level of the health-care system, since it is safe and beneficial for suitably trained mid-level health-care providers to provide first-trimester vacuum aspiration and medical abortions and to treat incomplete abortions (55). Yet, in most countries the only health care providers who are permitted to perform abortions are physicians. This makes it more difficult to provide highly accessible, quality abortion services at a low cost (49).

My study is an attempt to assess whether, similarly to what has been shown in the abortion literature, midwives can provide care that is similar in quality to that of physicians, thereby reducing costs and increasing access to high quality care, without compromising the health of women and their infants.

2.16 Ideal setting for birth attendant comparison

In order to assess the effect of birth attendant type on outcomes such as C-sections, infant deaths, and severe maternal morbidity, we need to compare the outcomes of women who deliver with a midwife to those who deliver with a physician. In an ideal setting, we would randomize women to the care of a physician or a midwife, and follow
them throughout their pregnancy and delivery, in order to compare the outcomes in the two groups. This would give us the ideal comparison group, since it would eliminate the confounding that occurs when we use observational data, in which women self-select themselves into the care of a physician or a midwife. The next best option would be to prospectively follow a very large group of women, some of whom use a midwife and some who use a physician, and follow them during their pregnancy, through the delivery and postpartum to assess the differences in care and in outcomes between these two groups of women. A crucial component that would be necessary to obtain is information regarding whether a woman intended to deliver with a midwife or with a physician. Finally, understanding if a transfer to a physician occurred, and why a transfer occurred would be very beneficial in understanding the labor and delivery process and the effect of having a midwife-attended birth.

2.17 Study using medical records

I used medical records and existing secondary data in order to answer the questions of which women use midwives for prenatal care, which women remain in midwife care through pregnancy and delivery, and how birth outcomes compare between women who use midwives and women who use physicians for care, while taking into account the limitations of using this data. Using medical records of women who attended prenatal care visits at a physician and/or midwife associated with The Ohio State University Medical Center, I will create a retrospective cohort of women and follow them from their initial prenatal care visit, through the delivery. The findings of this study will demonstrate if additional studies, particularly randomized controlled trials, are warranted.
2.18 Public health significance

As I have shown, the current state of US births is not optimal. There is room for improvement in terms of lowering the number of interventions that occur during labor, lowering the number of C-sections that take place, improving infant and maternal outcomes, and lowering costs. As midwives have been shown to provide comparable care at a lower cost to that of physicians in other countries, we need to assess how midwives impact birth outcomes in the US, in order to understand whether midwife care should be further integrated into the US system.
Chapter 3: Who uses a midwife for prenatal care and for birth in the US?

3.1 Abstract

Background: While midwife care is slowly but consistently increasing in the US, not much is known regarding women who choose to use a midwife. Our objectives were to compare the socio-demographic and health history characteristics, and the quality of interpersonal aspects of care, between women who used a midwife and those who used a physician for prenatal care and/or birth.

Methods: We performed a cross-sectional analysis of the Listening to Mothers III survey. We report descriptive findings using weighted proportions and means with standard deviations. We used the two one-sided tests (TOST) procedure to assess the equivalence of women who used midwives and those who used physicians.

Results: Nearly 13% of women used a midwife for prenatal care or as a birth attendant. Women who used a midwife for prenatal care were similar to women who used a physician in most socio-demographic and health history characteristics, as well as their interpersonal care scores, with the exception of the percentage of White [61.7±5.0 (midwives), 54.3±1.5 (physicians)] and married women [68.7±4.9 (midwives), 60.6±1.5 (physicians)]. Women who used a midwife as a birth attendant were similar to women who used a physician as a
birth attendant in most characteristics, with the exception of age over 35 [7.5±1.6 (midwives), 15.7±1.1 (physicians)] and WIC support [56.8±4.9 (midwives), 50.0±1.6 (physicians)].

Conclusion: Women who use midwives are similar to those who use physicians and our findings do not confirm the common perception that midwife patients are a self-selected group of wealthier, more educated women.

3.2 Introduction

Births in the United States are far more costly than births in other high-income countries (36). A crucial difference between the US and other comparable countries is the use of midwives to provide prenatal and birth care. In the U.S. the overwhelming majority of prenatal and birth care is provided by physicians (56), while in many other high-income countries midwives provide the majority of such care, particularly for healthy women with uncomplicated pregnancies (57). Since 1975, the percentage of midwife-attended births in the US has slowly but consistently increased, from less than 1% in 1975 to almost 8% in 2013 (2,56). Midwives may be a favorable alternative to physicians; studies from outside the US have found that midwives provide comparable or better outcomes among low-risk women, at lower costs, than do physicians (39,58). As the health care system in the US differs tremendously from those in other countries, understanding more about the state of midwife care in the US is important.

Studies of midwife-attended birth outcomes in the US are scarce. A few studies have found that outcomes of midwife-attended, low-risk births are comparable or better than those of physician-attended, low-risk births (40). A common perception among the US public is that wealthy, educated women choose midwives (59). This can lead to the assumption that any
favorable outcomes among midwife births are due to a self-selection of wealthier and more educated women into midwife-care. However, no evidence supports the public perception that midwife patients are wealthier or more educated than physician patients. Several studies have found differences between women who use midwives and women who use physicians in the US in terms of patient perceptions and attitudes (45,60–62). Three studies assessed differences in socio-demographic characteristics (45,46,63), two of which found no differences (45,63), and the other found that women with Medicaid were more likely to use midwives for delivery compared to women with private insurance (46).

We do not know whether the quality of care is similar between midwives and physicians in the US. The Donabedian model, a framework for evaluating quality of health care, includes three main categories: structure of care, clinical care processes and interpersonal care processes (64). While all aspects of quality are important, interpersonal care processes emerge as being most essential to quality in regards to prenatal care because they play a role in moderating adverse outcomes, and promoting women’s involvement in their own care (65). A previous study found that women whose prenatal care was provided by a midwife reported better communication with their provider compared to those cared for by other types of providers (63). To date no studies have assessed an overall measure of interpersonal care by provider type.

The objectives of our study were to compare the socio-demographic and health history characteristics as well as the quality of interpersonal aspects of care between women who used a midwife compared to those who used a physician for prenatal care and/or as a birth attendant. We hypothesized that women who used midwives for prenatal care or birth did not differ from women who used physicians.
3.3 Materials and Methods

3.3.1 Data source

Our analysis was based on the “Listening to Mothers III” (LTM III) Survey (66), which was conducted from July 2011 to June 2012, by The Harris Interactive. The de-identified LTM III dataset is publicly available (66). LTM III is a nationally representative cross-sectional U.S. survey of 2,400 women, aimed at understanding the experiences and perspectives of childbearing women. The design of LTM III is described in detail elsewhere (15). Briefly, potential respondents were drawn from four online panels. An email with a link to the survey invited a sample of women from the various panels to participate. Women were screened for eligibility after proceeding to the survey website, and those who met the eligibility requirements were able to continue to the survey. Women were eligible to participate if: they were 18 - 45 years of age, had given birth between July 1, 2011 and June 30, 2012 in a U.S. hospital to a single baby, were able to respond to a survey in English, and that child was still living at the time the survey was conducted. Respondents could choose whether to complete the entire questionnaire in one session, which took about 30 minutes to complete, or they could choose to complete the survey in multiple sessions. The data were weighted by key demographic variables, as well as by a propensity score, intended to reflect a respondent’s propensity to be online. The survey was designed to be representative of the national population of women giving birth in 2011 to 2012, with the following exclusions: teens younger than 18 and mothers older than 45, mothers who had given birth outside of a hospital, women with multiple births and with babies who had died, and women who do not
speak English as a primary or secondary language. The LTM III population was found to be comparable to the national population of mothers with singleton hospital births in terms of race/ethnicity, mother’s age, parity, education, and mode of birth. This secondary analysis of LTM III data was reviewed and found to be exempt by The Ohio State University institutional review board.

3.3.2 Variables of interest

We used a cross-sectional analysis of the survey data to compare characteristics of women who used midwives for 1) prenatal care or 2) as a birth attendant with those who used a physician for these types of care, respectively. We classified women as using a midwife for prenatal care based on their response to the following question: “Once you became pregnant, which type of caregiver was most directly involved with providing your prenatal care?” We excluded women who reported that they used a professional other than a physician or midwife, such as nurse who is not a midwife or a physician assistant, for prenatal care (n=63). We classified women as using a midwife as a birth attendant based on their response to the following question: “Which type of caregiver was the person who primarily attended the birth of your baby?” We excluded women who were missing a response to this question (n=47) as well as women who reported that they used a professional other than a physician or midwife (n=147).

Additional variables of interest included socio-demographic characteristics, health history characteristics, and score for interpersonal quality of care. Socio-demographic characteristics included age over 35 years (yes vs. no), race ethnicity (non-Hispanic white vs. other), relationship status (married vs. not married), highest educational level attained (college
graduate or higher vs. less than college), poverty level (above 200% federal poverty level vs. 200% poverty level or less), Medicaid coverage (yes vs. no), and receiving WIC (The Special Supplemental Nutrition Program for Women, Infants, and Children) support (yes vs. no). Health history variables included whether this was the woman’s first birth (yes vs. no), whether the woman had pre-pregnancy hypertension, based on her report of having used drugs for high blood pressure during the month before conception (yes vs. no), whether the woman had pre-pregnancy depression, based on her report of having used drugs for depression during the month before conception (yes vs. no), whether the woman had pre-pregnancy diabetes, based on her report of having ever been told prior to her pregnancy that she had type 1 or type 2 diabetes (yes vs. no), and whether the woman reported being told she had gestational diabetes (yes vs. no).

We created a composite measure to assess interpersonal care processes, based on three evaluative questions regarding aspects of care (how often did you experience...?), with answers ranging from 1 = never to 4 = always. The evaluative questions provided information regarding women’s perception of the quality of interpersonal aspects of care they received (provider spent enough time with you, provider answered all of your questions to your satisfaction, and provider encouraged you to talk about your health questions or concerns). We created one composite measure using the 3 items (Cronbach's alpha=0.85).

3.3.3 Data Analysis

We report descriptive findings using weighted proportions and means with standard deviations. To test our hypothesis that women who used midwives for prenatal care and as a birth attendant did not differ from women who used a physician, we used equivalence testing.
to compare the two groups, using the two one-sided test (TOST) procedure (67). To test for equivalence, we constructed \((1 - 2\alpha)\) 100 percent confidence intervals (CIs) for the difference between the two groups and \(\alpha = 0.05\) to test for statistical significance for all analyses. A detailed rationale for the choice of \((1 - 2\alpha)\) 100\% CI, instead of \((1 - \alpha)\) 100\% CI, appears elsewhere (67–69). Briefly, using a \((1 - \alpha)\) 100\% CI, with \(\alpha = 0.05\), would be excessively conservative given that the probability that the interval falls within the \(\pm \Delta\) limits when the difference in means is \(\Delta\), can be shown to be \(< \frac{1}{2} \alpha\), or .025. If we use this small \(\alpha\) to construct our CI, we would increase our \(\beta\), thereby increasing the likelihood of accepting our null hypothesis when the null hypothesis is false. In other words, we would increase our chances of declaring characteristics that are actually equivalent as being in-equivalent. If instead we use a \((1 - 2\alpha)\) 100\% confidence interval (in our case, 90\% confidence interval), then the probability of accepting the borderline case is \(< 0.05\) (70).

We used an interval of 10\% to compare the proportions of each characteristic between women who used a midwife and those who used a physician, as a difference of this magnitude would be substantial enough to have clinical relevance. The groups were considered equivalent if the constructed 90\% interval around the point estimate of the proportion is contained within the range of -10\% to +10\%.

The interval used for comparing the interpersonal care score for the two groups was \((-0.3, 0.3)\). This composite measure was created using 3 distinct questions, with 4 possible values for each. Therefore, a difference of 0.3 would indicate a mean difference of at least one point in at least one factor of the composite measure.
Analyses were performed using STATA software (release 12; Stata, StataCorp, College Station, TX, USA). Sample weights were used in all analyses and STATA survey commands were used to account for the complex survey sample design.

3.4 Results

After applying the survey weights, almost 13% of women in the population used a midwife either for prenatal care or as a birth attendant. A total of 10.7% of women reported using a midwife as their primary birth attendant, and 8.4% of women reported using a midwife as their prenatal care provider only. A smaller fraction, 6.4%, reported using a midwife as both a prenatal care provider and a birth attendant (Table 3.1).

3.4.1 Prenatal care provider

Women who used a midwife for prenatal care and women who used a physician for prenatal care were similar in most of the socio-demographic characteristics assessed (Table 3.2). Specifically, there was equivalence between the two groups in the proportion of women aged 35 years and over, who had graduated from college, who were at 200% or below the poverty level, who had Medicaid coverage and who received WIC support. However, women who used a midwife for prenatal care were more likely to be non-Hispanic white and married compared to women who used a physician for prenatal care (Figure 3.1 A).

All of the health history characteristics assessed (proportions experiencing their first birth, who had pre-pregnancy diabetes, pre-pregnancy hypertension, pre-pregnancy
depression, and those who had been diagnosed with gestational diabetes) were equivalent between the two groups (Table 3.2 and Figure 3.1 B).

The interpersonal care score among women who used a midwife for prenatal care was 3.33 ± 0.10, whereas among women who used a physician for prenatal care the score was 3.28 ± 0.02. These findings provide evidence for equivalence within our a-priori chosen definition of no difference (Table 3.2).

3.4.2 Birth attendant

Few differences in socio-demographic characteristics by type of birth attendant emerged (Table 3.3). Women who used a midwife as a birth attendant were less likely to be aged 35 years and over, and more likely to receive WIC support than were women used a physician as a birth attendant. All of the health history characteristics that we assessed were equivalent between those who used a midwife as a birth attendant and those who used a physician (Figures 3.2 A and B).

