Social Science & Medicine 372 (2025) 117973

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Womb to wisdom: Early-life exposure to midwifery laws and later-life disability☆

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ARTICLE INFO

Handling editor: Winnie Yip

JEL classification:
H75
I18
J13
J18

Keywords:
Disability
Midwifery
Health education
Public policy

ABSTRACT

Previous research documented that midwifery service quality improvements lead to improving maternal and infants' health outcomes. However, little is known about its influence for later-life outcomes including disability. This paper explores the potential effects of early-life exposure to the establishment of midwifery laws across US states on later-life disability outcomes. Midwifery laws were enacted during the late 19th and early 20th century and required midwives to gain formal education and training to obtain a license in order to legally practice. We use decennial census data over the years 1970–2000 and implement a difference-in-difference method and show that being born in a reform state is associated with significant reductions in various measures of disability, including work disability, cognitive difficulty, ambulatory difficulty, self-care difficulty, and a proxy for severe mental health. We also find significant increases in education, socioeconomic scores, housing wealth, and income. We further discuss the policy implications of the results.

1. Introduction

Studies in various settings document the early-life origins of later-life outcomes (Almond et al., 2018; Almond and Currie, 2011; Barker, 1994, 1995, 1997). This literature evaluates the effects of various exposures during in-utero, early-life, and childhood on different measures of socioeconomic attainments and health outcomes later in life, including cognitive development (Aizer; Rosales-Rueda, 2018), educational outcomes (Cunha and Heckman, 2007), labor market outcomes (Atwood, 2022), physical and mental health (Lillard), and old-age mortality (Hayward and Gorman, 2004; Montez and Hayward, 2011, 2014; Noghanibehambari, 2022). One important outcome with long-lasting legacies and economic costs is disability. Although the US and other developed countries experienced large reductions in disability during the past several decades (Schellekens), little is known about the potential sources of contribution to this secular trend. A narrow strand of research evaluates the role of early-life exposures in explaining later-life disability outcomes (Bowen, 2009; Freedman et al., 2008a,b; Lee, 2011; Lorenti et al., 2020; Testa et al., 2022). However, this literature focuses on cross-sectional data and evaluates the associations between early-life and childhood circumstances and later-life disability. Fewer studies explore the effects of policy changes that result in improvements in early-life conditions on later-life disability. This paper aims to fill this gap in the literature.

In this paper, we exploit the establishment of midwifery laws across US states in the late 19th and early 20th centuries. During this period, many American women gave birth at home with the help of midwives. However, the midwifery market was wildly unregulated, and many midwives were uneducated with minimal formal training. The establishment of midwifery laws resulted in quality improvements by

☆ The authors claim no conflict of interest. The authors would like to acknowledge financial support from the Center for Demography of Health and Aging (CDHA) at the University of Wisconsin-Madison under NIA core grant P30 AG17266.

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https://doi.org/10.1016/j.socscimed.2025.117973
Received 11 May 2023; Received in revised form 10 November 2023; Accepted 15 March 2025
Available online 21 March 2025
0277-9536/

enforcing midwives to receive formal training and education, and passing certain exams to obtain a license to practice and deliver services legally. Previous studies suggested improvements in infants' health, maternal health, and later-life longevity due to improvements in midwifery quality (Anderson et al., 2020; Lazuka, 2018). We use the staggered adoption of these laws across states and over the years to examine their impacts on later-life physical and mental disability outcomes. We find significant reductions in work disability, cognitive difficulty, ambulatory difficulty, independent living difficulty, self-care difficulty, vision-hearing difficulty, and hospitalization due to mental illness.

This paper makes several important contributions to the literature. First, to our knowledge, this is the first study to examine the later-life impacts of midwifery laws in the US. These laws were the first to regulate the wholly unregulated midwifery market. The effects could significantly differ from the incremental additions and modifications to already established policies observed in later decades. Therefore, the results of this paper could be valuable for developing countries with minimal laws to regulate healthcare services, particularly in the midwifery sector. This contribution can be highlighted by the fact that the majority of births in developing countries are delivered at home with the help of midwives and birth attendants (WHO, 2020). Second, our paper adds to the growing literature that evaluates the causes of disability and specifically to the narrow strand of research that explore the early-life origins of adult disability (Bowen, 2009; Huang et al., 2011; Lorenti et al., 2020). Third, our paper also contributes to the ongoing policy debates regarding occupational licensing. Obtaining licensure could affect the prices by raising the costs of entry (hence, the financial burden for consumers) and the quality of care by improving the knowledge and training (hence, beneficial for consumers). Therefore, the net effects on consumers are a priori unknown (Fillmore et al., 2020; Kleiner, 2000; Kleiner and Kudrle, 2000; Shapiro, 1986). This paper reveals a long-run externality of midwifery occupational licensing and adds to the benefits side of this policy debate.

The rest of the paper is as follows. Section 2 provides a background of midwifery laws and related literature. In section 3, we discuss the empirical approach. Section 4 introduces data sources and sample selections. Section 5 reviews the results. Finally, section 6 concludes the paper.

2. Background

2.1. Midwifery laws

During the beginning of the 20th century, most births were delivered at home with the help of traditional attendants and midwives. The midwives in the US were mostly unregulated, and the practice of midwifery was mostly carried out through traditional apprenticeship instead of formal education. However, this began to change as licensure has been justified on the basis that formal training of licensees will eliminate low-quality service providers from the market and cause an increase in the quality of the remaining ones, and improve the health and safety of consumers (GittlemanKleiner; Kleiner, 2000; Shapiro, 1986).

In the late 19th and early 20th, the medical profession began to assert greater control over childbirth and midwifery care. As a result, many states passed laws requiring midwives to acquire licenses and registrations to continue their occupations, and some laws asserted that midwives should work under the supervision of a physician. The bases of these laws were often focused on infant mortality rates and the need for greater standardization and professionalization of midwifery education.

The Illinois Medical Practice Act of 1877 was one of the earliest examples of state-level medical licensing and regulation in the United States. This act made a basic model for regulating midwifery in the state. The midwives were required to pass an evaluation regarding their knowledge of anatomy, physiology, and hygiene and get licensed by the state's Board of Health. It also required midwives to report cases of infectious disease to the Board of Health (Goebel, 1994). This act set a precedent for similar laws in other states and helped establish modern medical licensure and regulation systems. By 1900, similar laws were passed by seven other states in an attempt to solve the "midwife problems." These included Connecticut, Indiana, Louisiana, Minnesota, New

