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Nurse practitioners' workforce outcomes under implementation of full practice authority

Kelli DePriest, PhD, RN^{*}, Rita D'Aoust, PhD, ACNP, ANP-BC, CNE, FAANP, FNAP, FAAN, Laura Samuel, PhD, MSN, RN, Yvonne Commodore-Mensah, PhD, MHS, RN, FAHA, FPCNA, FAAN, Ginger Hanson, PhD, MS, Eric P. Slade, PhD

Johns Hopkins University School of Nursing, Baltimore, MD

Abstract

Background: Full practice authority laws that permit nurse practitioners (NPs) to practice independently and prescribe medications may influence NPs' workforce outcomes.

Purpose: To examine whether implementation of full practice authority laws affect NP self-employment, average earnings, and likelihood of residing in a primary care health professional shortage area (HPSA).

Methods: A nationally representative U.S. sample of 9,782 NPs employed in health care during 2010 to 2018 was drawn from the American Community Survey. Difference-in-differences regression was used to estimate covariate-adjusted mean differences in NPs' workforce outcomes after full practice authority implementation.

Findings: Among full-time employed NPs, full practice authority was associated with an increased probability of residing in a HPSA (adjusted odds ratio [aOR]:2.34, 95% CI 1.14, 4.83) and with a higher mean probability of self-employment (aOR:4.97, 95% CI 1.00, 24.86).

Discussion: Full practice authority implementation improves access to primary care providers in health professional shortage areas and may increase practice ownership among NPs.

Keywords

Self-employment; health professional shortage; areas; difference-in-differences; American Community surveys; earnings

Introduction

Need for nurse practitioner (NP) primary care providers is growing in many areas of the United States (U.S.; Dall et al., 2019; US Department of Health and Human Services & Health Resources & Services Administration, 2013). Shortages of primary care medical providers are expected to worsen in the coming decade, as need for primary care providers is

^{*}Corresponding author: Kelli DePriest, Johns Hopkins University School of Nursing, 525 N Wolfe Street, Baltimore, MD. addresses: KDePriest@jhu.edu, kellidepriest@gmail.com (K. DePriest).

Supplementary materials

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expected to rapidly outstrip provider supply due largely to a projected 48% increase in the fraction of the U.S. population over age 65, increased retirement among the current physician workforce, and decreased specialization in primary care among new physicians (Dall et al., 2019, Reynolds, Jones, Chakrabarti, & Iacobucci, 2019; Knight, 2019). One recent prediction model suggests a shortfall of between 7,300 and 43,100 primary care providers by 2030 (Dall et al., 2019, Reynolds, Jones, Chakrabarti, & Iacobucci, 2019). Shortages of primary care providers are a particular concern in many rural and lower-income urban areas that have had difficulty attracting enough primary care providers (Venhuizen & Pritchard, 2017).

Full practice authority legislation for NPs may allow states to improve primary care access and quality in local areas that have difficulty attracting and retaining sufficient numbers of primary care providers (Davis et al., 2018; Federal Trade Commission, 2014; Xue et al., 2018). NPs deliver safe, high quality medical care and achieve similar patient outcomes to physician providers (Federal Trade Commission, 2014; Kleiner, Marier, Park, & Wing, 2016; Timmons, 2017). NPs are also more likely than physicians to locate in geographic areas with above-average poverty and below-average health outcomes (Davis et al., 2018). Additional information regarding how full practice authority laws affect NPs' workforce outcomes such as geographic location, earned income, and clinical practice ownership are needed to inform states' efforts toward fostering full practice among NPs.

Scope of Practice

NP scope of practice laws regulate the range of health care services and procedures that NPs may offer and their authority to practice without direct physician supervision (Federal Trade Commission, 2014). According to the American Association of Nurse Practitioners (AANP), full practice authority laws permit NPs to act independently in the following three domains of practice: (a) evaluating patients; (b) diagnosing, ordering, and interpreting diagnostic tests; and (c) initiating and treating medical conditions, including prescribing medications and controlled substances under the exclusive licensure authority of the state board of nursing (AANP, 2018). By contrast, in states with restricted and reduced practice laws, NPs are required to have career-long supervision, delegation, or team management by a physician, which prevents them from independently engaging in at least one of the domains of practice (AANP, 2018). Moreover, many self-employed NPs in restricted/reduced states pay fees for collaborative agreements with physicians (Lyden, Sekula, Higgins, & Zoucha, 2018), which may be a disincentive to NPs setting up practices in underserved areas.