3.5 Discussion

Nearly 13% of women in our study had used a midwife as either their main prenatal care provider or as their birth attendant. As we hypothesized, women who used a midwife and women who used a physician for prenatal care were similar in their interpersonal care scores as well as in most socio-demographic and health history characteristics, with the exception of race-ethnicity and marital status. Likewise, women who used a midwife as a birth attendant were similar to women who used a physician as a birth attendant in most of the characteristics
we assessed, with the exception of a smaller proportion of women over age 35, and a larger proportion of women receiving WIC support among midwife patients.

Most of the data available regarding the prevalence of midwife care in the US come from vital statistics, which indicate that midwives attend 7.8% of all hospital births (56). We found that midwives attended 10.7% of births. This discrepancy most likely stems from the differences in the way birth attendant was classified in our study compared to vital statistics studies, which are based on birth certificate information. In birth certificates, the only available provider information is that of the final birth attendant. If a birth began with a midwife and was transferred to the care of a physician, the birth certificate will indicate a physician-attended birth. Our study allowed women to report who their main birth attendant was, thereby allowing women to identify a midwife, even in the case where the baby was ultimately delivered by a physician. This provides a different insight, which has not been available in prior studies, regarding the care provided throughout labor, rather than information about the type of provider who delivered the baby. It is also possible that this discrepancy stems in part due to the fact that the survey excluded non-English speakers, as well as women without Internet access.

Women who used a midwife for both prenatal care and as a birth attendant received care consistent with the midwife-led continuity of care model, which describes receiving care from a known midwife during pregnancy, birth and postpartum (71). This model of care has been found to lead to fewer interventions with comparable adverse outcomes (or better outcomes) for women and their infants compared to those of women who received other models of care (58,72). We found that women in the US, who used a midwife at some point during their pregnancy, did not necessarily use midwives for both prenatal care and as a birth
attendant. While 6.4% of women used a midwife for both prenatal care and as a birth attendant, 2.0% of women used a midwife for the former and then a physician for the latter. These women may have transferred from the care of a midwife to that of a physician before or during delivery due to complications or due to the woman’s choice. Interestingly, 4.3% of women used a physician for prenatal care and a midwife as a birth attendant. It is unclear whether these women intended to deliver with a midwife, whether they delivered with a midwife who happened to be on call, or whether the physician and midwife worked together within one clinic. These findings highlight the need for distinct assessments of women who use a midwife for prenatal care and women who use a midwife as a birth attendant, as these are not all one group of women. To date, many studies have focused on birth attendant provider type when comparing birth outcomes of “midwife births” (12,43,73), and our study highlights the importance of understanding the detailed nuances of each group of women, with their unique progression of care.

There are two common opposing public perceptions regarding women who choose midwives as birth attendants. One perception is that women who are wealthy and highly-educated choose to use a midwife more often than lower-income, less educated women (59). The opposite perception is that as midwives provide less costly care, it must be lower quality care, and therefore midwife care is an option which is used mainly for women who cannot afford the care of an expert (74). However, few studies have assessed whether women who use midwives differ from those who use physicians. One small study of 88 women found that women who choose midwives do not differ from women who use other care providers in terms of their education, income, experience with childbirth, age or religious affiliation, or birth order (45). In contrast, a larger study using birth certificate data found that women with
Medicaid were 3.5 times more likely to use a certified nurse-midwife compared to those with private insurance (46). This study has limitations: first, the data comes from a single state and may not reflect national trends, and second, the data are from 1990, and may not reflect the current state of midwife care. A previous analysis of the LTM III survey data assessed differences in several socio-demographic characteristics between women who used a midwife for prenatal care and those who used other providers and did not find differences in the variables that they assessed (63). However, this analysis did not assess differences in health history characteristics and did not compare characteristics by birth attendant type. In addition, our study was the first to assess multiple socio-economic variables, including education level, poverty level, Medicaid coverage and WIC support. Our finding that women who used a midwife for prenatal care did not differ in any of the measures of socio-economic status from those who used a physician for prenatal care suggest that women who use midwives for prenatal care are not wealthier or more highly educated. However, when we assessed differences in socio-economic factors between women who used a midwife as a birth attendant and those who used a physician, we found that although there were no differences in poverty or education level, or in Medicaid coverage, women who used a midwife as a birth attendant were more likely to report receiving WIC support. As this difference is found only for WIC and not the other indicators of socio-economic status that we assessed, this may stem from a difference in the care that women receive while on WIC rather than a difference in SES specifically.

Finally, we assessed a measure of interpersonal aspects of prenatal care, which indicated how well providers communicated with their patients. The prior analysis of the LTM III survey data assessed aspects of the interpersonal quality of care individually and
found that women who used a midwife for prenatal care had lower odds of reporting not feeling encouraged to discuss their concerns (63). Our study builds on the previous work as our analysis combines multiple factors of interpersonal care into one composite measure, using a continuous score for each component included, to provide an overall quality of care score. We found no differences between women who used midwives and those who used physicians for prenatal care, indicating that the perceived interpersonal quality of care was similar with midwives and physicians. A study conducted in Canada found that women with low-risk pregnancies in the care of midwives had higher satisfaction scores compared to those in the care of physicians (75). However, in that study, women who requested midwife care were recruited to the study, and assigned to either physician or midwife care. Thus, the lower satisfaction scores could have resulted from women’s disappointment with being assigned to the physician group rather than the quality of the care received.

Our study strengths include the use of a nationally representative survey of postpartum women, and the availability of provider type classifications for prenatal care and the main birth attendant. Study limitations relate mainly to the use of secondary data, which limited the variables available. In addition, the use of a cross-sectional survey, administered at one time point after delivery could lead to recall bias. For most of the variables assessed, such as age, college education, and birth order, the likelihood of having recall bias are slight. A series of validation studies examined the accuracy of women’s recall and reporting about pregnancy and childbirth for the survey, and they support the validity of data reported by mothers (15). Despite this validation, the variable that was most at risk of having recall bias was the interpersonal quality of care score. It is possible that women who experienced complications during their pregnancy may have remembered their prenatal care less favorably than women
who had no complications during pregnancy. However, if recall bias did occur, we would expect it to be non-differential as to provider type, as the biased reports would stem from all women who experienced complications during pregnancy, regardless of the type of provider they used. We do not have information regarding why 2.0% of women transferred from using a midwife during prenatal care to using a physician as a birth attendant, and whether the transfer was due to medical complications or to women’s choice. Finally, the wording of the questions does not allow us to identify women whose care was transferred from a midwife to a physician (or vice versa) during the prenatal or the perinatal period. This information would be beneficial in helping us understand the process of care for women who use midwives for prenatal care.

3.5.1 Implications for practice and/or policy

Our findings provide the first step in attempting to assess whether midwife care should be incorporated more routinely in the US maternity health care system. Our study indicates that differences in birth outcomes that may be found in future studies comparing women who used midwives for prenatal care and those who used physicians cannot be attributed to differences in socio-demographic characteristics between the two populations. If these studies find positive outcomes associated with midwife care in the US, as has been shown elsewhere, midwifery care should be integrated into the US maternity health care delivery system more frequently.
Table 3.1: Type of main prenatal care provider by type of main birth attendant

<table>
<thead>
<tr>
<th>Main prenatal care provider</th>
<th>Main birth attendant (unweighted n=2,162)</th>
<th>(%)</th>
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<td>Midwife</td>
<td>(6.4)</td>
<td></td>
<td></td>
<td>(8.4)</td>
</tr>
<tr>
<td>Physician</td>
<td>(4.3)</td>
<td>(87.3)</td>
<td></td>
<td>(91.6)</td>
</tr>
<tr>
<td>Total</td>
<td>(10.7)</td>
<td>(89.3)</td>
<td></td>
<td>(100.0)</td>
</tr>
</tbody>
</table>
### Table 3.2: Assessing equivalences in socio-demographic and health history characteristics, by main prenatal care provider

<table>
<thead>
<tr>
<th>Prenatal Care Provider</th>
<th>90% Confidence interval from equivalence testing ( \Delta=10% )‡</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Midwife</strong> (unweighted ( n=193 ))</td>
<td><strong>Physician</strong> (unweighted ( n=2,144 ))</td>
</tr>
<tr>
<td><strong>Proportion (s.e)§</strong></td>
<td><strong>Proportion (s.e)§</strong></td>
</tr>
<tr>
<td><strong>Socio-demographic characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Age 35 years and greater</td>
<td>10.3 (2.2)</td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>61.7 (5.0)</td>
</tr>
<tr>
<td>Married</td>
<td>68.7 (4.9)</td>
</tr>
<tr>
<td>College graduate or higher</td>
<td>31.2 (4.1)</td>
</tr>
<tr>
<td>200% federal poverty level or less</td>
<td>40.3 (5.3)</td>
</tr>
<tr>
<td>Medicaid coverage</td>
<td>33.9 (5.0)</td>
</tr>
<tr>
<td>WIC support¥</td>
<td>49.4 (5.2)</td>
</tr>
<tr>
<td><strong>Health history characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>First birth</td>
<td>29.6 (4.4)</td>
</tr>
<tr>
<td>Pre-pregnancy diabetes</td>
<td>9.4 (4.1)</td>
</tr>
<tr>
<td>Pre-pregnancy hypertension</td>
<td>5.4 (3.0)</td>
</tr>
<tr>
<td>Pre-pregnancy depression</td>
<td>10.4 (3.8)</td>
</tr>
<tr>
<td>Gestational diabetes</td>
<td>8.5 (3.4)</td>
</tr>
<tr>
<td><strong>Interpersonal Care Score</strong> * (Mean ± S.D)</td>
<td>3.33 ± 0.10</td>
</tr>
</tbody>
</table>

§Standard error ‡ 90% confidence interval for the difference in proportions between women who use midwives for prenatal care and women who do not use midwives for prenatal care. Equivalent characteristics are indicated in bold. Groups are equivalent for a given characteristic if (point estimate of proportion midwife PNC − point estimate of proportion physician PNC) ± 1.645(standard deviation midwife PNC \( 2 \) + standard deviation physician PNC \( 2 \))\(^{0.5}\) is contained within the range of −10% and +10%.

¥The Special Supplemental Nutrition Program for Women, Infants, and Children

* A composite measure to assess interpersonal care processes, based on three questions regarding aspects of care; The interval used for comparing the interpersonal care score, was (−0.30, 0.30)
Table 3.3: Assessing equivalences in socio-demographic and health history characteristics, by main prenatal care provider

| Socio-demographic characteristics                  | Main Birth Attendant (n=221) | Physician (n=1,985) | 90% Confidence interval from equivalence testing $\Delta=10\%$
|--------------------------------------------------|------------------------------|---------------------|-----------------------------------------------------------
| Age 35 years and greater                         | 7.5 (1.6)                    | 15.7 (1.1)          | [-11.4, -5.0]                                              |
| Non-Hispanic white                               | 55.8 (5.1)                   | 55.0 (1.6)          | [-5.0, 6.6]                                               |
| Married                                          | 58.4 (5.0)                   | 61.7 (1.6)          | [-9.0, 2.4]                                               |
| College graduate or higher                       | 26.8 (3.5)                   | 30.0 (1.2)          | [-7.9, 2.4]                                               |
| 200% federal poverty level or less               | 34.7 (4.8)                   | 37.5 (1.6)          | [-8.4, 2.7]                                               |
| Medicaid coverage                                | 34.8 (5.1)                   | 36.3 (1.6)          | [-7.0, 4.1]                                               |
| WIC support                                      | 56.8 (4.9)                   | 50.0 (1.6)          | [1.0, 12.6]                                               |
| **Health history characteristics**               |                              |                     |                                                           |
| First Birth                                      | 32.2 (4.5)                   | 32.5 (1.4)          | [-5.8, 5.1]                                               |
| Pre-pregnancy diabetes                           | 12.6 (4.0)                   | 8.1 (0.9)           | [0.7, 8.3]                                               |
| Pre-pregnancy hypertension                       | 7.5 (3.2)                    | 7.4 (0.8)           | [-3.0, 3.2]                                               |
| Pre-pregnancy depression                         | 16.5 (4.3)                   | 12.1 (1.1)          | [0.1, 8.7]                                               |
| Gestational diabetes                             | 6.5 (2.6)                    | 12.0 (1.0)          | [-8.6, -2.6]                                              |

$\S$Standard error ‡ 90% confidence interval for the difference in proportions between women who use midwives as birth attendants and women who use physicians as birth attendants. Characteristics that are equivalent are marked in bold. The groups are equivalent if $(\text{point estimate of proportion midwife birth} - \text{point estimate of proportion physician birth}) \pm 1.645(\text{standard deviation midwife birth}^2 + \text{standard deviation physician birth}^2)^{0.5}$ is contained within the range of $-10\%$ and $+10\%$. ¥The Special Supplemental Nutrition Program for Women, Infants, and Children
Figure 3.1 Equivalence test of socio-demographic (A) and health history (B) characteristics in women who used a midwife and women who used a physician for prenatal care

*Zero indicates no difference between midwife and physician patients, less than 0 indicates lower proportions among midwife group, greater than 0 indicates higher proportions among midwife group. Variables that range within [-10, 10] are considered to be equivalent, variables that cross 10 or (-10) are considered not to be equivalent.
Figure 3.2 Equivalence test of socio-demographic (A) and health history (B) characteristics, in women who used a midwife and women who used a physician as a birth attendant.

*Zero indicates no difference between midwife and physician patients, less than 0 indicates lower proportions among midwife group, greater than 0 indicates higher proportions among midwife group. Variables that range within [-10, 10] are considered to be equivalent, variables that cross 10 or (-10) are considered not to be equivalent.
Chapter 4: The progression of care among women who use a midwife for prenatal care: who remains in midwife care?