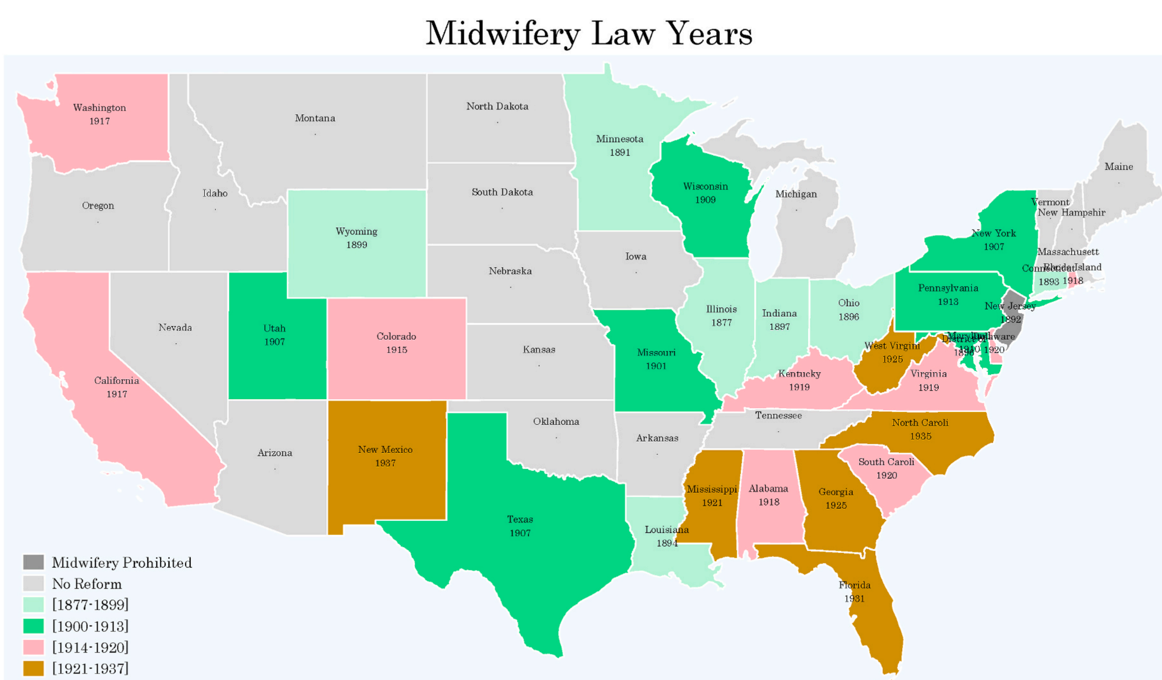

Fig. 1. Geographic distribution of midwifery laws across states.

Jersey, Ohio, and Wyoming (Rude, 1923). Between 1900 and 1920, sixteen states passed laws necessitating the licensure of midwives, under increasing pressure from public health officials and medical profession members, to address this problem (Kobrin). At the same time, at least 12 municipalities (including Los Angeles and New York City) implemented ordinances requiring practicing midwives to obtain a license, certificate, or permit (Van Blarcom, 1913). As public health concerns regarding midwifery practices rose, there was escalating pressure on authorities to regulate the market of midwifery professionals. Therefore, 8 more states joined the movement between 1920 and 1940. Fig. 1 shows states and years of midwifery law adoption.

The laws surrounding midwives were not unified across states. For instance, under the California Midwifery Act of 1917, midwives were required to train through a program covering anatomy, physiology, obstetrics, and hygiene topics. In addition, midwives were required to pass an exam to demonstrate their knowledge and skills in these areas. The 1907 midwifery law of New York established minimum age requirements for midwifery licensure applicants. In addition, midwives had to attend at least 20 supervised deliveries in order to acquire a license. While the law in Washington (1917) required applicants to attend 14 months of training from a state-recognized midwifery school. Further, according to Mississippi midwifery law, passing an exam and going through formal training was unnecessary. Instead, they were judged based on their character, cleanliness, intelligence, and "reputation for calling a doctor in difficult or abnormal cases" (Mississippi Board of Health, 1921). Even in states such as North Carolina, in which licensure was not demanded until 1935, midwives had to wash their hands before touching a patient. They also prohibited women who were addicted to drugs or alcohol from the practice of midwifery (Van Blarcom, 1913). In spite of these discrepancies, licensing requirements changed over time, and new provisions were added to these midwifery laws, which changed several aspects of these laws to a more standardized one. These included formal education, training, and knowledge.

2.2. Literature review

There are various channels through which midwifery quality improvements under state-level regulation and licensing mandates could affect later-life health and disability outcomes. In this section, we review these channels and relevant studies.

The first channel relates to midwives providing more services than just birth attendance. Midwives regularly check on the pregnant mother to monitor their health and the fetus's health, advise mothers on healthy nutrition and safe exercises, and offer emotional and psychological support throughout their pregnancy (LoewenbergWeisband; Rooks, 1999). These prenatal care services have several positive benefits for birth outcomes and infants' health (Camacho and Conover, 2013; Carrillo, 2020; Cesur et al., 2017). Improvements in fetal conditions and infants' health will, in turn, positively affect life-cycle outcomes (Cook and Fletcher, 2015; Figlio et al., 2014; Fletcher, 2011b; Maruyama and Heinesen, 2020; Noghanibehambari and Fletcher, 2023b, 2023d; Noghanibehambari and Noghani, 2023; Pehkonen et al., 2021). Based on theories in medical literature, such as the Fetal Development Hypothesis and the Developmental Origins of Adult Health and Disease, fetal exposures and in-utero conditions can predict the onset of a series of adult chronic diseases and influence a battery of physical and mental health outcomes later in life (Almond and Currie, 2011; Barker, 1990, 1992b, 1992a, 1994, 1995, 1997; Barker et al., 1993, 2002; Cunha and Heckman, 2007; Godfrey and Barker, 2000). A relatively large and growing empirical evidence documented the direct link between initial health endowment and later-life health outcomes. For instance, Roseboom et al. (2001) examined the impact of fetal exposure to the Dutch famine of 1944-45 on later-life health outcomes. They showed that exposed individuals have lower glucose tolerance, higher risks of coronary heart diseases, higher atherogenic lipid profile, and higher mortality risks. Goodman-Bacon (2021b) showed that the exposure to the introduction of Medicaid during the 1960s, which increased healthcare access among the disadvantaged population, was associated with reductions in later-life mortality and increased educational attainments and earnings. Maruyama and Heinesen (2020) showed that additional birth weight, an important marker for health at birth, is associated with reductions in cerebral palsy during adulthood. Fletcher (2011a) documented that low birth weight is associated with large increases in learning disability and Attention-Deficit Hyperactivity Disorder (ADHD) among children. Hossin et al. (2021) documented a positive association between the incidence of low birth weight and later-life Ischemic Heart Disease (IHD). Behrman and Rosenzweig (2004) found that increases in birth weight are associated with increases in height, education, and income during adulthood. Black et al. (2007) documented that increases in birth weight result in reductions in infant mortality, and improvements in adult height, Body Mass Index (BMI), education, and earnings. One mediatory channel that these studies suggest is reductions in disability through increases in education. Higher educational attainment has been associated with lower disability for Europeans (e.g., Krokstad and Westin (2004)) as well as for Americans (e.g., Clarke et al. (2009) and Freedman et al. (2008)).

Second, midwifery quality improvement under the new regime enhances the quality of birth delivery and thus result in improvements in postnatal care. The early days and weeks of life are essential for children's initial health endowment that can be detected in their later-life outcomes in several ways. Firstly, the early-life hygiene environment is an important factor in the development of the immune system. Gensollen et al. (2016) investigated how disturbances in the colonization of the microbiota during early life can affect immune function and the potential long-term health implications of these disruptions. The authors emphasized the significance of microbiota colonization in early life, as it influences the formation and operation of the immune system. They proposed that the interaction between the immune system and microbiota is vital for establishing immune tolerance and safeguarding against future pathogenic infections. Secondly, healthier delivery and better early-life care are associated with improved neurocognitive development improvements (McCauley et al., 2022; Vogel et al., 2020). These improvements in early-life conditions (as a result of improvements in midwifery postnatal care services) may affect later-life outcomes, including health, disease, education, and labor market outcomes (Case et al., 2005; Case and Paxson, 2009, 2010; Cunha and Heckman, 2007; Smith, 2009a, 2009b).