4.1 Abstract

Background: Prenatal care provided by midwives may provide a safe and cost-effective alternative to care provided by physicians. However, no studies have evaluated the proportion of women who initiate prenatal care with a midwife and remain in midwife care through delivery. Our study objectives were to assess proportions and describe the socio-demographic and pregnancy-related characteristics of women who transferred to the care of a physician during prenatal care and at delivery, and to assess correlates of these transfers.

Methods: We performed a retrospective cohort study of women who delivered at The Ohio State University Wexner Medical Center (OSUWMC) and had at least one prenatal care visit within OSUWMC’s network, using electronic medical records. We report descriptive findings using proportions and means with standard deviations. We used logistic regression, with Firth’s bias correction as necessary, to assess correlates of transferring to a physician during prenatal care and delivery.
Results: A majority of women who initiated prenatal care with a midwife remained in midwife care throughout delivery, with 4.7% transferring to a physician during prenatal care, and an additional 21.4% transferring to a physician during delivery. Black race was the only non pregnancy-related factor that was significantly associated with leaving midwife care during prenatal care (AOR 3.0; 95% CI: 1.4, 6.5) and delivery (AOR 2.4; 95% CI: 1.4, 4.1).

Discussion: Our findings indicate that prenatal care with a midwife is a viable option for women with low-risk pregnancies, but raise important questions regarding the possible role that race has in pregnancy care.

4.2 Introduction

Births in the US are costly (36) and highly medicalized, with over a third of women with vaginal births reporting that they had experienced labor induction, received intravenous fluids, been given oxytocin to speed up labor, or had a bladder catheter during their previous birth (15). Births attended by certified nurse midwives are associated with fewer interventions and equal or better maternal and neonatal outcomes compared to births attended by physicians, and have the potential to improve women’s birth experiences (40). However, midwives are infrequently used in the US; 8% of women used a midwife as a main prenatal care provider, and between 8-10% of births are attended by midwives (1,15). Integrating midwife care more routinely into the US health care system may reduce costs without jeopardizing quality.
Midwife care in the US is not often studied, and most of the few studies have focused on outcomes of midwife-attended births (40,43). No studies have evaluated the proportion of women who initiate care with a midwife, and how their care progresses throughout pregnancy and delivery. Before we can suggest increasing the use of midwives, we need to know if such a recommendation is viable. Therefore, it is important to understand how often women who begin their prenatal care with a midwife transfer to the care of a physician, and when those transfers are most likely to occur. Studies from England and Ireland found that 45% of women transferred to a physician during prenatal care, and 13-21% transferred during delivery (72,76). In addition to understanding how care progresses throughout pregnancy, assessing factors associated with transfers during delivery will provide us with insight into why women transfer, and whether transfers are due to medical reasons or other factors.

The objectives of our study were to assess the proportion of women who initiate midwife care and the proportion which, after initiating midwife care, transfer to the care of a physician during pregnancy. In addition, we aimed to describe the socio-demographic and pregnancy-related characteristics of women who leave midwife care during pregnancy, and to assess the correlates of transferring to the care of a physician during prenatal care or at delivery.
4.3 Materials and Methods

4.3.1 Data source

In our retrospective cohort study, we included women who did not have pre-existing medical conditions that would have precluded midwife care during prenatal care or at delivery, who had at least one prenatal care visit within the Ohio State University network, and delivered a singleton infant between January 2012 and December 2015 at The Ohio State University Wexner Medical Center (OSUWMC). We assembled the cohort using data retrieved from OSUWMC’s electronic medical records (EMRs) from all prenatal care visits and the delivery. For women who delivered more than once within the study period, we included only the first birth and the associated prenatal visits.

We excluded women from the cohort if they had any of the following pre-existing conditions, using ICD-9 codes: HIV infection, status asthmaticus, indication of cocaine or unprescribed opiates and benzodiazepines use, treatment with methadone or suboxone, pre-existing diabetes, lupus, sickle-cell disease, cardiac disease, renal disease, acute hepatitis, advanced syphilis, active tuberculosis, active seizure disorder, hydatidiform mole, and previous vertical uterine incision. These exclusion criteria were based on the OSUWMC midwives’ clinical guidelines on indications for required transfers of care (11) (see appendix A). Finally, we excluded from our analysis women who were due to deliver after December 15, 2015 (n=32). We excluded these women in order to prevent fixed cohort bias, in which births at the beginning of the interval were more likely to be term and post term, while those at the end of the interval were more likely to be preterm, and as a result need to transfer to the care of a physician. From this cohort, we evaluated
the subgroup of women who initiated prenatal care with a midwife affiliated with OSUWMC.

A total of 17,804 women delivered at OSUWMC in our study period, of whom 11,804 met our inclusion criteria. Of these women, a total of 1,253 women (10.6%) initiated prenatal care with a midwife.

4.3.2 Variables of interest

**Pregnancy Care Connection (PCC)**

Women could have initiated prenatal care with a midwife through the OSUWMC system in one of two ways: electing to attend OSUWMC’s midwife clinic (n=993) or being assigned through Franklin County’s Pregnancy Care Connection (PCC) program (n=260). PCC is a hotline that allows pregnant women living in Ohio’s Franklin County to schedule their initial pregnancy visit. The hotline serves women who are uninsured, have Medicaid or are insured but have limited resources. Calling the PCC hotline enables pregnant women to see a provider sooner than they would have access to on their own. In contrast to women who choose to use a midwife, women who attend their first prenatal care appointment through the PCC do not choose their provider, but rather are assigned to whichever provider is able to see them soonest.

**Transfer from midwife to physician**

We determined the provider type (midwife or physician) at each prenatal visit, as well as at the time of the delivery. Women were considered to have transferred to the care of a physician if they had a prenatal care visit with a physician, and did not return to a
midwife for any subsequent prenatal visits or for delivery. The time of the transfer was defined as the gestational age at the first prenatal visit at which a woman transferred to the care of a physician. Women could transfer to the care of a physician for various reasons, including but not limited to: pregnancy complications, breech position, and patient choice.

**Socio-demographic characteristics**

We assessed several socio-demographic characteristics including age (as a continuous variable), race (black vs. white and other), relationship status (married vs. not married), and insurance type (public vs. private insurance).

**Pregnancy characteristics**

We assessed pregnancy-related characteristics using the ICD-9 codes assigned to prenatal care visits including whether the woman smoked during her pregnancy (yes vs. no), had a mental health condition (diagnosed with depression, anxiety or bi-polar disorder vs. none of these), was obese (yes vs. no), had gestational diabetes (yes vs. no), and was categorized as having a high-risk pregnancy. Pregnancies can be defined as high-risk due to pre-existing comorbidities, such as narcotics dependence, HIV infection, and auto-immune disease, or due to conditions that are related to the pregnancy, such as advanced maternal age, gestational diabetes, and pre-eclampsia. As we excluded women with pre-existing conditions from this study, “high-risk pregnancies” in our study indicate conditions related to pregnancy.

In addition, other variables regarding the woman’s pregnancy were assessed using data from the EMR, including whether this was the woman’s first pregnancy (yes vs. no), and whether the fetus was in breech position (yes vs. no).
**Labor complications**

Women with documentation of any of the following in their EMR were defined as having labor complications: fetal intolerance, protracted first or second stage of labor, failure to progress in first stage of labor, chorioamnionitis, shoulder dystocia, or excessive bleeding.

4.3.3 Data analysis

We used descriptive statistics and contingency tables to describe the proportion of women without pre-existing conditions who used a midwife for the initial prenatal care visit and left midwife care during prenatal care or at delivery. Our initial analysis included all women who had used a midwife for their initial prenatal care visit, regardless of their PCC status. We found substantial differences between women who attended prenatal care visits at the midwife clinic and those who were assigned to a midwife through the PCC program, with nearly all of the latter women leaving midwife care by delivery. Thus, we restricted subsequent analyses to only women who saw a midwife through the midwife clinic, as they represent a group of women who chose the care of a midwife. Although we do not have information regarding women’s intention to deliver with a midwife, the women who chose the care of a midwife initially could be expected to be more likely to want to remain in midwife care throughout their pregnancy, compared to women who were assigned to midwives through the PCC program. Therefore, the women from the OSUWMC midwife clinic represent more closely the midwifery continuity of care model (77).
We used t-tests to compare continuous variables, and $\chi^2$ or Fisher’s exact test to compare categorical variables as appropriate. We used the Kaplan-Meier estimate to assess women’s “survival” within midwife care at each trimester, and through delivery. As few women left midwife care during prenatal care ($n=47$), we used bivariate logistic regression, with Firth’s bias correction to identify the variables that were correlated with leaving midwife care during prenatal care. We used bivariate logistic regression to identify the variables that were correlated with leaving midwife care during delivery. In both cases we included all variables that were significant in the univariate analysis in a multivariable logistic regression model. We regarded p-values less than 0.05 as statistically significant. All statistical analyses were performed using SAS 9.4. The study was reviewed and approved by the Ohio State University Institutional Review Board.

4.4 Results

A total of 1,253 women initiated prenatal care with a midwife. Just over one-fifth of these women were assigned their initial prenatal care visit through the Pregnancy Care Connection (PCC) program ($n=260$) (Table 4.1). Women in the PCC group were younger, and were more likely to be black, not married, and have public insurance compared to women who elected to attend OSUWMC’s midwife clinic. A higher proportion of women in the PCC group left midwife care at every stage of pregnancy. Nearly all women in the PCC group left care by delivery, with only 1.8% of women in this group remaining with a midwife throughout delivery.
In contrast to women in the PCC group, nearly all women (95.3%) who saw a midwife through the OSUWMC midwife clinic remained in midwife care throughout prenatal care (Figure 4.1). Among these women, 4.7% transferred to the care of a physician during prenatal care and 21.4% transferred to the care of a physician during delivery (Table 4.2). The proportions of women who were black, were obese, smoked during pregnancy, or had a high-risk pregnancy were larger among women who transferred to a physician at some point during prenatal care, compared to those remaining in midwife care (Tables 4.2 and 4.3).

Women who transferred to the care of a physician at delivery were statistically significantly different compared to those who did not. The proportions of women who were black, not married, or had public insurance were larger among those who transferred to the care of a physician at delivery compared to women who did not (Tables 4.4 and 4.5). In addition, a larger proportion of these women were experiencing their first birth, smoked during pregnancy, had a high-risk pregnancy, had gestational diabetes or had a fetus in breech position. Finally, women who transferred to a physician had statistically significantly higher frequency of experiencing complications during labor.

Several pregnancy-related factors were statistically significantly associated in the bivariate analysis with increased odds of transferring to the care of a physician during prenatal care, including smoking during pregnancy, obesity, having gestational diabetes, and having a pregnancy that was defined as high-risk. Black race was the only socio-demographic factor that increased the odds of transfer during prenatal care (Table 4.6). In the multivariable analysis, four factors remained statistically significantly associated with transferring to the care of a physician during prenatal care: black race (AOR 3.0;
95% CI: 1.4, 6.5), smoking during pregnancy (AOR 4.6; 95% CI: 1.4, 14.8), having a high-risk pregnancy (AOR 2.7; 95% CI: 1.2, 5.9), and having gestational diabetes (AOR 13.6; 95% CI: 5.8, 31.8).

We also found several statistically significant factors associated in the bivariate analysis with higher odds of transferring to the care of a physician at delivery. Black women had significantly higher odds of transferring to the care of a physician at delivery, as did those with public insurance, having their first birth, smoking during pregnancy, having a high-risk pregnancy, having a fetus in breech position, and experiencing any labor complication. In contrast, being married significantly reduced the odds of transferring to the care of a physician during delivery (OR 0.6; 95% CI: 0.4, 0.9) (Table 4.7). In the multivariable analysis, black race was the only non-pregnancy related variable that remained significantly associated with the transfer to the care of a physician (AOR 2.4; 95% CI: 1.4, 4.1). Several pregnancy related variables also remained significantly associated with transferring to the care of a physician including first birth (AOR 1.5; 95% CI: 1.1, 2.1), smoking during pregnancy (AOR 2.7; 95% CI: 1.0, 7.4), high-risk pregnancy (AOR 2.7; 95% CI: 1.5, 4.7), breech presentation (AOR 46.2; 95% CI: 10.3, 206.9), and any labor complications (AOR 4.4; 95% CI: 2.8, 6.7).

4.5 Discussion

Nearly all women who chose to initiate prenatal care with a midwife remained in midwife care throughout their pregnancy. One-fifth of women who remained with a midwife throughout prenatal care transferred to the care of a physician at delivery. As
expected, transfers to physicians during both prenatal care and delivery were correlated with a number of medical factors, and these were associated with several socio-demographic factors as well. Surprisingly, even after adjusting for all of the potential medical reasons for transfers, black race remained significantly associated with transferring to the care of a physician in both models.

No previous studies were available regarding the proportion of transfers out of midwifery care in the US, among women who intended to deliver with a midwife in a hospital. However, several European studies have assessed the rate of transfer out of midwife care. A prospective cohort study in England assessed the transfer rate among women who intended to deliver in a midwife-led unit in a hospital (6). About 21% of women transferred to an obstetric unit during labor, which was similar to the transfer rate in our study. In contrast, a randomized trial in Ireland found that 45% of women transferred out of midwife-led care during pregnancy, and 13% of women transferred during labor (72). The transfer rate during prenatal care was significantly lower in our study, and the transfer rate during labor was higher. The most common reasons for transfer prior to labor in the Irish study were for induction of labor and for fetal assessment. The scope of practice for midwives in Ireland may require transfers that are not required in the US, as midwives in our US study are able to perform inductions and fetal assessment, and therefore these would not be indications for transfer in our study. The substantial proportion of women who transferred out of care prior to labor in Ireland likely reduced the number of transfers during labor.

The most relevant US data comes from a study that assessed the care available in stand-alone midwife-led birth centers. This prospective cohort study of women who
intended to deliver in a birth center, and were eligible to do so, found that 4% of women were transferred to a hospital prior to labor, and 12% were transferred during labor after admission (78). Our results indicate a similar transfer rate prior to labor; however, the transfer rate during labor was higher in our study. This may be due to differences in eligibility criteria for midwife care in a hospital compared to that of a birth center. In the case of a complication requiring a transfer, women delivering in a birth center would need more time to transfer compared to women in a hospital. As a result, the eligibility criteria to deliver with a midwife in a stand-alone birth center are likely to be more stringent than the eligibility criteria to deliver with a midwife in a hospital. This would leave a lower-risk pool of women in the birth center group, who are less likely to transfer during labor.

Our findings suggest that black women are more likely to transfer during prenatal care as well as delivery, even after adjusting for medical indications that could explain the transfer. Although no literature explores racial disparities in care provided by midwives, there is evidence of differences in care by racial status in overall medical care, and specifically in prenatal care provided to black and white women. Examples of racial disparities include black patients being less likely to be referred for medically-indicated invasive cardiac procedures (79,80), and being less likely to be given all the information about and put on the waiting list for a renal transplant (81). Black patients also receive less treatment for post-operative, cancer-related or chronic pain (82).

In prenatal care, black women are less likely to report receiving advice from their prenatal care provider regarding smoking cessation and alcohol use (83). Black pregnant women are also less likely to get medical advice, information about health risks and
complications, and common prenatal treatments, such as medications to suppress premature labor and antenatal steroids (84). Black women also have a higher likelihood of Cesarean section, after adjusting for known risk factors (85,86). Aron and colleagues (2000) suggest that several factors may contribute to the increased risk of Cesarean sections among black women, including: provider biases that cause providers to recommend a Cesarean section sooner for black patients, poor provider-patient communication as a result of ethnic and cultural differences between providers and patients, which may lead to patients' unwillingness to undergo a recommended course of treatment, and patient mistrust of the health care system resulting from social inequities (85). The increased likelihood of Cesarean sections among black women also has been attributed to possible unidentified biological or genetic factors that increase the risk of “non-reassuring fetal testing” in some populations (86). These biological factors also may play a role in the increased transfer of care from midwives to physicians during delivery, even if these deliveries do not end in a Cesarean section. However, even if such factors existed, they are unlikely to completely explain this significant racial disparity (84).

Implicit biases may also be impacting the increased likelihood of transfer among black women. A study which included a large volunteer sample of people who took the Implicit Association Test (IAT) found that physicians had an implicit preference for whites over blacks, similar to the pattern observed for other professionals (87). A study of internal medicine and emergency medicine residents found that although physicians did not report any explicit biases for white relative to black patients, their IAT scores reflected implicit preferences favoring the former. As their scores increased, physicians were more likely to recommend treatment for white patients and less likely to
recommend treatment for black patients among those presenting with the same symptoms (88). Implicit biases also can influence access to high-quality health care, as blacks and other minorities receive fewer procedures and receive poorer-quality care compared to whites for a wide range of procedures and treatments. These differences remain after adjusting for socio-economic status, health care facility, and health insurance type (89).

In addition to implicit biases, cultural racism may contribute to the increased transfer rate among black women. Cultural racism, which plays a major role in creating negative racial stereotypes among stigmatized racial groups, is defined as a prejudice against individuals that is deeply embedded within a culture (87). These negative racial stereotypes can adversely affect the patient-provider relationship through a process called stereotype threats (87). A stereotype threat occurs when a person feels they are at risk of confirming a negative stereotype about their group (90). A patient does not need to experience any actual prejudice or bias in order for stereotype threat to manifest (91). As a result, many minority patients may feel a sense of threat even when they do not experience unfair treatment (92). In a clinical setting, stereotype threats can compromise the communication process, limit the information that patients share with their providers, and may explain why clinical interactions across racial lines are characterized by less patient involvement and shared decision-making (91). As patient-provider communication is so important during the birth process, all of these factors can lead to an increased risk of transferring to the care of a physician during delivery.

Finally, several studies of patients found that when caring for non-white patients, physicians choose a more biomedical communication pattern rather than a more patient-involved decision-making pattern (93). This too harms patient-provider communication,
which in turn can lead to poorer interpersonal quality of care. While quality of care is made up of several important aspects, interpersonal care processes are one of the most essential in providing high-quality prenatal care. Improved interpersonal care can promote women’s own involvement in their care, leading to a reduction in adverse outcomes (65).

Our study is the first to assess the progression of care among women who intend to deliver with a midwife in a US hospital setting. A key strength of the study is that because the data came from a single midwife clinic situated within an urban academic hospital with standard transfer protocols, differences found regarding women who are more likely to transfer cannot be attributed to differences in transfer protocols. On the other hand, because our findings came from a single midwife clinic and hospital, this may limit the generalizability of our results to a broader population. There are many models of providing midwifery care: as a single provider, as part of a midwife group clinic, and as part of a combined physician–midwife group. The progression of care may differ by model.

Second, using secondary data has several restrictions. Unfortunately, the EMRs do not provide reliable data for income or education, and we therefore used insurance status as a proxy for socio-economic status. In addition, we used ICD-9 codes to assess medical history characteristics and to exclude women who would be ineligible for midwife care. The use of ICD-9 codes may not be the optimal way of assessing patient’s comorbidities. The use of ICD-9 codes for research purposes has been extensively studied, and although the sensitivity of ICD-9 codes varies greatly depending on the type of disease, they are consistently found to have high specificity (94–96). We also used
ICD-9 codes to determine several health conditions including smoking during pregnancy, having a mental health condition such as bi-polar or anxiety, and having a high-risk pregnancy. Low sensitivity for these variables may have led to misclassifications of these conditions. However, ICD-9 codes for these common conditions have higher sensitivity than those of uncommon conditions (94).

Our study establishes that the majority of women who choose to initiate care with a midwife remain in the care of a midwife throughout prenatal care and delivery. These findings support the recommendation of increasing the use of midwife-led prenatal care. Having a greater proportion of midwife-led births can reduce the number of interventions that women experience during labor, and improve women’s childbirth experiences while still ensuring high-quality care.

Our findings raise important questions regarding the origins of racial disparities in the transfer of care during delivery and highlight the possible role that implicit biases hold in provider care, although we do not have data regarding the specific reasons for transfers. Providers may benefit from cross-cultural education, as this has been shown to improve communication between providers and their patients (89).

More research is necessary to investigate whether the progression of care is similar across different midwife-care settings. Our results provide initial support that increasing the proportion of women who use midwives for prenatal care will lead to an increase in midwife-attended births, paving the way to positive birth outcomes at lower costs.
Table 4.1: Socio-demographic and pregnancy characteristics, and proportions of transfers to physicians, by Pregnancy Care Connection status

<table>
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<tr>
<th></th>
<th>Prenatal care through Pregnancy Care Connection (PCC)</th>
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<tbody>
<tr>
<td></td>
<td>Yes (n=260)</td>
<td>No (n=993)</td>
<td>P-value(^1,2)</td>
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<tr>
<td>Total</td>
<td>20.8</td>
<td>79.2</td>
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<tr>
<td><strong>Socio demographic characteristics</strong></td>
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</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>26.3 ± 5.5</td>
<td>29.6 ± 4.6</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Race</td>
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<tr>
<td>White</td>
<td>29.6</td>
<td>82.2</td>
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<td>Black</td>
<td>51.5</td>
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<tr>
<td>Relationship status</td>
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<td>&lt;0.0001</td>
</tr>
<tr>
<td>Married</td>
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<td>76.9</td>
<td></td>
</tr>
<tr>
<td>Not married</td>
<td>80.0</td>
<td>23.1</td>
<td></td>
</tr>
<tr>
<td>Insurance type</td>
<td></td>
<td></td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Public insurance</td>
<td>80.4</td>
<td>27.2</td>
<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>19.6</td>
<td>72.8</td>
<td></td>
</tr>
<tr>
<td><strong>Pregnancy characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Birth</td>
<td>41.5</td>
<td>46.6</td>
<td>0.1425</td>
</tr>
<tr>
<td>Smoking during pregnancy</td>
<td>14.2</td>
<td>2.3</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mental health condition(^3)</td>
<td>8.1</td>
<td>8.7</td>
<td>0.7643</td>
</tr>
<tr>
<td>Obesity</td>
<td>15.4</td>
<td>3.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Pregnancy defined as high-risk</td>
<td>46.9</td>
<td>8.2</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Gestational diabetes</td>
<td>6.2</td>
<td>3.9</td>
<td>0.1188</td>
</tr>
<tr>
<td><strong>Transfer of care to physician</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During prenatal care - First trimester</td>
<td>1.9</td>
<td>0.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>During prenatal care - Second trimester</td>
<td>25.8</td>
<td>0.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>During prenatal care - Third trimester</td>
<td>30.8</td>
<td>3.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>During delivery</td>
<td>39.6</td>
<td>20.1</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

\(^1\)Values in bold indicate a significant difference at the 0.05 level. \(^2\)T-test for continuous variables and \(\chi^2\) for categorical variables. \(^3\)Mental health issues include: anxiety, depression, and bipolar disorder.
Table 4.2 Socio-demographic characteristics of women who initiated prenatal care with a midwife, not through Pregnancy Care Connection, at the Ohio State University, by status of transfer to physician during prenatal care.

<table>
<thead>
<tr>
<th></th>
<th>Transferred to physician during prenatal care</th>
<th></th>
<th></th>
<th>P-value$^{1,2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (n=993)</td>
<td>Yes (n=47)</td>
<td>No (n=946)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4.7</td>
<td>95.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socio demographic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>29.6 ± 4.6</td>
<td>29.4 ± 5.3</td>
<td>29.6 ± 4.6</td>
<td>0.6833</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td>0.0005</td>
</tr>
<tr>
<td>White</td>
<td>82.2</td>
<td>61.7</td>
<td>83.2</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>10.5</td>
<td>25.5</td>
<td>9.7</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>7.3</td>
<td>12.8</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Relationship status</td>
<td></td>
<td></td>
<td></td>
<td>0.2621</td>
</tr>
<tr>
<td>Married</td>
<td>76.9</td>
<td>70.2</td>
<td>77.3</td>
<td></td>
</tr>
<tr>
<td>Not married</td>
<td>23.1</td>
<td>29.8</td>
<td>22.7</td>
<td></td>
</tr>
<tr>
<td>Insurance type</td>
<td></td>
<td></td>
<td></td>
<td>0.2752</td>
</tr>
<tr>
<td>Public insurance</td>
<td>27.2</td>
<td>34.0</td>
<td>26.8</td>
<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>72.8</td>
<td>66.0</td>
<td>73.2</td>
<td></td>
</tr>
</tbody>
</table>

$^1$Values in bold are significant at the 0.05 level. $^2$T-test for continuous variables, and $\chi^2$ or exact $\chi^2$ for categorical variables as appropriate
Table 4.3 Pregnancy characteristics of women who initiated prenatal care with a midwife, not through Pregnancy Care Connection, at the Ohio State University, by status of transfer to physician during prenatal care.

<table>
<thead>
<tr>
<th>Pregnancy characteristics</th>
<th>Transferred to physician during prenatal care</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (n=993)</td>
</tr>
<tr>
<td>First Birth</td>
<td>46.6</td>
</tr>
<tr>
<td>Smoking during pregnancy</td>
<td>2.3</td>
</tr>
<tr>
<td>Mental health condition&lt;sup&gt;3&lt;/sup&gt;</td>
<td>8.7</td>
</tr>
<tr>
<td>Obesity</td>
<td>3.0</td>
</tr>
<tr>
<td>Pregnancy defined as high-risk</td>
<td>8.2</td>
</tr>
<tr>
<td>Gestational diabetes</td>
<td>3.9</td>
</tr>
<tr>
<td>Breech presentation</td>
<td>2.0</td>
</tr>
</tbody>
</table>

<sup>1</sup>Values in bold are significant at the 0.05 level.  
<sup>2</sup>χ<sup>2</sup> or exact χ<sup>2</sup> as appropriate  
<sup>3</sup>Mental health issues include: anxiety, depression, and bipolar disorder.
Table 4.4 Socio-demographic characteristics of women who initiated prenatal care with a midwife, not through Pregnancy Care Connection, at the Ohio State University, and remained in the care of a midwife throughout prenatal care, by status of transfer to physician at delivery.

<table>
<thead>
<tr>
<th>Transferred to physician at delivery</th>
<th>Yes (n=200)</th>
<th>No (n=746)</th>
<th>P-value$^{1,2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21.1</td>
<td>78.9</td>
<td></td>
</tr>
</tbody>
</table>

**Socio demographic characteristics**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>30.1 ± 4.8</td>
<td>29.5 ± 4.5</td>
<td>0.1268</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>77.0</td>
<td>84.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Black</td>
<td>18.0</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5.0</td>
<td>7.6</td>
<td></td>
</tr>
<tr>
<td>Relationship status</td>
<td></td>
<td></td>
<td>0.0057</td>
</tr>
<tr>
<td>Married</td>
<td>70.0</td>
<td>79.2</td>
<td></td>
</tr>
<tr>
<td>Not married</td>
<td>30.0</td>
<td>20.8</td>
<td></td>
</tr>
<tr>
<td>Insurance type</td>
<td></td>
<td></td>
<td>0.0169</td>
</tr>
<tr>
<td>Public insurance</td>
<td>33.5</td>
<td>25.1</td>
<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>66.5</td>
<td>74.9</td>
<td></td>
</tr>
</tbody>
</table>

$^1$Values in bold are significant at the 0.05 level. $^2$T-test for continuous variables, and $\chi^2$ or exact $\chi^2$ for categorical variables as appropriate.
Table 4.5 Pregnancy characteristics of women who initiated prenatal care with a midwife, not through Pregnancy Care Connection, at the Ohio State University, and remained in the care of a midwife throughout prenatal care, by status of transfer to physician at delivery.