The third channel considers the influence of midwifery laws on maternal mortality. For instance, Anderson et al. (2020) documented that the establishment of midwifery laws across US states in the early decades of the 20th century was associated with reductions in maternal mortality rates. Homer et al. (2014) argued that improving midwifery access and quality of service could reduce maternal, neonatal, and fetal deaths. Specifically, they estimated that maternal and neonatal deaths could decrease by up to 60 percent as a result of improving midwifery in countries with the lowest Human Development Index. Empirical research supports these claims. Ten Hoope-Bender et al., 2014 showed that the midwifery package of support and care is an efficient and effective way to optimize normal reproductive processes and improve health and psychosocial outcomes. Law and Kim (2005) found a statistically significant association between restricting licensure of physicians and maternal mortality. On the other end, several studies documented an association between childhood exposure to parental death and later-life outcomes, including cognitive development, emotional development, and later-life physical and mental health outcomes (Case and Ardington, 2006; Luecken, 2014; Luecken & Roubinov, 2012; Rostila and Saarela, 2011; Zubrick et al., 2011). For example, Zubrick et al. (2011) showed that maternal death during childhood was associated with a higher risk of substance abuse, contemplating suicide, and attempting suicide. In another study, Zhou et al. (2016) found that children who lost their mothers were more prone to delinquency in school and more likely to drop out of school. Also, these children were at

Table 1
Summary statistics.

Variables	Observations	Mean	SD
Female	40910526	0.53069	0.49906
White	40910526	0.88356	0.32075
Black	40910526	0.0983	0.29772
Exposure	40910526	0.65547	0.47522
Birth Year	40910526	1932.1927	18.33704
Socioeconomic Index	29575768	41.41911	23.62816
Occupational Income Score	29575768	26.78737	9.9167
Is House Owner	40004719	0.73626	0.44066
Years of Schooling	21296149	10.87141	3.96714
Education < High School	40910526	0.17881	0.38319
Education <12 Years	40910526	0.31895	0.46607
Is Employed	40910526	0.5657	0.49567
Log Household Income	29296141	10.81552	0.88732
Log Wage Income	23400859	10.11796	1.12698
Log Welfare Income	1259044	8.11847	1.25547
Disability Outcomes:	31987602	0.16455	0.37077
Work Disability	8773874	0.07381	0.26146
Cognitive Difficulty	8773874	0.17441	0.37946
Ambulatory difficulty	19614377	0.09467	0.29276
Independent Living Difficulty	19614377	0.06389	0.24456
Self-care Difficulty	8773874	0.07361	0.26113
Vision or Hearing Difficulty	21296149	0.00259	0.05079
Is in Mental Institution	24706854	0.00255	0.05048

Notes. The data is from decennial censuses that cover the years 1960–2000 for cohorts born between 1870 and 1960 with at least 22 years of age.

higher risk of death, abandonment, and malnutrition.

Studies that directly examine the effects of midwifery laws on long-term outcomes are limited. An exception is the recent study of Noghanibehambari and Fletcher (2023c) that examine the effects of exposure to midwifery laws during in-utero and early-life on old-age longevity. They find significant increases in longevity and improvements in several measures of education and socioeconomic outcomes.

We should note that the impacts of occupational licensing are not always beneficial for consumers. Previous research on occupational licensing has primarily focused on the consequences of licensing for the providers and on the effects of these programs on market equilibrium (Federman; Fillmore et al., 2020; Kleiner, 2000, 2017; Kleiner and Krueger, 2010, 2013; Kleiner and Kudrle, 2000; Maurizi, 1974; McMichael, 2017; Pashigian, 1979; Timmons and Mills, 2018). For instance, scholars have looked at the changes in dental health and dental service prices as a result of licensing strictness. Using dental records of Air Force enlistees, Kleiner and Kudrle (2000) examined this relationship and found that as the licensing strictness increased, so did dental service prices and practitioners' earnings. However, dental health outcomes did not change. In another research, Wing and Marier (2014) found that by broadening scope of practice of dental hygienists, the cost of basic dental services was lowered while there was an increase to the usage of these services. These regulations may benefit consumers by reducing allocative inefficiencies created by information asymmetries in some service and labor markets (Arrow, 1965; Kleiner, 2000).

3. Econometric method

The empirical method exploits state-year variations in the establishment of midwifery law changes. Specifically, we utilize a panel data fixed effect model as follows:

$$y_{ibryst} = \alpha_0 + \alpha_1 EXP_{bry} + \alpha_2 X_i + \eta_{bs} + \zeta_{ry} + \xi_{st} + \varepsilon_{ibryst} \quad (1)$$

Where y is the outcome of individual i who was born in birth-state b region-of-birth r in birth-year y who, at the time of the census, resides in state s and is observed in census-year t. The variable EXP is a dummy that equals one if the person is born in a state that has established a midwifery law and zero otherwise. In X, we include controls for individual gender, race, and ethnicity. Birth-state and current-state fixed effects absorb place-specific time-invariant characteristics. To control for cross-state migration caused by exposure to midwifery laws, we

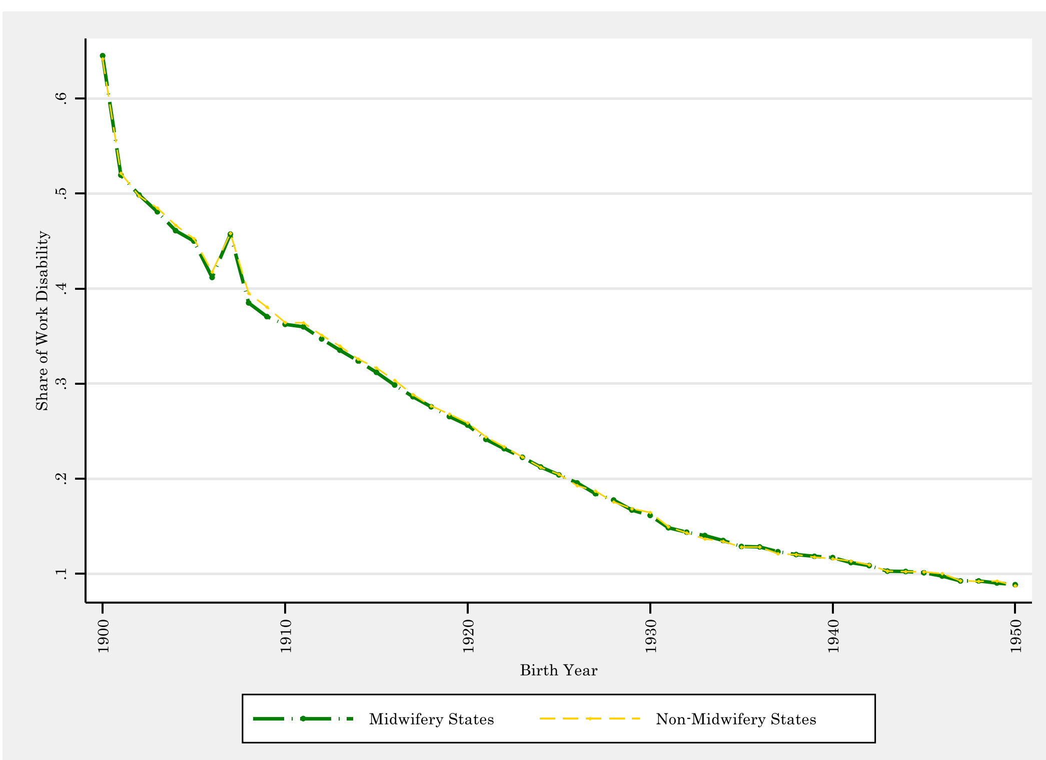

Fig. 2. Evolution of share of work disability across birth cohorts.