<table>
<thead>
<tr>
<th>Pregnancy characteristics</th>
<th>Transferred to physician at delivery</th>
<th></th>
<th></th>
<th>P-value¹,²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (n=200)</td>
<td>No (n=746)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Birth</td>
<td>56.0</td>
<td>43.8</td>
<td></td>
<td>0.0022</td>
</tr>
<tr>
<td>Smoking during pregnancy</td>
<td>4.5</td>
<td>1.3</td>
<td></td>
<td>0.0047</td>
</tr>
<tr>
<td>Mental health issues³</td>
<td>8.5</td>
<td>8.9</td>
<td></td>
<td>0.8775</td>
</tr>
<tr>
<td>Obesity</td>
<td>4.0</td>
<td>2.1</td>
<td></td>
<td>0.1384</td>
</tr>
<tr>
<td>Pregnancy defined as high-risk</td>
<td>13.0</td>
<td>5.9</td>
<td></td>
<td>0.0007</td>
</tr>
<tr>
<td>Gestational diabetes</td>
<td>1.0</td>
<td>3.2</td>
<td></td>
<td>0.1395</td>
</tr>
<tr>
<td>Breech presentation</td>
<td>8.0</td>
<td>0.3</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Labor Complications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any labor complication⁴</td>
<td>26.5</td>
<td>8.0</td>
<td></td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

¹Values in bold are significant at the 0.05 level. ²χ² or exact χ² for categorical variables as appropriate
³Mental health issues include: anxiety, depression, and bipolar disorder.
⁴Labor complications included: fetal intolerance, protracted first or second stage of labor, failure to progress in first stage of labor, chorioamnionitis, shoulder dystocia, or excessive bleeding.
Table 4.6 Correlates of transferring to the care of a physician during prenatal care, among women who initiated prenatal care with a midwife, not through pregnancy care connection, at the Ohio State University

<table>
<thead>
<tr>
<th></th>
<th>Socio demographic characteristics</th>
<th>Univariable analysis</th>
<th>Multivariable analysis&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unadjusted OR 95% CI</td>
<td>Adjusted OR 95% CI</td>
</tr>
<tr>
<td>Age</td>
<td>0.99 (0.93, 1.05)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Black Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3.25 (1.65, 6.43)</td>
<td>3.02 (1.41, 6.47)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Relationship status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>0.68 (0.36, 1.29)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Not married</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Insurance type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public insurance</td>
<td>1.43 (0.77, 2.63)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Private insurance</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pregnancy characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Birth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.20 (0.67, 2.15)</td>
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<td>-</td>
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<tr>
<td>No</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Smoking during pregnancy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>4.92 (1.65, 14.64)</td>
<td>4.59 (1.43, 14.78)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mental health&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.81 (0.27, 2.49)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>Obesity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5.89 (2.32, 14.98)</td>
<td>1.48 (0.47, 4.68)</td>
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</tr>
<tr>
<td>No</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Pregnancy defined as high-risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3.92 (1.93, 7.96)</td>
<td>2.69 (1.22, 5.94)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Gestational diabetes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13.59 (6.45, 28.65)</td>
<td>13.61 (5.83, 31.79)</td>
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Continued
### Table 4.6 continued

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<th>Multivariable analysis&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
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<td>95% CI</td>
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<tr>
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<td>(0.69, 11.02)</td>
</tr>
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<sup>1</sup>Values in bold are significant at the 0.05 level. <sup>2</sup>All variables that were significant in the univariate analysis were included in the multivariate model. <sup>3</sup>Mental health issues include: anxiety, depression, and bipolar disorder.
Table 4.7 Correlates of transferring to the care of a physician at delivery, among women who initiated prenatal care with a midwife, not through pregnancy care connection, at the Ohio State University, and remained in the care of a midwife throughout prenatal care

<table>
<thead>
<tr>
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<th>Univariable analysis</th>
<th>Multivariable analysis¹</th>
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</thead>
<tbody>
<tr>
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<td>95% CI</td>
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<td>Socio demographic characteristics</td>
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<td></td>
</tr>
<tr>
<td>Age</td>
<td>1.03</td>
<td>(0.99, 1.06)</td>
</tr>
<tr>
<td>Black Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2.71</td>
<td>(1.72, 4.25)</td>
</tr>
<tr>
<td>No</td>
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<td>1</td>
</tr>
<tr>
<td>Relationship status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>0.61</td>
<td>(0.43, 0.87)</td>
</tr>
<tr>
<td>Not married</td>
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<td>1</td>
</tr>
<tr>
<td>Insurance type</td>
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<td></td>
</tr>
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<td>Public insurance</td>
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<td>(1.07, 2.11)</td>
</tr>
<tr>
<td>Private insurance</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pregnancy characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.63</td>
<td>(1.19, 2.23)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Smoking during pregnancy</td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3.47</td>
<td>(1.39, 8.66)</td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mental health²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.96</td>
<td>(0.55, 1.67)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>1</td>
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<td>Obesity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.90</td>
<td>(0.80, 4.51)</td>
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<tr>
<td>No</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pregnancy defined as high-risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2.38</td>
<td>(1.43, 3.98)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gestational diabetes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.30</td>
<td>(0.07, 1.30)</td>
</tr>
<tr>
<td>No</td>
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Continued
## Table 4.7 Continued

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<td>95% CI</td>
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<td>Breech Presentation</td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>32.34</td>
<td>(7.37, 141.90)</td>
</tr>
<tr>
<td>No</td>
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<td></td>
</tr>
<tr>
<td>Labor Complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any labor complication(^3)</td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>4.12</td>
<td>(2.74, 6.21)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)Values in bold are significant at the 0.05 level. \(^1\)All variables that were significant in the univariate analysis were included in the multivariate model. \(^2\)Mental health issues include: anxiety, depression, and bipolar disorder. \(^3\)Labor complications included: fetal intolerance, protracted first or second stage of labor, failure to progress in first stage of labor, chorioamnionitis, shoulder dystocia, or excessive bleeding
Figure 4.1: Kaplan-Meier survival curves indicating women’s likelihood of remaining in midwife care throughout prenatal care and delivery, by Pregnancy Care Connection status.
Chapter 5: Birth outcomes of women who use a midwife for prenatal care compared to women who use a physician for prenatal care

5.1 Abstract

Background: Few studies have assessed whether midwives provide a safe alternative to physician-led prenatal care in the US. Our objective was to compare the frequency of birth interventions, maternal and neonatal outcomes between low-risk women who used a midwife for prenatal care and their counterparts who used a physician.

Methods: We performed a retrospective cohort study of women delivering at a large public hospital who had at least one prenatal visit before 20 weeks gestation, between 2012-2015. Midwife-care was assessed using an intent-to-treat analysis, using provider type at first prenatal visit. We used modified Poisson regression to calculate adjusted risk ratios (ARR) of common outcomes, and logistic regression with Firth’s bias correction to produce adjusted odds ratios (AOR) of rare outcomes. Potential confounders included race, marital status, previous pregnancy complications and previous cesarean sections (C-sections).
Results: Women using midwives for prenatal care (8.2%) were less likely to be black, have Medicaid insurance, or have a history of pregnancy complications or C-sections compared with physician patients (91.8%). Midwife patients had lower risk of C-section (ARR 0.63; 95% CI 0.53-0.74), and preterm birth (ARR 0.54; 95% CI 0.39-0.74), with no increased odds of neonatal intensive care unit admissions, neonatal deaths, or severe maternal morbidity. Midwife patients had increased odds of excessive bleeding during labor (AOR 3.16; 95% CI: 1.32-7.56); however, the absolute risk was small (<1%).

Conclusions: Midwives provide a safe alternative to physician prenatal care for women with low-risk pregnancies, and their care involve substantially fewer preterm births and labor interventions.

5.2 Introduction

The vast majority of births in the United States (US) are attended by a physician, with only 8% attended by certified nurse midwives (1). Midwifery and obstetrics are separate but complimentary professions, and each provides a unique approach to the care surrounding pregnancy and birth. Physicians are experts in pathology, and bring substantial value when caring for women with complicated pregnancies. In contrast, midwives are experts in normal, physiological pregnancy and birth, providing a holistic approach to the care of women during their pregnancy (97).

Maternity care in the US includes costly and sometimes unnecessary interventions. Many interventions, including electronic fetal monitoring during labor, induction, and cesarean sections (C-sections), are routinely part of birth despite a
substantial gap between clinical standards of practice and scientific evidence of their benefit (98). Despite a slight decrease in recent years, the C-section rate in the US remains high, with 32% of births delivered via C-section (1).

Studies from countries outside the US, where midwifery is more common, found that for women with low-risk pregnancies, midwife care was associated with fewer interventions and no adverse effects for mothers and infants, compared with physician-led care (38,99). However, less is known about the impact midwives have on birth outcomes within the US health care system, which is vastly different from those studied. Few studies have assessed midwives impact on birth outcomes in the US, and most of the existing studies used data which is more than 20 years old (40,42–44,100). During this time, much has changed in the patterns of delivery, including a substantial increase in C-sections and a decrease in episiotomies (101,102). A recent ecologic study in the US found a correlation between living in a state that has autonomous certified nurse midwife practice and having lower rates of C-sections and preterm birth (103), providing initial support for the potential role midwives may play in providing care with fewer interventions during birth in the US. However, few studies have assessed the potential adverse outcomes that may be associated with reduced interventions experienced by patients of midwife care in the US (44,100). Therefore, the objective of our study was to compare birth interventions, maternal outcomes and neonatal outcomes between women with a low-risk pregnancy who use midwives for prenatal care and those who use physicians for prenatal care.
5.3 Materials and Methods

5.3.1 Data source

In our retrospective cohort study, we included women who delivered a singleton infant between January 2012 and December 2015 at The Ohio State University Wexner Medical Center (OSUWMC), who had attended at least one prenatal care visit within the OSUWMC network, with either a physician or a midwife, prior to 20 weeks gestation, and fit our definition of low-risk pregnancy. For women who delivered more than once within the study period, we included only the first birth and the prenatal visits associated with that birth (n=10,188). We assembled the cohort with data retrieved from OSUWMC’s electronic medical records (EMRs) for all prenatal care visits and deliveries.

We limited our analysis to low-risk women who potentially could have used a midwife for prenatal care. In order to create a low-risk cohort, we excluded women from the cohort if they had any of the following pre-existing conditions, using ICD-9 codes: active seizure disorder, active tuberculosis, acute hepatitis, advanced syphilis, cardiac disease, HIV infection, hydatidiform mole, indication of cocaine or unprescribed opiates and benzodiazepines use, lupus, pre-existing diabetes, previous vertical uterine incision, renal disease, sickle-cell disease, status asthmaticus, and treatment with methadone or suboxone (n=1,266). These criteria were based on the OSUWMC midwives’ clinical guidelines on indications for required transfers of care (11). Finally, we excluded from our analysis women who were due to deliver after December 15, 2015 (n=143). We excluded these women in order to prevent fixed cohort bias, in which births at the
beginning of the interval are more likely to be term and post term, while those at the end of the interval are more likely to be preterm, and as a result contribute disproportionately to poor birth outcomes. A total of 8,779 women were included in our analysis.

5.3.2 Exposure of interest: prenatal care provider type

Our exposure of interest was the provider type at the initial prenatal care visit in the OSUWMC system. Women who saw a midwife through the OSUWMC midwife clinic for their first prenatal care visit were categorized as midwife patients, and women who did not were categorized as physician patients. Women who were assigned a midwife through the pregnancy care connection program were not categorized as midwife patients, as they had not chosen midwife care and the vast majority of women in this setting did not remain with a midwife.

5.3.3 Outcomes of interest

5.3.3.1 Birth interventions

We assessed the following birth interventions, using data extracted from the EMRs: labor induction (yes vs. no), labor augmentation (yes vs. no), episiotomy (yes vs. no), and the use of epidural analgesia during labor (yes vs. no).
5.3.3.2 Maternal birth outcomes

We assessed the following maternal birth outcomes, using data extracted from the EMRs: C-section delivery (yes vs. no), third or fourth degree perineal lacerations (yes vs. no), excessive bleeding during labor (yes vs. no), and shoulder dystocia, defined as obstructed labor in which after the delivery of the head, the anterior shoulder of the infant cannot pass below the pubic symphysis (yes vs. no). In addition, we used ICD-9 codes to assess severe maternal morbidity. Women were classified as having severe maternal morbidity if they experienced any of the following: acute renal failure, liver failure, respiratory failure, obstetric shock, cerebrovascular accident, pulmonary embolism, amniotic fluid embolism, eclampsia, septicemia, complications of anesthesia, or a cardiac event, and their length of stay for delivery was over 72 hours. Our definition of severe maternal morbidity was based on the definition used in the recent assessment of national severe maternal morbidity trends (34).

5.3.3.3 Neonatal birth outcomes

In addition to maternal outcomes, we assessed the following neonatal birth outcomes using data extracted from the EMRs: preterm birth (yes if birth occurred before 37 weeks, no otherwise), admission to level 3 or 4 neonatal intensive care unit (NICU) (yes if neonate was admitted to a level 3 or 4 NICU, no otherwise), low Apgar score (yes if five minute Apgar score was less than 7, no otherwise), and stillbirth or neonatal death (yes vs. no).
5.3.3.4 Common vs. rare outcomes

Finally, we separated the birth interventions, maternal outcomes and neonatal outcomes into two groups, common and rare outcomes, according to whether each occurred in at least 5% or in fewer than 5% of births, respectively.

5.3.4 Potential confounders

The following variables were considered a priori as potential confounders: age, race, public insurance status, marital status, first birth, having previous pregnancy complications (including history of pre-term labor, fetal anomaly, fetal loss, postpartum hemorrhage, pre-eclampsia, gestational diabetes, fourth degree perineal laceration, or pulmonary embolism), having a previous C-section, obesity, hypertension, and smoking during pregnancy. Of these, variables that were associated with the exposure of interest (provider type for initial prenatal care visit) in our data, using a 0.1 significance level, were considered to be potential confounders. The variables that met this criterion were age, race, marital status, public insurance status, previous pregnancy complications, previous C-section, hypertension and smoking. Potential confounders were included in an adjusted model if their inclusion satisfied an a-priori change-in-estimate criterion of at least a 5% change in the appropriate odds ratio or prevalence ratio.
5.3.5 Data analysis

5.3.5.1 Intent-to-treat model

Our study used an intent-to-treat model, in which women remained in the exposure category they were initially assigned to, even if they transferred to the care of another provider during pregnancy. This approach limits the bias that would have occurred if we instead had assessed provider type at delivery, given that women with complications during pregnancy would be more likely to transfer to the care of a physician, thus biasing the outcomes in favor of midwife births.

5.3.5.2 Statistical analysis

We used descriptive statistics and contingency tables to describe the proportion of women who used a midwife and those who used a physician for the initial prenatal care visit. We used t-tests to compare continuous variables, and chi-square or Fisher’s exact test to compare categorical variables as appropriate. We used a bivariate modified Poisson regression approach (Poisson regression with a robust error variance) to assess unadjusted risk ratios of common outcomes, and used logistic regression with Firth’s bias correction to assess odds ratios of rare outcomes. Logistic regression with Firth’s bias correction was used because of its superiority over exact logistic regression in cases where multiple predictors are of interest, and because it produces finite, consistent estimates of regression parameters when the maximum likelihood estimates do not exist.
because the outcome variable completely or quasi-completely separates the predictor variables (104,105). We regarded p values less than 0.05 as significant. All statistical analyses were performed using SAS 9.4. The study was reviewed and approved by the Ohio State University Institutional Review Board.

5.4 Results

Among women with a low-risk pregnancy who delivered at OSUWMC and attended at least one prenatal visit in the OSUWMC network prior to 20 weeks gestation, 8.2% used a midwife for their initial visit, and 91.8% used a physician. Midwife patients were older, and more often were married, compared to physician patients. In addition, the proportions of women who were black, had Medicaid insurance, had a complication in a previous pregnancy, had a previous C-section, or smoke during pregnancy were significantly lower among the midwife patients (Table 5.1).

Statistically significantly smaller proportions of midwife patients experienced labor induction, labor augmentation, or episiotomies, or had an epidural compared to physician patients (Table 5.2). The most substantial differences in frequencies of birth outcomes (either maternal or neonatal) between midwife and physician patients were in C-section deliveries and preterm births. While only 16.3% of women who saw a midwife for prenatal care had a C-section, 30.5% of patients who saw a physician for prenatal care had a C-section (p<0.01). The proportion of preterm births also was significantly lower among midwife patients compared to physician patients (5.3% vs. 11.4%, respectively; p<0.01).
In the regression analyses, we assessed birth interventions and outcomes separately based on whether they were common or rare outcomes. In the bivariate analysis, midwife patients had significantly reduced risks of experiencing all of the common birth interventions and outcomes that we assessed (Table 5.3). These outcomes remained significant in the multivariable analysis. Low-risk women who used a midwife for prenatal care had 14% lower risk of having their labor augmented (ARR 0.86; 95% CI 0.79, 0.95), 34% lower risk of having their labor induced (ARR 0.66; 95% CI 0.58, 0.75), and 32% lower risk of having an epidural during labor (ARR 0.68; 95% CI 0.63, 0.74) compared to similarly low-risk women who used a physician for prenatal care. We also found significant differences in maternal and neonatal outcomes. Women who used a midwife for prenatal care had 37% lower risk of having a C-section (ARR 0.63; 95% CI 0.53, 0.74), and 44% lower risk of preterm birth (ARR 0.56; 95% CI 0.41, 0.76) compared to similarly low-risk women who used a physician for prenatal care.

We found significant differences in rare interventions and outcomes as well. In the unadjusted models, women who used a midwife for prenatal care had lower odds of having an episiotomy, and had higher odds of having third or fourth degree lacerations and excessive bleeding during labor compared to patients who used a physician for prenatal care (Table 5.4). In the multivariate models, using a midwife for prenatal care remained significantly associated with reduced odds of having an episiotomy (AOR 0.38; 95% CI: 0.23, 0.63) and increased odds of excessive bleeding during labor (AOR 3.10; 95% CI: 1.30, 7.41). We also have evidence of an increase in shoulder dystocia among women who used a midwife for prenatal care (AOR 1.83; 95% CI: 1.02, 3.28). Prenatal
care provider type was not significantly associated with increased odds of severe maternal morbidity, admission to a level 3 or 4 NICU, low Apgar scores, or stillbirth and neonatal deaths in either the unadjusted or adjusted models.

5.5 Discussion

Overall, women who used a midwife for prenatal care were less likely to be black and have Medicaid insurance, have a history of previous pregnancy complications or previous C-sections, and were less likely to have experienced interventions during birth, including labor induction, augmentation, epidural, and episiotomy, compared to women who used a physician for prenatal care. In our intent-to-treat analysis, we found that the risk of having a C-section and preterm birth were substantially lower among women who used a midwife for prenatal care, while there was no increase in the odds of adverse outcomes such as NICU admissions, low Apgar scores, or severe maternal morbidity. However, women who used a midwife for prenatal care had an increase in the odds of excessive bleeding during labor.

Numerous studies have compared birth outcomes among women who use midwives and women who use physicians for prenatal care and delivery in countries where midwife care is common. A recent Cochrane systematic review including 15 randomized controlled trials from Canada, the United Kingdom (UK), Australia and Ireland found that midwife-led care was associated with several benefits without evidence of adverse effects for mothers and infants, compared with physician-led care (38). The review found a significant reduction in epidural analgesia, episiotomies, and
preterm births among women in midwife care. However, they found no difference between the groups in the frequency of C-sections, perineal lacerations requiring suturing, postpartum hemorrhage, or low Apgar scores. In addition, the UK’s National Institute for Health and Care Excellence found that for low-risk women, deliveries in a midwife-led unit had lower rates of interventions and that the infant outcomes were no different compared with deliveries in an obstetric-led unit (99). Our results support many of these findings. However, in contrast to the findings in the Cochrane review, we found a significant reduction in C-sections and a significant increase in excessive bleeding during labor in women who used midwife care. These disparities may be due to differences in the models of care compared in the studies. Only three of the studies included in the Cochrane review compared midwife-led care with physician-led care. The additional studies included in the review compared midwife-led care with a shared model of care (i.e., sharing of care between physicians and midwives to various degrees), or with various options of standard care including shared and physician-led models. In addition, the scope of practice of midwives in the US differs from that in the countries where these studies were performed. In some countries such as Canada, the scope of practice for midwives is limited to the care of women with uncomplicated pregnancies as in the US, whereas in other countries, including the UK and Australia, midwives, in collaboration with obstetricians, provide care to women experiencing medical complications (38). Our finding of a significant reduction in C-section rates may only be applicable to a low-risk population as was included in our study.

In the US, midwife care is far less common, with 8% of births attended by midwives (1), and, perhaps as a result, fewer studies of midwife care exist. A recent
systematic review of studies performed in the US between 1990 and 2008 found that women who used midwives had lower rates of C-sections, fewer interventions during birth, and equally good maternal and neonatal outcomes (40). However, most of these data were collected over 20 years ago. Much has changed in obstetric care during this time, the most striking of which has been a 60% increase in the overall C-section delivery rate from 20.7% in 1996 to 32.9% 2009 (101).

Only three published studies have used data collected since 2000 to compare midwife-led prenatal care to physician-led care in the US (42–44). In a retrospective review of anal sphincter tears occurring among vaginal births at a single hospital in 2000-2004, investigators found a reduction in tears among women who used a midwife as a birth attendant compared to women who used a physician (43). We found non-statistically significant reduced odds of having third or fourth degree tears among women who used a midwife for prenatal care. Findings from the two other studies were consistent with our results in that they found a reduction in labor interventions and in C-section rates in the midwife group (42,44). Both studies used an intent-to-treat model; however, in the Benatar et al study, midwife deliveries occurred in a stand-alone birth center rather than in a hospital (44). As a result, the findings do not directly compare outcomes of midwife-led care and physician-led care, but rather compare the care of midwives in a free-standing birth center to the care of physicians in a hospital. Our study directly compares birth outcomes of women who used a midwife for prenatal care and women who used a physician for prenatal care, as all births in our study occurred within the same facility.
Benatar et al also found a statistically significant reduction in preterm birth among women who used a midwife for prenatal care (44), which is consistent with our findings. However, a study using data collected in 1994-1996 that assessed differences in outcomes between women who used midwives and physicians for prenatal care did not find a significant reduction in preterm birth (100). Midwives spend more time on average with patients during prenatal care visits, and a considerable part of this time is spent on patient counselling and education (97,106). This additional time focused on helping women make changes for a healthier pregnancy could perhaps explain part of the reduction we found in preterm births among midwife patients.

Jackson et al was the most recent study to assess shoulder dystocia and excessive bleeding (100). The study did not assess these variables directly, but rather included them as part of an aggregate measure, and did not find a significant difference in the aggregate measure of major intrapartum morbidity. Our study is the first to find a significant increase in excessive bleeding during labor and shoulder dystocia among women who used a midwife for prenatal care. The most substantial risk factor for shoulder dystocia is fetal macrosomia (107). Given the significant increase in C-sections among women who used a physician, it is probable that some women with large infants had C-sections as well and thus their labor was not obstructed by shoulder dystocia. However, it is important to note that shoulder dystocia is considered an unpredictable and unpreventable event, and prophylactic C-sections are not a recommended potential solution, as this would further increase C-section rates without reducing the risk of shoulder dystocia (107).
The measure of excessive blood loss during delivery is determined by birth attendants, based on their estimate of the patient’s blood loss, and is therefore highly subjective (108). As a result, estimates of blood loss at delivery are known to be inaccurate, and are commonly underreported (109). Perhaps midwives and physicians estimate blood loss differently due to differences in their training. Finally, although we observed a three-fold increase in excessive bleeding among women who used a midwife for prenatal care, the absolute risk for all women was still very low, with less than 1% of women in either group experiencing excessive bleeding. Unfortunately, we did not have information regarding the frequency of transfusions in the two groups. Future studies should include transfusion rates in the two groups to assess whether the difference in bleeding between midwife and physician births are due to actual differences in excessive bleeding, or due to differences in assessing the amount of blood loss in the two groups.

The midwife philosophy views birth as a natural part of a women’s lifecycle. As a result, midwives emphasize watchful waiting and not intervening in normal processes. However, midwives support the appropriate use of interventions and technology for current or potential health problems, and they consult and collaborate with other members of the health care team as needed to provide optimal health care (110). This approach leads to fewer interventions such as episiotomy, labor induction and augmentation, and C-section.

Besides these motivating factors, external influences may play a role in midwives not transferring patients hastily. As midwives do not perform C-sections themselves, the need to hand-off care to another provider may act as a barrier. In addition, there is a financial disincentive for midwives to provide their patients with a C-section. The
Centers for Medicare and Medicaid Services (CMS) fee rates determine the rates that physicians and midwives receive for the care they provide to Medicaid patients, and indirectly also influence the fee schedules of other public and private patients (111). According to the CMS fee schedule for 2016, if a physician provides prenatal care and his/her patient has a C-section, the fee for prenatal care, C-section and postpartum care is $2,324 (112). However, since midwives do not perform C-sections, when a midwife patient ultimately requires a C-section, the midwife would only receive payment for providing prenatal care ($451 – $806), and the physician who performed the C-section would receive $930.45. Therefore, midwives have a clear financial disincentive to avoid C-sections whenever possible, while physicians do not face the same financial disincentive.

Few previous analyses on this topic have used an intent-to-treat model, and the present study is the first to assess the potential reduction of labor interventions alongside the potential risk of increased adverse effects between women who used a midwife and women who used a physician and delivered in the same US hospital. This approach allowed us to compare midwife and physician outcomes directly, without the need to account for institutional differences. This choice is particularly important when assessing C-section rates, as these rates vary substantially across hospitals (113). The variation in C-section rates cannot be explained by hospital bed size, teaching status, geographic location, or clinical risk factors, and therefore may largely stem from differences in institutional policies (113). By comparing outcomes of births that occur within a single hospital, we eliminated these external factors that could lead to differences in labor
interventions. However, having data from only one hospital may limit the generalizability of our findings.

Our study was powered to detect small differences in C-section rates, and our large sample size also enabled us to detect differences in fairly rare outcomes, such as episiotomies. However, our study was not powered to detect small differences in extremely rare outcomes such as severe maternal morbidity and neonatal deaths, which occurred in only 0.2-0.3% of births. An additional limitation was the use of secondary data extracted from electronic medical records. As these data were not collected for research purposes, providers might have failed to document every labor intervention appropriately.

Finally, as this was an observational study and not a randomized trial, it is possible that some unmeasured confounding remained after we adjusted for the measures that we considered. Given the magnitude of the effect that we found in regards to C-section rates, there would need to be substantial unmeasured confounding in order for that to be the driving factor behind our outcome.