Table 2
Balancing tests: Association between exposure to midwifery laws and observable individual characteristics.

	Outcomes:				
	Female	White	Black	Other Race	Hispanic
	(1)	(2)	(3)	(4)	(5)
Exposure	−0.0004	0.00035	−0.001	0.00065*	0.00024
	(0.00113)	(0.00109)	(0.001)	(0.00035)	(0.00049)
Observations	40910526	40910526	40910526	40910526	40910526
R-squared	0.0056	0.21536	0.2282	0.17428	0.16167
Mean DV	0.529	0.879	0.103	0.018	0.026
%Change	−0.076	0.040	−0.971	3.613	0.922

Standard errors, clustered on birth-state, are in parentheses. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. All regressions are weighted using IPUMS-provided personal weights.
***p < 0.01, **p < 0.05, *p < 0.1.

interact birth-state and current-state fixed effects (represented by η). Therefore, the variation comes from comparing within-group of migrants and stayers, separately. Moreover, we include region-by-birth-year fixed effects (ζ) to absorb secular changes in disability across cohorts that may converge/diverge over different regions. In Appendix Table A-5, we show the main results across more parsimonious models and slightly add stricter set of fixed effects. We find that the inclusion of region-cohort fixed effects is the main set of fixed effects that affect the magnitude of coefficients and suggest the importance of these controls to account for potential confounders.

Further, since our main source of variation is at the birth-state-year level, we attempt to isolate those variations from other contemporaneous confounders by adding current-state-by-current-year fixed effects (ξ). These fixed effects absorb all current state-level policy exposures and other sociodemographic and socioeconomic differences that may affect the early-life exposure impacts. Finally, ε is a disturbance term. All regressions are weighted using personal weights provided by the census. We cluster standard errors at the birth-state level to account for serial correlation in error terms.

In the main results of the paper, we use Ordinary Least Square (OLS) estimation strategy. However, recent innovations in difference-in-difference suggest that OLS-produced coefficients might be biased in a staggered adoption setting (Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021a). In Appendix A, we show that the results are robust and similar if we use Sun and Abraham (2021)'s estimation strategy.

4. Data and sample selection

We employ decennial census data for the years 1970–2000, extracted from Ruggles et al. (2020). We pool all available random samples to boost the sample size. Specifically, we use 7 % random sample of 1970, 9 % random sample of 1980, 9 % random sample of 1990, and 8 % random sample of 2000 censuses. There are three benefits in using this data. First, it contains birth-state and birth-year variables, necessary information in our setting. Second, it contains several measures of physical and mental disability, including work disability, various measures of physical difficulties, and whether the individual is hospitalized in a mental institution. Third, it contains millions of observations, adding power to our statistical tests and allowing for further heterogeneity analyses. Moreover, we employ the midwifery law database extracted from Anderson et al. (2020). We merge the census sample with this database based on individuals' birth-state and birth-year.

Since our primary focus is to explore the impacts during adulthood and old age, we exclude all individuals below age 22. Further, we restrict the sample to those born between 1870 and 1950 to have several cohorts exposed and unexposed to the midwifery laws. Moreover, we remove those born in New Jersey, as midwifery was prohibited in this state in 1892.

Summary statistics of the final sample are reported in Table 1. Roughly 53 percent of the observations are female, with whites and Blacks account for 88.4 and 9.8 percent of the sample, respectively.

Table 3
Exploring endogenous policy change: Association between midwifery laws and other state-level policy and sociodemographic characteristics.

	Outcomes:						
	Birth Registration Law	Child Labor Law	Compulsory Attendance Law	Standardized Per Capita Health Department	Standardized Per Capita Physicians	Standardized Per Capita Nurse	Standardized Per Capita Midwives
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Midwifery Law (1/0)	0.00769	−0.00344	0.00225	−0.00907	0.01024	−0.00368	−0.00472
	(0.00478)	(0.00271)	(0.00236)	(0.00946)	(0.00945)	(0.00274)	(0.00309)
Observations	3861	3861	3861	1488	1488	3861	3861
R-squared	0.77853	0.53494	0.81849	0.56376	0.9328	0.97176	0.90066
	Standardized Share of Whites	Standardized Share of Blacks	Standardized Share of Hispanics	Standardized Share of Females	Standardized Share of Immigrants	Standardized Share of Literate	Standardized Labor Force Participation Rate
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Midwifery Law (1/0)	0.00027	−0.00042	0.00141	−0.00116	−0.00099	0.00051	0.00017
	(0.00113)	(0.0011)	(0.001)	(0.00115)	(0.00291)	(0.0008)	(0.0003)
Observations	3861	3861	3861	3861	3861	3861	3858
R-squared	0.99306	0.9935	0.84679	0.90915	0.9712	0.99612	0.999
	Standardized Share of White-Collar Occupations	Standardized Share of Farmers	Standardized Share of Other Occupation	Standardized Socioeconomic Index	Standardized Occupational Income Score	Standardized Per Capita Property Value	Standardized Homeownership Rate
	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Midwifery Law (1/0)	0.00037	−0.00198	0.00204	0.00057	0.00019	0.00282	−0.00083
	(0.00407)	(0.0021)	(0.00233)	(0.00144)	(0.0014)	(0.01125)	(0.00162)
Observations	3861	3861	3861	3861	3861	1488	3861
R-squared	0.95505	0.97527	0.97145	0.98851	0.99191	0.89468	0.9734

Standard errors, clustered on state, are in parentheses. Regressions include state fixed effects and year-by-census-region fixed effects. All regressions are weighted using state population.
***p < 0.01, **p < 0.05, *p < 0.1.