One in three women in the US currently deliver by C-section. Our study indicates that midwives provide a safe alternative to physician prenatal care, while delivering babies with 1/3 lower C-section rate. In order to reap the full benefits of midwifery, midwives must be integrated into US maternity care in a collaborative manner. A team-based and patient-centered approach, in which physicians and midwives work side by side, and where midwives take the lead as appropriate, can lead to a reduction in the overall treatment intensity among women who do not benefit from these additional interventions (114). Further research is necessary to assess whether the same effects are
found in different models of midwife care, in order to understand the best way to incorporate midwife care more routinely into the US health care system.
Table 5.1: Socio-demographic and health characteristics of women who initiated prenatal care visits in The Ohio State University network by 20 weeks gestation, by initial provider type

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Midwife (n=721)</th>
<th>Physician (n=8,058)</th>
<th>P-value**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>8.2</td>
<td>91.8</td>
<td></td>
</tr>
<tr>
<td><strong>Socio-demographic characteristics</strong></td>
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<tr>
<td>Age</td>
<td>29.8±4.6</td>
<td>29.2±5.8</td>
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<td>Race</td>
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<td></td>
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<td>Black</td>
<td>9.3</td>
<td>23.5</td>
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<tr>
<td>Non-Black</td>
<td>90.7</td>
<td>76.5</td>
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</tr>
<tr>
<td>Insurance type</td>
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<tr>
<td>Public (Medicaid)</td>
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<td>34.5</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>75.7</td>
<td>65.5</td>
<td></td>
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<tr>
<td>Marital status</td>
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<td>&lt;<strong>0.0001</strong></td>
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<tr>
<td>Married</td>
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<td>59.6</td>
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</tr>
<tr>
<td>Not married</td>
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<td>40.4</td>
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<td><strong>Health characteristics</strong></td>
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<td>First birth</td>
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<tr>
<td>No</td>
<td>52.8</td>
<td>54.0</td>
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<tr>
<td>Previous pregnancy complication¹</td>
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</tr>
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<td>Yes</td>
<td>6.7</td>
<td>11.6</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>93.3</td>
<td>88.4</td>
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<tr>
<td>Previous C-section delivery</td>
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<td>Yes</td>
<td>11.1</td>
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<td>No</td>
<td>88.9</td>
<td>81.1</td>
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<tr>
<td>Obesity</td>
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Table 5.1 continued

<table>
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<tr>
<th></th>
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<th>Physician (n=8,058)</th>
<th>P-value**</th>
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<td>Hypertension</td>
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<td>No</td>
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<td>92.3</td>
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<td>Smoking during pregnancy</td>
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<td>5.1</td>
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<tr>
<td>No</td>
<td>96.7</td>
<td>94.9</td>
<td></td>
</tr>
</tbody>
</table>

Bold values indicate variables significant at 0.05 level.

**T-test for continuous variables, χ² or Fisher’s exact test as appropriate for categorical variables.

Previous pregnancy complication includes any of the following in a previous pregnancy: pre-term labor, fetal anomaly, fetal loss, postpartum hemorrhage, pre-eclampsia, gestational diabetes, fourth degree perineal laceration, and pulmonary embolism.
Table 5.2: Birth interventions, maternal outcomes and neonatal outcomes of women who initiated prenatal care visits in The Ohio State University network by 20 weeks gestation, and delivered between 2012-2015, by initial provider type

<table>
<thead>
<tr>
<th>Birth intervention or outcome</th>
<th>Midwife (n=721)</th>
<th>Physician (n=8,058)</th>
<th>P-value**</th>
</tr>
</thead>
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<tr>
<td><strong>Birth intervention</strong></td>
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<td>Labor induction</td>
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<td></td>
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<tr>
<td>Yes</td>
<td>25.1</td>
<td>36.0</td>
<td>&lt;0.0001</td>
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<tr>
<td>No</td>
<td>74.9</td>
<td>64.0</td>
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<tr>
<td>Labor augmentation</td>
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<td>Yes</td>
<td>41.5</td>
<td>45.5</td>
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<tr>
<td>No</td>
<td>58.5</td>
<td>54.5</td>
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<tr>
<td>Episiotomy</td>
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</tr>
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<td>Yes</td>
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</tr>
<tr>
<td>No</td>
<td>97.8</td>
<td>95.2</td>
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<tr>
<td>Epidural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>49.9</td>
<td>69.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>No</td>
<td>50.1</td>
<td>30.2</td>
<td></td>
</tr>
<tr>
<td><strong>Maternal outcome</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-section delivery (n=8,636)(^1)</td>
<td></td>
<td></td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Yes</td>
<td>16.3</td>
<td>30.5</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>83.7</td>
<td>69.5</td>
<td></td>
</tr>
<tr>
<td>Third and fourth degree perineal lacerations</td>
<td></td>
<td></td>
<td>0.3059</td>
</tr>
<tr>
<td>Yes</td>
<td>1.3</td>
<td>1.9</td>
<td></td>
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<tr>
<td>No</td>
<td>98.8</td>
<td>98.1</td>
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<tr>
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<td>0.0376</td>
</tr>
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<td>Yes</td>
<td>0.8</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>99.1</td>
<td>99.7</td>
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</tr>
<tr>
<td>Shoulder dystocia</td>
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<td></td>
<td>0.1553</td>
</tr>
<tr>
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<td>1.8</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>98.2</td>
<td>98.8</td>
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</tr>
<tr>
<td>Severe maternal morbidity</td>
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<td></td>
<td>0.3932</td>
</tr>
<tr>
<td>Yes</td>
<td>0.0</td>
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<tr>
<td>No</td>
<td>100.0</td>
<td>99.8</td>
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Continued
<table>
<thead>
<tr>
<th>Neonatal outcome</th>
<th>Midwife (n=721)</th>
<th>Physician (n=8,058)</th>
<th>P-value**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Preterm birth</td>
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<td></td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Yes</td>
<td>5.3</td>
<td>11.4</td>
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</tr>
<tr>
<td>No</td>
<td>94.7</td>
<td>88.6</td>
<td></td>
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<tr>
<td>Stillbirth or neonatal death</td>
<td></td>
<td></td>
<td>0.2538</td>
</tr>
<tr>
<td>Yes</td>
<td>0.0</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>100.0</td>
<td>99.7</td>
<td></td>
</tr>
<tr>
<td>Low Apgar score</td>
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<td></td>
<td>0.2057</td>
</tr>
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<td>Yes</td>
<td>1.7</td>
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<tr>
<td>No</td>
<td>98.3</td>
<td>97.5</td>
<td></td>
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<tr>
<td>Admission to level 3 or 4 NICU(^2)</td>
<td></td>
<td></td>
<td>0.0829</td>
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<tr>
<td>Yes</td>
<td>2.4</td>
<td>4.8</td>
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<tr>
<td>No</td>
<td>97.6</td>
<td>95.2</td>
<td></td>
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</tbody>
</table>

Bold values indicate variables significant at 0.05 level.

**\(\chi^2\) or Fisher’s exact test as appropriate for categorical variables.

\(^1\)delivery type missing for 143 women. \(^2\) Neonatal intensive care unit (NICU) admissions available for deliveries up to August 2014, n=6,066
Table 5.3: Relative risks of common birth interventions and outcomes, comparing women who initially saw a midwife for prenatal care with women who initially saw a physician for prenatal care, among women who initiated prenatal care in The Ohio State University network by 20 weeks gestation, and delivered at Ohio State University 2012-2015

<table>
<thead>
<tr>
<th>Birth intervention or outcome</th>
<th>Unadjusted RR</th>
<th>(95% CI)</th>
<th>Adjusted RR</th>
<th>(95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birth intervention</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Augmentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.91</td>
<td>(0.83, 1.00)</td>
<td>0.86²</td>
<td>(0.79, 0.95)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Induction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.70</td>
<td>(0.61, 0.79)</td>
<td>0.66²</td>
<td>(0.58, 0.75)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epidural</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.72</td>
<td>(0.66, 0.77)</td>
<td>0.68²</td>
<td>(0.63, 0.74)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maternal outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-section delivery (n=8,779)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.53</td>
<td>(0.45, 0.63)</td>
<td>0.63²</td>
<td>(0.53, 0.74)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
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<td></td>
<td></td>
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<tr>
<td><strong>Neonatal outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preterm birth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.46</td>
<td>(0.34, 0.63)</td>
<td>0.56³</td>
<td>(0.41, 0.76)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
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</tr>
</tbody>
</table>

CI – confidence interval; RR – Relative risks estimated using Poisson regression
Birth outcomes were considered to be common if they occurred in at least 5% of births.
¹delivery type missing for 143 women. ² Model was adjusted for previous C-section. ³ Model was adjusted for black race, marital status, previous pregnancy complication, and hypertension.
Table 5.4: Unadjusted and adjusted Odds ratios of rare birth interventions and outcomes, comparing women who initially saw a midwife for prenatal care with women who initially saw a physician for prenatal care, among women who initiated prenatal care in The Ohio State University network by 20 weeks gestation, and delivered at The Ohio State University, 2012-2015

<table>
<thead>
<tr>
<th>Birth intervention or outcome</th>
<th>Unadjusted OR</th>
<th>95% CI</th>
<th>Adjusted OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birth intervention</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Episiotomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.47</td>
<td>(0.28, 0.77)</td>
<td>0.38(^4)</td>
<td>(0.23, 0.63)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Maternal outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third and fourth degree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perineal lacerations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.11</td>
<td>(1.03, 1.20)</td>
<td>0.56(^4)</td>
<td>(0.29, 1.08)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Excessive bleeding during</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>labor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2.86</td>
<td>(1.21, 6.80)</td>
<td>3.10(^2)</td>
<td>(1.30, 7.41)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Shoulder dystocia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.51</td>
<td>(0.85, 2.69)</td>
<td>1.83(^3)</td>
<td>(1.02, 3.28)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Severe maternal morbidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.30</td>
<td>(0.02, 5.01)</td>
<td>0.53(^4)</td>
<td>(0.04, 7.76)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Neonatal outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admission to level 3 or 4</td>
<td></td>
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</tr>
<tr>
<td>NICU**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.53</td>
<td>(0.26, 1.11)</td>
<td>0.62(^5)</td>
<td>(0.29, 1.29)</td>
</tr>
<tr>
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Continued
Table 5.4 continued

<table>
<thead>
<tr>
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<th>95% CI</th>
<th>Adjusted OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Apgar score</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.68</td>
<td>(0.38, 1.22)</td>
<td>0.76(^6)</td>
<td>(0.43, 1.36)</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stillbirth or neonatal death</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.24</td>
<td>(0.01, 3.91)</td>
<td>0.30(^7)</td>
<td>(0.02, 4.58)</td>
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<td></td>
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</tbody>
</table>

CI – confidence interval; OR - Odds ratios were estimated using logistic regression, with Firth's bias correction.

**NICU - Neonatal intensive care unit**

Birth outcomes were considered to be rare if they occurred in less than 5% of births.

\(^1\)Model was adjusted for race, public insurance, marital status, and previous C-section. \(^2\)Model was adjusted for age, race and marital status. \(^3\)Model was adjusted for race and marital status. \(^4\)Model was adjusted for race, marital status, public insurance, previous C-section, and hypertension. \(^5\)Model was adjusted for previous pregnancy complications and hypertension. \(^6\)Model was adjusted for race, marital status and public insurance. \(^7\)Model was adjusted for age, race, marital status, public insurance and previous pregnancy complications.
Chapter 6: Conclusions and implications for future research

6.1 Overview

Births in the United States are costly and include many and often-unnecessary interventions in comparison to other developed countries. This study provides important information regarding the potential benefit of increasing the use of midwives in the US. We assessed the socio-demographic and health characteristics of women who used a midwife for prenatal care and for delivery compared to women who used a physician, in a nationally representative survey, and found that these women were similar in most regards. We also investigated the progression of care among midwife patients, to understand when and why women transfer to the care of physicians, and found that in addition to expected pregnancy-related factors, black race was associated with transferring to the care of a physician. Finally, we explored the differences in birth interventions, maternal outcomes and neonatal outcomes between women who used a midwife for prenatal care and those who used a physician. We found that women who used a midwife for prenatal care were less likely to experience labor induction or augmentation, C-sections and preterm birth.
6.2. Aim 1

6.2.1 Summary

Almost 13% of women used a midwife for either prenatal care or as a birth attendant, with 6% of women using a midwife for both prenatal care and as a birth attendant. Women who used a midwife for prenatal care were similar to women who used a physician in most factors that we assessed, with the exception of a greater proportion of white and married women in the midwife group. When we compared women who used a midwife as a birth attendant to those who used a physician, we again found that they were similar in most factors. However, a smaller proportion of midwife patients were over age 35, and a greater proportion received WIC support.

6.2.2 Interpretation

On a national level, women who used a midwife for prenatal care and/or birth had similar socio-demographic and health history characteristics compared to those who used a physician. Our findings do not support the perception that women who use midwives are wealthier and more highly educated than those who use a physician.

6.2.3 Public health significance

As we found that women who used a midwife for prenatal care were similar in most regards to women who used a physician, the results of future studies that compare outcomes of these two groups are not likely to be due to substantial socio-demographic and health differences between these two groups.
6.2.4 Future research directions

As midwives care for women with a wide range of socio-demographic backgrounds, in a variety of settings, future studies regarding the outcomes of midwife births must be performed in a variety of settings as well, encompassing the many different women that are cared for by midwives. These studies should aim to assess whether birth experiences and outcomes differ between women who use a midwife for prenatal care and/or birth attendants compared to those who use a physician, and whether these outcomes are modified by patient socio-demographic characteristics.

6.3 Aim 2

6.3.1 Summary

A majority of the 993 women who initiated prenatal care with a midwife remained in midwife care throughout delivery, with 4.7% transferring to a physician during prenatal care, and an additional 21.4% transferring to a physician during delivery. Black race was the only non pregnancy-related factor that was significantly associated with leaving midwife care during prenatal care and delivery.

6.3.2 Interpretation

Most women who initiate care with a midwife, remain in midwife care throughout pregnancy and delivery, indicating that midwife-care is a viable option for women with
low-risk pregnancies. However, our findings also indicate that race may play a possible role in pregnancy care.

6.3.3 Public health significance

As we found that most women remain in midwife care, interventions targeted at increasing the proportion of women who seek prenatal care with a midwife are likely to lead to an increase in midwife-attendant births, thus paving the way we can expect to see a reduction in birth interventions while providing high quality care.