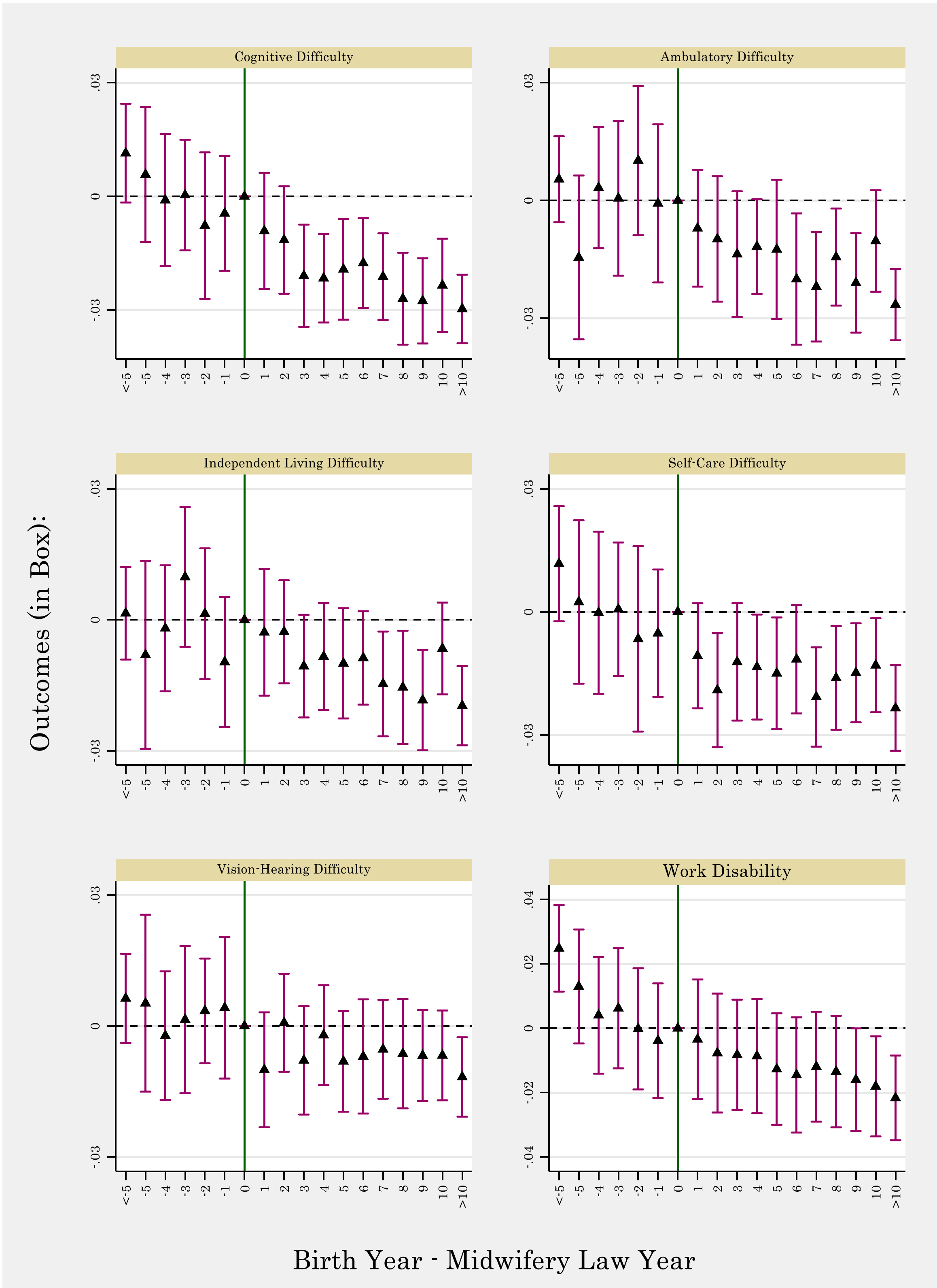

Fig. 3. Event study results to examine the impacts of midwifery policies on later-life disability.
Notes. Standard errors are clustered on birth-state. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. Regressions also include gender, race, and ethnicity dummies. All regressions are weighted using IPUMS-provided personal weights.

Table 4
Main results: Early-life exposure to midwifery laws and later-life disability.

	Outcomes:						
	Work Disability	Cognitive Difficulty	Ambulatory difficulty	Independent Living Difficulty	Self-care Difficulty	Vision or Hearing Difficulty	Is in Mental Institution
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Exposure	−0.00499***	−0.00682***	−0.00612**	−0.00356***	−0.00203*	−0.001	−0.00027***
	(0.00123)	(0.00216)	(0.00269)	(0.00122)	(0.00115)	(0.00211)	(0.00008)
Observations	31987602	8773872	8773872	19614377	19614377	8773872	21296149
R-squared	0.10175	0.05655	0.10897	0.12775	0.08538	0.08712	0.00232
Mean DV	0.158	0.071	0.170	0.092	0.062	0.072	0.003
%Change	−3.155	−9.599	−3.602	−3.869	−3.272	−1.387	−9.050

Standard errors, clustered on birth-state, are in parentheses. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. Regressions also include gender, race, and ethnicity dummies. All regressions are weighted using IPUMS-provided personal weights.
***p < 0.01, **p < 0.05, *p < 0.1.

Table 5
– Other outcomes: Early-life exposure to midwifery laws and later-life socioeconomic outcomes.

	Outcomes:				
	Socioeconomic Index	Occupational Income Score	House Owner	Years of Schooling	Education < High School
	(1)	(2)	(3)	(4)	(5)
Exposure	0.25056***	0.07951***	0.00478***	0.07734***	−0.02483***
	(0.06446)	(0.02257)	(0.00113)	(0.01464)	(0.00246)
Observations	29575754	29575754	40004719	21296149	40910526
R-squared	0.09208	0.13108	0.1689	0.39079	0.293
Mean DV	41.875	26.898	0.719	10.746	0.179
%Change	0.598	0.296	0.665	0.720	−13.873
	Education <12 Years of Schooling (6)	Is Employed (7)	Log Household Income (8)	Log Wage Income (9)	Log Welfare Income (10)
Exposure	−0.01142***	0.0008	0.0058**	0.01537***	−0.01745**
	(0.00207)	(0.00108)	(0.00282)	(0.00385)	(0.00708)
Observations	40910526	40910526	29296141	23400852	1258864
R-squared	0.26409	0.25387	0.15324	0.17633	0.09662
Mean DV	0.318	0.574	10.840	10.147	8.134
%Change	−3.591	0.139	0.053	0.151	−0.215

Standard errors, clustered on birth-state, are in parentheses. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. Regressions also include gender, race, and ethnicity dummies. All regressions are weighted using IPUMS-provided personal weights.
***p < 0.01, **p < 0.05, *p < 0.1.

Approximately 65.2 percent of observations are born in state-years with an established midwifery law. The average years of completed education is 10.9 years and 32 percent have less than 12 years of education.

Our primary outcomes of interest are reported in the bottom panel of Table 1. The definition of these outcomes is as follows. The first outcome is *work disability* that indicates if the participants suffer from any persistent physical or mental health ailment that hinders their work performance, restricts the nature or extent of their work, or entirely prevents them from engaging in work. In the final sample, about 16.3 percent of individuals reported having a work disability. Further, Fig. 2 illustrates the evolution of work disability across cohorts born between 1900 and 1950 who were born in a midwifery state (green) and non-midwifery state (yellow). We observe a very similar trend across cohorts in both group of states.

The next outcome variable is *ambulatory difficulty* which is a dummy that indicates if the individual has a condition that significantly restricts one or more fundamental physical activities, such as walking, climbing stairs, reaching, lifting, or carrying. The variable *independent living difficulty* is a dummy that indicates if the individual has a physical, mental, or emotional condition that persists for six months or longer and impairs their ability to carry out fundamental tasks alone outside their residence. *Self-care difficulty* is a dummy that equals one if the individual has a physical or mental health condition that endures for at least six months and obstructs their ability to attend to their personal needs, such as bathing, dressing, or moving around within their residence. *Vision-hearing difficulty* is a dummy indicating that the individual has a long-lasting condition of blindness, deafness, or a severe vision or hearing impairment. Finally, the census reports whether individuals reside in institutional group quarters or not. For those residing in institutions, the census also reports the type of institution, e.g., correctional institutions and mental institutions. We should note that the distinction between different institutions is available only in 1970–1980 in our final sample. For later years, census aggregates all institutionalized people into one category. We employ census 1970–1980 and use this information to construct a dummy that indicates whether or not an individual resides in a mental institution, a proxy for severe mental health issues. On average, 0.25 percent of individuals reside in mental institutions in the final sample.

5. Results

5.1. Endogeneity issues

One concern in interpreting the coefficients of equation (1) is the change in the composition of births due to midwifery laws. This compositional change could be the results of endogenous inflow/outflow of migration or the decision of parents to have children that are influenced by midwifery law changes. For instance, if white individuals are more likely to give birth under the new midwifery regime, our coefficients over-state the true effects as whites have, on average, lower disability rates for unobserved reasons. We can empirically test this by regressing several observable characteristics on *exposure* measure, conditional on the full set of fixed effects in equation (1). The results are reported in Table 2. We do not find a significant association between observable features (i.e., gender, race, and ethnicity) and exposure to midwifery laws. The coefficients for most outcomes are statistically insignificant, and the implied percentage changes with respect to the mean of the outcomes are very small. For instance, exposure is associated with a 3.5 basis-points increase in the share of whites, which corresponds to approximately a 0.04 percent increase from the outcome's mean. The only anomaly is regarding the coefficient of other races, which is significant at 10 percent level.

Another concern is the changes in other state-level sociodemographic and socioeconomic characteristics and other state-level policy changes that may confound the midwifery effects on infants' health outcomes and can be detected in later-life disability outcomes. We employ several historical datasets to empirically test for this source of endogeneity. In the analyses of this section, we construct a state-year panel dataset for the years 1880–1950 to have similar years as the cohorts in the final sample of the paper. Moreover, we include state and region-year fixed effects to have a similar model to our main analyses. We then regress various policy measures and state characteristics on a dummy variable that indicates the state has enacted a midwifery law. The results are reported in Table 3.

In column 1, we explore the association between midwifery and birth registration laws as studies suggest the association between these laws for later-life outcomes (Fagernäs; Noghanibehambari and Fletcher, 2023a). These laws indicate whether the state has established a universal birth registration or not. In column 2, we build a dummy that indicates an age restriction of 14 per state child labor law. In column 3, we use a dummy that indicates a compulsory schooling law of 8 years, per state law. The rationale to examine the effects on these laws stem from their long-term effects on various social and health outcomes (Fletcher, 2015; Lleras-Muney, 2005; Mazumder, 2008). In all cases, we do not find a statistical association between midwifery laws and birth registration, child labor, and compulsory schooling laws.

During this period, many counties experienced expansions in healthcare access. For instance, there were sharp rises in openings of County Health Departments (CHD) and increases in medical staff, nurses, and physicians, which benefited local health outcomes (Hoehn-Velasco, 2018, 2021). In columns 4–6, we examine the association between these expansions and state-level per capita CHD, physicians, and nurses. The results do not provide a statistically significant association. In column 7, we examine the effect of laws on supply of midwives. Although the coefficient is negative, it remains small and insignificant.

Next, we use historical full-count censuses over the years 1880–1940 and 1 % random sample of 1950 to construct a state-year panel of sociodemographic characteristics. In columns 8–12, we find no discernible changes in the share of whites, blacks, Hispanics, females, and immigrants. In column 13, we find no association with literacy rates. In columns 14–19, we focus on various measures of labor force outcomes, including labor force participation rate, share of different occupations, and socioeconomic scores. In columns 20–21, we focus on measures of wealth, including property value and homeownership. In virtually all cases, the associations are statistically and economically insignificant.

5.2. Main results

Before presenting the main results of equation (1), we implement a series of event study analyses to examine the changes in disability outcomes for cohorts born in different years relative to midwifery laws in reform versus non-reform states. These event studies include the same set of fixed effects and controls as discussed in equation (1). The results are reported in panels of Fig. 3. Across panels and outcomes, we do not observe significant pre-trend coefficients for several periods prior to the state-specific law change. These results further lend to our parallel trend assumption by providing evidence of no preexisting trend in disability outcomes. However, for most outcomes, the post-trend coefficients reveal significant reductions in disability.

The main results of the paper are reported in Table 4. We observe reductions for various measures of disability. The effects are, in most cases, statistically significant. The implied percentage changes of the effects with respect to the mean of outcomes are reported in the last row and suggest economically meaningful changes. For instance, exposure to midwifery law at birth is associated with a reduction of roughly 3.2 percent in work disability, 9.6 percent in cognitive difficulty, and 3.6 percent in ambulatory difficulty later in life. We also observe a 9 percent reduction in the likelihood of being in a mental institution (column 7).

We should point to a caution in interpreting the main results of work disability due to changes in questionnaire text across years. For instance, in 2000, the questionnaire asks, "Because of a physical, mental, or emotional condition lasting 6 months or more, does this person have any difficulty in doing any of the following activities: Working at a job or business?". In 1970 census, the question is as follows "Does this person have a health or physical condition which limits the kind or amount of work he can do at a job?". The different question text may result in different perception of the question and results in inconsistent responses. In Appendix Table A-6, we examine the effects across different census years and find relatively stable coefficients.

In the year 2000, 10.5 percent of people reported having some work disability. Using the results of column 1 of Table 4, a back-of-an-envelope calculation suggests a reduction of about 874,000 incidences of work disability if all states had established a midwifery law in the early decades of the 20th century. The Social Security Disability Insurance paid an average per-person monthly benefit of $700, or a full year of $8400 in 2000 dollars (Martin et al., 2001). Based on Annual Social and Economic Supplement (ASEC) of the Current Population Survey for the year 2000, about 7.8 percent of people who are disable receive disability benefit. Therefore, of 874,000 people who could have avoided disability, roughly 68,636 persons receive the disability benefits. The social saving could add up to about $576M in 2000 dollars.

Moreover, assuming that the disability limits their labor force participation, these individuals are losing the potential gains from employment. Using an employment rate of 95 percent and an average income of $31,200 (U.S. Census Bureau, 2023), we can calculate a per-person loss of income of about $29,640 in 2000 dollars. Using the number of avoided incidences in the counterfactual world (874,000) and income gain (29,640), we reach an annual increase in total income of $25.9B for early-life exposure to midwifery laws. However, we should note that this back-of-an-envelope calculation likely over-state the true costs as the population most likely affected by midwifery laws are low socioeconomic status families with lower than average income.

5.3. Other related outcomes

Health status and disability are tightly connected to other socioeconomic measures such as education and income (Hessel et al., 2020; Matthews et al., 2005). Therefore, one expects to observe differences in socioeconomic measures due to exposure to midwifery in the same direction as the effects on disability. In Table 5, we explore the effects on several individual measures of education, wealth, and socioeconomic standing. In columns 1–2, we observe increases in the socioeconomic index and occupational income score. We also observe small rises in the probability of being a house owner (column 3).