6.3.4 Future research directions

Future studies should assess whether women who are randomized to the care of midwives remain in care in a similar fashion to the women in our study who chose the care of midwives. Although our findings are positive in that they suggest that most women with initially low-risk pregnancies are able to remain in the care of a midwife, it is important to understand whether women who do not specifically seek out midwife care would follow a similar pattern and remain in midwife care as well.

6.4 Aim 3

6.4.1 Summary

Women who used a midwife for prenatal care were more likely to be older and married, and less likely to be black and have public insurance compared to women who
used a physician for prenatal care. Women with low-risk pregnancies who used a midwife for prenatal care had significantly lower risk of experiencing interventions during birth, including labor induction and augmentation, and the use of epidural during labor compared to those who used a physician. In addition, midwife patients had lower risk of having a C-section and delivering prematurely compared to physician patients. Most adverse maternal and neonatal outcomes were similar between midwife and physician patients, however, midwife patients had increased odds of excessive bleeding during labor.

6.4.2 Interpretation

This study suggests that midwife-led prenatal care provides a safe alternative to physician-led prenatal care, while reducing the risk of birth interventions without increasing the likelihood of severe adverse outcomes.

6.4.3 Public health significance

Nearly one-third of women in the US currently deliver via C-section. While in some cases C-sections are life-saving procedures, when the rate of C-section becomes too high, it begins to adversely impact public health, as C-sections are associated with significantly increased morbidity and mortality compared to vaginal births. Our study indicates that in a US setting, midwives deliver low-risk women with one-third fewer C-sections, without increasing the risk to women or infants. Efforts to increase the use of midwives for
prenatal care in the US can play a substantial role in attempts to reduce the current C-section rates.

6.4.4 Future research directions

As with aim 2, it is important to understand whether these results can be replicated in randomized trial. Future studies which randomize women to the care of physicians or midwives will allow us to understand whether the improved outcomes among midwives is truly an effect related to the provider type rather than a byproduct of a selection of specific women into midwife care. In addition, future studies which assess how outcomes of different midwifery models of care compare to outcomes of physician led care will allow us to assess the preferred model of care to reduce unnecessary interventions while maintaining the health of mothers and infants.

6.5 Conclusions

The findings of our three studies provide insight into three different aspects of midwife care. Our results indicate that while on a national level women who use a midwife are similar to those who use a physician, at a clinic-level scale there are differences between women who use midwives and those who use physicians. We found that most women who initiated care with a midwife remained in midwife-care throughout pregnancy and delivery. Finally, we found that after accounting for differences between midwife and physician patients, midwife patients had significantly lower risks of having a C-section and having preterm birth. Reducing C-section rates and preterm births are
both crucial to public health, as they both carry risk for major long-term morbidity and mortality, for the mother and the infant. Thus, increasing the proportion of low-risk women who use a midwife for prenatal care can have a considerable positive impact on adverse maternal and neonatal outcomes, thereby improving the public’s health.
References


36. 2013 Comparative Price Report: Variation in Medical and Hospital Prices by Country [Internet]. International Federation of health plans; 2013 [cited 2016 Jan 18]. Available from:
http://static1.squarespace.com/static/518a3cf6e4b0a77d03a62e98/t/534fe9ebe4b05a88e5fbab70/1397737963288/2013+iFHP+FINAL+4+14+14.pdf


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Appendix A: Clinical practice guidelines - OSU midwives

FUNCTIONS AND RESPONSIBILITIES OF THE MIDWIFE

Midwives are expected to independently manage the care of the healthy, low-risk pregnant woman during pregnancy and postpartum. Midwives may also co-manage moderate to high-risk women according to a mutually agreed upon plan of care with a consultant physician. The midwife may decline to manage women whom she deems inappropriate for midwifery care.

In providing antenatal care, the midwife will:

A. Review a pregnant woman’s medical, obstetric, and family medical history, and identify risk factors.

B. Perform initial physical exam, including speculum and pelvic exam, as needed

C. Determine appropriateness of the pregnant woman for midwifery care. Seek appropriate physician consultation. Transfer woman to physician care as necessary.

D. Evaluate maternal adaptation to the pregnancy, monitoring signs of both physical and psychosocial adjustment. Evaluate adaptation of family to pregnancy, including preparation for childbirth.

E. Manage minor conditions (e.g. vaginitis, UTI’s, URI’s) and/or common
complaints of pregnancy. Identify deviations from normal and seek appropriate consultation, co-management, and/or initiate transfer of woman to physician care as indicated.

F. Provide timely and appropriate counseling and teaching for pregnant women and family members during pregnancy, in the interest of pregnancy well being and in preparation for labor and birth, postpartum adjustment and child rearing.

G. Agreed upon mutually by the midwife and an obstetrician, the midwife may manage that part of the care of the medically complicated woman, which is appropriate to the skills and knowledge of the particular midwife. This care will be provided in consultation with an obstetrician.

In providing care during the postpartum period, the midwife will:

A. Evaluate maternal well-being and adaptation at appropriate postpartum intervals. Perform appropriate physical and gynecological exam at the 6-week postpartum visit. Provide contraceptive management or refer women to appropriate provider for contraceptive management, if desired.

At all times, the midwife will:

A. Comply with the Standards of Care as outlined by the American College of Nurse Midwives.

B. Practice in accordance with the Ohio Revised Code Chapter 4723: Nurse Practice Act.
C. Practice in accordance with the Standard Care Arrangement outlined by The Ohio State University, as well as within The Ohio State University Medical Center bylaws.

D. Document actions and findings appropriately in the medical record.

FUNCTIONS AND RESPONSIBILITIES OF PHYSICIANS

A physician is always available to the midwife for consultation by phone or in person. The consultant physician will:

A. Provide appropriate consultation for antepartum women, for women in labor and during delivery, for postpartum women, and for women seeking gynecologic care from midwives.

B. Provide mutually agreed upon co-management with midwives and document the plan for co-management in the medical record.

C. Provide care to pregnant women, laboring or birthing women, women in the puerperium, or non-pregnant women whose care has been transferred to them by the midwives.

D. Assist the midwife, as needed, in obtaining appropriate referrals to other physicians
MIDWIFERY STANDARDS OF CARE: ANTEPARTUM

Initial Visit (New OB Visit): The Midwife will:

A. Explain Midwifery Service as well as other OB providers
B. Review dating criteria and order dating ultrasound
C. Review medical, family medical, obstetrical, and psychosocial histories.
   Obtain records from medical record chart or from other institutions, as indicated.
D. Perform screening physical, if indicated, including collection of Pap smear (if indicated) and cultures.
E. Order routine NOB labs and discuss optional screening blood tests (i.e. Cystic Fibrosis, Sickle-Cell, genetic screening)
F. Order Prenatal Vitamins
G. Determine indications for further testing, and order as needed (e.g.: Early 1hr GTT, TSH, or varicella)
H. Obtain consultations or referrals, as indicated, for plan of care and follow-up
I. Initiate problem list
J. Document relevant findings in the prenatal chart and New OB information as appropriate

Subsequent Antepartum Visits: Suggested Timing:

• 6-28 weeks: every four weeks
• 28-36 weeks: every two weeks
• 36 weeks to birth: every week

A midwife may choose to schedule visits more frequently, when indicated.

At Subsequent Antepartum Visits the Midwife will:

A. Evaluate maternal and fetal adjustment to pregnancy, including:
   1. Weight, blood pressure
   2. Results of urine dipstick (as indicated)
   3. Fundal growth and presence of fetal heart tones
   4. Determine presentation and/or lie by Leopold maneuvers (after 30 weeks gestational age)

B. Address other physical conditions, as indicated

C. Address psychosocial issues as indicated

D. Evaluate risk of pre-term labor

E. Obtain consultations and referrals, as indicated

F. Subsequent Laboratory Testing
   1. Offer QUAD screen at 15-20 weeks
   2. 24-28 weeks:
      a. Gestational Diabetes screening – 1-hour glucose load – followed by 3 hour GTT if abnormal.
      b. CBC with Platelets
      c. HIV, if higher risk
      d. Syphilis antibody screening (recommended to take out RPR or note that it is declined)
e. If Rh negative – Rhogam workup and Rhogam injection as indicated.

3. At 36 weeks:
   a. CBC, as clinically indicated.
   b. Group B Strep Culture
   c. GC/CT cultures, if indicated

4. Any other laboratory testing, as indicated.

CONSULTATION, COLLABORATION, AND TRANSFER OF CARE

For women with certain conditions, the midwife may obtain consultation with an obstetrician, either written or verbal. The midwife may also collaborate with the obstetrician by having the woman see a physician for one visit, or the midwife may transfer her to an obstetrician’s care for the duration of the pregnancy.

All consultations with an obstetrician and resultant plans of care should be documented in the patient’s chart. If the physician sees the woman, the physician should document the visit as well as the management plan in the chart. This management plan will include the need for subsequent physician visits, and special needs for ante-, intra-, or postpartum care.
Ambulatory Obstetric Care:

Consultation:

For women with the following conditions, consultation with an obstetrician and documentation of the plan of care is recommended:

- Anemia: severe (Hemoglobin less than 9) or unresolved after treatment
- Chronic hypertension, well-controlled on medication
- Hepatitis B, chronic carrier or known/suspected carrier
- Hepatitis C positive, or known exposure
- Severe Hyperemesis Gravidarum
- Intrauterine fetal demise
- IUGR documented by ultrasound
- Obstetrical history with severe complications, including: stillbirth, severe pre-eclampsia requiring preterm delivery, or eclampsia
- Polyhydramnios documented by ultrasound
- Pregnancy Induced Hypertension or evolving Pre-eclampsia
- Thrombocytopenia of less than 100,000
- Thyroid disease, uncontrolled
- Uterine fibroids affecting fetal growth or mode of delivery
- Class A2 Gestational Diabetes
Collaboration:

For women with the following conditions, the midwife will co-manage the patient with the physician, and a one-time visit with an obstetrician should be considered:

- Breech presentation at 36 weeks – for possible external version
- Cerclage in place at 37 weeks
- Previous birth by cesarean section
- Desiring postpartum sterilization
- IUGR diagnosed on ultrasound (<10%)
- Macrosomia diagnosed on ultrasound (>90%)
- Multiple co-morbidities
- History of seizure disorder with no diagnosed seizure in the last year and on no medications
- History of 4th degree tear
- History of shoulder dystocia that resulted in permanent injury
- Uterine anomaly
- Uterine scar, other than lower uterine segment transverse incision
- Active deep vein thrombosis

Transfer of Care:

Women with the following conditions must be transferred to physician care:

- Status Asthmaticus
- HIV positive
• Urine toxicology screen positive for cocaine or unprescribed opiates and benzodiazepines
• Patients currently receiving addiction treatment with methadone or suboxone
• Multiple gestation
• Pre-existing Diabetes Mellitus Class B or greater
• Uncontrolled Class A2 Gestational Diabetes
• Lupus
• Sickle-cell disease
• Cardiac disease
• Renal disease
• Acute Hepatitis disease
• Ectopic pregnancy
• Hydatidiform mole
• Incompetent cervix (until successful cerclage is placed)
• Missed abortion requiring surgical intervention
• Placenta previa, persistent after 32 weeks
• Syphilis, advanced states (until treated)
• Known vertical uterine incision
• Active tuberculosis
• Active seizure disorder, defined as seizure in the last year
**Intrapartum**

**Consultation:**

For women with the following conditions, consultation with an obstetrician and documentation of the plan of care is recommended. Consultation can take place in the form of a phone call or in person.

- Trial of labor after cesarean
- History of shoulder dystocia
- Abnormal bleeding in labor
- Prolonged active labor after 6 cm
- Prolonged second stage of labor greater than 2 hours in multip and 3 hours in primip
- Category 3 or category 2 unresponsive to intrauterine resuscitation
- Chorioamnionitis
- Known fetal anomaly
- Mild pre-eclampsia

**Collaboration:**

For women with the following conditions, the midwife may co-manage the patient with the physician.

- Preeclampsia with severe features on Magnesium Sulfate
• Elevated blood pressure in labor requiring anti-hypertensive therapy
• Preterm labor/ preterm delivery < 32 weeks
• IUFD
• Repair of third or fourth degree laceration
• Complicated postpartum hemorrhage
• Repair of cervical laceration
• Retained placenta with unsuccessful attempt at manual removal
• Women requiring vacuum or forceps delivery
• Persistent brow or compound presentation

Transfer:

Women with the following conditions will be transferred to physician care:

• Mal-presentation of fetus, e.g.: breech or face, **not necessary for asyncliticism**
• Eclampsia
• Failure to progress or non-reassuring fetal heart tones in need of operative delivery
• Preterm delivery less than 32 weeks

Postpartum Care:

Consultation:

For women with the following conditions, consultation with an obstetrician and documentation of the plan of care is recommended. Consultation can take place in the form of a phone call or in person.
• Hypertension requiring medication
• Severe, symptomatic anemia with hemoglobin <7

**Collaboration:**

For women with the following conditions, the midwife will co-manage the patient with the physician.

• Postpartum hemorrhage unresponsive to treatment
• Retained placenta or products of conception
• Postpartum care after cesarean section
• Deep vein thrombosis (suspected or active)
• Postpartum psychosis
• Patients desiring tubal ligation
• Poor wound healing

**Transfer:**

Women with the following conditions will be transferred to physician care:

• Seizure
• Pulmonary Embolus
• Severe medical complication
• Breast abscess
MIDWIFERY PRESCRIPTIVE POLICY

A Certified Nurse-Midwife in the state of Ohio can prescribe medications per the statutes and regulations governing midwifery practice in the state. Midwives must receive authorization by the state of Ohio to independently prescribe controlled substances (Categories II-V) after appropriate application and registration with the DEA and the Ohio Automated Rx Reporting System (OARRS).