In columns 4–6, we examine the impacts on educational outcomes. We observe an increase of 0.07 years of schooling. However, this effect is larger for those people at the lower tails of educational distribution. For instance, exposure is associated with 2.4 and 1.1 percentage-points reduction in the likelihood of having less than a high school education and less than 12 years of education, respectively. These effects represent a change of 13.8 and 3.6 percent with respect to the mean of outcomes.

We do not find an effect on the probability of being employed (column 7). We observe increases in household and personal income of about 0.6 and 1.5 percent, respectively (columns 8–9). Finally, we observe a reduction in welfare income (column 10). This is expected as reductions in disability decrease the probability of claims for Social Security programs such as Disability Insurance.

Overall, Table 5 implies improvements in adulthood education and socioeconomic status. We argue that these could be potential mediatory channels of impact as several studies provide empirical evidence of associations between disability and education, socioeconomic measures, and occupational choice (Bowen, 2009; Freedman et al., 2008; KC & Lentzner, 2010; Mandemakers and Monden, 2010; Michaud and Wiczer, 2018; Tremblay et al., 2010).

6. Conclusion

A rapidly growing literature in different fields examines the role of early-life exposures on later-life outcomes. These studies suggest that exposures during in-utero and early-life that affect the initial health endowment of infants may change the trajectory of their outcomes during adulthood and old age (Godfrey and Barker, 2000; Schmitz and Duque, 2022; Thompson, 2017). Our paper added to this literature by evaluating the long-run impacts of early-life exposure to midwifery reforms on disability later in life. The midwifery laws aimed at improving midwives' knowledge, training, and service quality provide a unique setting for two reasons. First, midwives provide prenatal care services such as nutrition advice, hence adding to the in-utero benefits of midwifery quality improvements. Further, midwives also facilitate the hygiene of infants during their first days, which is an important contributor to the immune system for later-life diseases (Gensollen). Second, the state of the midwifery market and general socioeconomic conditions in the early decades of the 20th century mirror the current developmental stage of many developing countries. As a result, our findings could offer valuable insights for regulating the midwifery market in these countries.

We implement a difference-in-difference strategy and find that being born in reformed states is associated with significant reductions in disability later in life. The largest effects appear to be related to mental health outcomes (cognitive difficulty and hospitalization in mental health institutions). We also find significant improvements in socioeconomic scores, educational outcomes, and income. We extensively discussed the relatively large economic gains due to reductions in disability as a result of exposure to midwifery laws decades earlier in life. These findings add to our understanding of the potential long-run externalities of midwifery laws and, more generally, the relevance of prenatal and early-life hygiene environments.

Appendix A

Recent innovations in difference-in-difference provided insight as to the issues of ordinary least square estimations in staggered adoption settings (Baker et al., 2022; Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021a). In this appendix, we use the method developed by Sun and Abraham (2021) and re-estimate the main results of the paper. These estimates are reported in Appendix Table A-1. We find quite similar effects as the main results suggesting that the OLS-induced coefficients are not biased.

Moreover, the OLS estimates in a staggered adoption setting compares early-adopter states with late-adopter states and vice versa. This means that already treated states join the control groups for the later adopter states. To partly avoid this issue, we remove states that passed a law prior to 1900 and re-estimate the regressions. These results are reported in Appendix Table A-2. The estimated effects are quite comparable to those of Table 4.

In Table 5, we examined the impacts across alternative outcomes that could operate as potential pathways. However, their sample sizes are different since many observations contain missing values for those outcomes. In Appendix Table A-3, we limit the sample to observations that have non-missing values for socioeconomic index. We observe smaller coefficients compared to those of Table 4. The effects become statistically insignificant for columns 3–7. One explanation is that those who are post-retirement ages or out of the labor force (probably because of disability) are more likely to not report income and occupation, hence measures of socioeconomic and occupational score. Therefore, this limitation may indeed exclude individuals in the control group, and result in underestimation of effects.

To further examine the robustness of the results, we limit the sample to cohorts born within a 10-year window of the state-specific midwifery law. This selection limits the concern that the effects pick up on the overall reduction in disability rate across cohorts with differential trend in midwifery versus non-midwifery law states. The results are reported in Appendix Table A-4. We observe comparable coefficients to the main results.

In Appendix Table A-5, we examine the results across more parsimonious models. In panel A, we report the regressions that only include birth-state and birth-year fixed effects. We observe coefficients that are substantially larger than those of Table 4. In Panel B, we add region-cohort fixed effects. The coefficients drop in magnitude suggesting that region differences in cohorts' evolution of health outcome is an important factor in our regressions. Hence, we include this in all regressions throughout the paper. However, we observe a very robust point estimates as we add more restrictive sets of fixed effects in panel C through E.

As discussed in section 5.2, the census questionnaire changed slightly over the years regarding work disability. For instance, in 1980, it asks "Does this person have a physical, mental, or other health condition which has lasted for 6 or more months and which prevents this person from working at a job?" while in 1970 asks "Does this person have a health or physical condition which limits the kind or amount of work he can do at a job?". While we acknowledge this issue and exercise caution in interpreting the main results, we examine the effects on work disability in each census separately. These results are reported in Appendix Table A-6. The coefficients for 1970, 1990, and 2000 are almost identical. However, the effect for 1980 census is larger, suggesting a 71 basis-points reduction in contrast with roughly 40–50 basis-points reduction of other census years.

Appendix Table A-1
Robustness of the results to using Sun-Abraham estimates

	Outcomes:						
	Work Disability	Cognitive Difficulty	Ambulatory difficulty	Independent Living Difficulty	Self-care Difficulty	Vision or Hearing Difficulty	Is in Mental Institution
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Exposure	−0.00457***	−0.00682***	−0.00612**	−0.00328***	−0.00232**	−0.001	−0.0002**
	(0.0012)	(0.00216)	(0.00269)	(0.00119)	(0.00115)	(0.00211)	(0.00009)
Observations	31987602	8773872	8773872	19614377	19614377	8773872	21296149
R-squared	0.10145	0.05655	0.10897	0.12757	0.08529	0.08712	0.00215
Mean DV	0.158	0.071	0.170	0.092	0.062	0.072	0.003
%Change	−2.893	−9.599	−3.602	−3.564	−3.735	−1.387	−6.512

Standard errors, clustered on birth-state, are in parentheses. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. Regressions also include gender, race, and ethnicity dummies. All regressions are weighted using IPUMS-provided personal weights.
***p < 0.01, **p < 0.05, *p < 0.1.

Appendix Table A-2
Robustness of the results to exclusion of states with a midwifery law prior to 1900

	Outcomes:						
	Work Disability	Cognitive Difficulty	Ambulatory difficulty	Independent Living Difficulty	Self-care Difficulty	Vision or Hearing Difficulty	Is in Mental Institution
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Exposure	−0.0044***	−0.00622***	−0.00631**	−0.00399***	−0.00258**	0.00004	−0.00039***
	(0.00132)	(0.00214)	(0.00276)	(0.00126)	(0.00112)	(0.00215)	(0.00009)
Observations	25011029	6857309	6857309	15324598	15324598	6857309	16660675
R-squared	0.10306	0.05759	0.1088	0.12754	0.08559	0.08752	0.00237
Mean DV	0.162	0.073	0.175	0.094	0.063	0.074	0.003
%Change	−2.715	−8.516	−3.603	−4.243	−4.096	0.057	−13.119

Standard errors, clustered on birth-state, are in parentheses. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. Regressions also include gender, race, and ethnicity dummies. All regressions are weighted using IPUMS-provided personal weights.
***p < 0.01, **p < 0.05, *p < 0.1.

Appendix Table A-3
Limiting the sample to observations with non-missing values for socioeconomic measures

	Outcomes:						
	Work Disability	Cognitive Difficulty	Ambulatory difficulty	Independent Living Difficulty	Self-care Difficulty	Vision or Hearing Difficulty	Is in Mental Institution
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Exposure	−0.0033***	−0.0072***	−0.00677	−0.00178	−0.0013	0.00123	−0.00004
	(0.00119)	(0.00272)	(0.00476)	(0.00123)	(0.00129)	(0.00391)	(0.00004)
Observations	23066091	5937720	5937720	13536901	13536901	5937720	16038852
R-squared	0.03688	0.01542	0.03933	0.03472	0.0234	0.03224	0.00074
Mean DV	0.097	0.033	0.088	0.037	0.026	0.037	0.001
%Change	−3.397	−21.805	−7.697	−4.798	−5.017	3.322	−3.709

Standard errors, clustered on birth-state, are in parentheses. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. Regressions also include gender, race, and ethnicity dummies. All regressions are weighted using IPUMS-provided personal weights.
***p < 0.01, **p < 0.05, *p < 0.1.

Appendix Table A-4
Limiting the sample to cohorts in a 10-year distance from law change

	Outcomes:						
	Work Disability	Cognitive Difficulty	Ambulatory difficulty	Independent Living Difficulty	Self-care Difficulty	Vision or Hearing Difficulty	Is in Mental Institution
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Exposure	−0.00531***	−0.00802**	−0.01319***	−0.00399*	−0.00235	−0.00406	−0.00039**
	(0.00161)	(0.00371)	(0.00502)	(0.00208)	(0.00202)	(0.00387)	(0.00016)
Observations	7768328	2111959	2111959	4742742	4742742	2111959	5251956
R-squared	0.10232	0.06004	0.11136	0.12933	0.08677	0.09058	0.0032
Mean DV	0.160	0.071	0.173	0.094	0.063	0.074	0.003
%Change	−3.318	−11.300	−7.627	−4.243	−3.729	−5.491	−13.015

Standard errors, clustered on birth-state, are in parentheses. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. Regressions also include gender, race, and ethnicity dummies. All regressions are weighted using IPUMS-provided personal weights.
***p < 0.01, **p < 0.05, *p < 0.1.

Appendix Table A-5
Replicating the main results across more parsimonious models

	Outcomes:						
	Work Disability	Cognitive Difficulty	Ambulatory difficulty	Independent Living Difficulty	Self-care Difficulty	Vision or Hearing Difficulty	Is in Mental Institution
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Birth-State and Birth-Year FE							
Exposure	−0.02491***	−0.02986***	−0.02479***	−0.01751***	−0.01615***	−0.01268***	−0.00034***
	(0.00217)	(0.00259)	(0.00288)	(0.00154)	(0.00143)	(0.0021)	(0.00009)
Observations	31987602	8773874	8773874	19614377	19614377	8773874	21296149
R-squared	0.08706	0.05192	0.10307	0.1072	0.07985	0.08233	0.00113
Mean DV	0.158	0.071	0.170	0.092	0.062	0.072	0.003
%Change	−15.765	−42.054	−14.584	−19.037	−26.049	−17.617	−11.412
Panel B = Panel A + Birth-Region-by-Birth-Year FE							
Exposure	−0.00452***	−0.00739***	−0.00732***	−0.00386***	−0.00306***	−0.00092	−0.00021**
	(0.00119)	(0.00215)	(0.00271)	(0.00121)	(0.00116)	(0.00211)	(0.00009)
Observations	31987602	8773874	8773874	19614377	19614377	8773874	21296149
R-squared	0.08829	0.0529	0.10392	0.10784	0.08055	0.08274	0.0013
Mean DV	0.158	0.071	0.170	0.092	0.062	0.072	0.003
%Change	−2.861	−10.408	−4.306	−4.196	−4.939	−1.275	−7.002
Panel C = Panel B + Current-State-by-Current-Year FE							
Exposure	−0.00494***	−0.00718***	−0.0068**	−0.00408***	−0.00263**	−0.00073	−0.00028***
	(0.00122)	(0.00215)	(0.0027)	(0.00122)	(0.00115)	(0.0021)	(0.00008)
Observations	31987602	8773874	8773874	19614377	19614377	8773874	21296149
R-squared	0.09865	0.05333	0.10461	0.12359	0.08143	0.08314	0.0018
Mean DV	0.158	0.071	0.170	0.092	0.062	0.072	0.003
%Change	−3.126	−10.108	−3.998	−4.433	−4.236	−1.019	−9.374
Panel D = Panel C + Birth-State-by-Current-State FE							
Exposure	−0.00517***	−0.00712***	−0.00675**	−0.00394***	−0.00231**	−0.00102	−0.00027***
	(0.00123)	(0.00215)	(0.00266)	(0.00122)	(0.00114)	(0.0021)	(0.00008)
Observations	31987602	8773872	8773872	19614377	19614377	8773872	21296149
R-squared	0.09945	0.05484	0.10632	0.12453	0.0823	0.08444	0.00213
Mean DV	0.158	0.071	0.170	0.092	0.062	0.072	0.003
%Change	−3.269	−10.031	−3.970	−4.281	−3.732	−1.416	−9.102
Panel E = Panel D + Individual Covariates							
Exposure	−0.00499***	−0.00682***	−0.00612**	−0.00356***	−0.00203*	−0.001	−0.00027***
	(0.00123)	(0.00216)	(0.00269)	(0.00122)	(0.00115)	(0.00211)	(0.00008)
Observations	31987602	8773872	8773872	19614377	19614377	8773872	21296149
R-squared	0.10175	0.05655	0.10897	0.12775	0.08538	0.08712	0.00232
Mean DV	0.158	0.071	0.170	0.092	0.062	0.072	0.003
%Change	−3.155	−9.599	−3.602	−3.869	−3.272	−1.387	−9.050

Standard errors, clustered on birth-state, are in parentheses. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. Regressions also include gender, race, and ethnicity dummies. All regressions are weighted using IPUMS-provided personal weights.
***p < 0.01, **p < 0.05, *p < 0.1.

Appendix Table A-6
Exploring the robustness of effects of work disability across census years

	Outcome: Work Disability			
	Census 1970	Census 1980	Census 1990	Census 2000
	(1)	(2)	(3)	(4)
Exposure	−0.0048***	−0.00711***	−0.00404**	−0.00402*
	(0.00182)	(0.00152)	(0.00172)	(0.00243)
Observations	1769676	10603474	10840503	8773872
R-squared	0.05255	0.14703	0.13157	0.0466
Mean DV	0.120	0.152	0.180	0.154
%Change	−4.004	−4.679	−2.243	−2.611

Standard errors, clustered on birth-state, are in parentheses. Regressions include birth-state fixed effects, birth-year-by-region-of-birth fixed effects, residence-state-by-birth-state fixed effects, and current-year-by-residence-state fixed effects. Regressions also include gender, race, and ethnicity dummies. All regressions are weighted using IPUMS-provided personal weights.

Data availability

Data will be made available on request.

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