Full Practice Authority

As of 2018, 22 states and the District of Columbia allowed full practice authority for NPs (AANP, 2018). Evidence from prior research indicates that full practice authority for NPs is correlated with greater population access to NP providers in rural and underserved areas (Barnes, Richards, McHugh, & Martsolf, 2018; Kuo, Loresto Jr., Rounds, & Goodwin, 2013; Traczynski & Udalova, 2018; Xue et al., 2018). Since 2012, the number of NPs has increased in both rural and non-rural areas, with the highest NP prevalence in states where NPs have full practice authority (Barnes et al., 2018; Kuo et al., 2013). Residents of states with full practice authority are also more likely to have a primary care provider within a 30-

minute travel distance than individuals in states with restricted or reduced practice environments (Neff et al., 2018). Xue et al. (2018) conducted a time-series analysis of county-level supply of NPs from 2009 to 2013, and found that full practice authority was associated with a higher prevalence of NPs per capita in rural counties and in primary care health professional shortage area counties, but not with differential growth in NPs per capita over time. Implementation of full practice authority for NPs is also associated with increased frequency of routine checkups, improved patient satisfaction, and decreased emergency room use (Traczynski & Udalova, 2018). Despite these potential benefits of NP full practice authority, only four of the 20 states facing the highest shortages of primary care providers have adopted full practice authority for NPs (Bean, 2019).

Workforce Outcomes

Few research studies have examined associations between state full practice authority laws and NPs' workforce outcomes, such as their earnings and whether they are self-employed (Kleiner et al., 2016; Yang et al., 2020). Workforce outcomes such as these are important for gaining insight into how full practice authority laws influence NPs' labor market decisions, including their decisions about where to practice and whether to be an employee or a business owner. It is likely that NPs' decisions about geographic location and practice ownership are influenced by options that offer potential workplace benefits such as greater earnings potential and practice autonomy. For example, in one of the only qualitative research studies on this topic, Waite (2019) conducted interviews with 17 self-employed NPs who owned their own practices in full practice authority states, and found that practice ownership was driven chiefly by a desire to have more control over one's practice and career growth. In another study, Kleiner et al. (2016) pooled American Community Survey data from 2001 to 2013 on NPs and physicians, and found that allowing NPs to practice without physician oversight resulted in 5% higher mean earnings for NPs. Results from these studies indicate that NPs in states with full practice authority may be motivated by economic incentives associated with practice independence and ownership as well as higher income potential.

We used nationally representative data on NPs to investigate longitudinal associations between states adopting full practice authority for NPs between 2010 and 2018 and changes in NPs' probability of residing in or near a primary care health professional shortage area (HPSA), self-employment, and hourly earnings. We hypothesized that those states that implemented full practice authority experienced relative increases in the percentage of NPs who locate in primary care HPSAs, in NP self-employment, and in NPs' hourly earnings relative to those states that maintained restricted/reduced practice authority throughout this time period.

Methods

Data and Sample

The data for this study come from the American Community Survey Public Use Microdata Sample (ACS PUMS) databases. The ACS is a nationally representative U.S. population-based household survey that is conducted annually by the U.S. Census Bureau (U.S. Census

Bureau, 2019). Each year's ACS sample is designed to be a geographically representative crosssection of 1% of all U.S. households in the 50 states and the District of Columbia not including U.S. territories (U.S. Census Bureau, 2019). We pooled together the annual ACS PUMS datasets for the years 2010 to 2018, resulting in a multi-year longitudinal repeated cross-section of the U.S. population. We operationally defined NPs as individuals whose main job occupation was coded as 2010 Census Occupation Code 3258 "Nurse midwives and nurse practitioners"(see Bureau of Labor Statistics <https://www.bls.gov/cps/cenocc2010.htm>) and whose highest degree completed was a master's degree or higher, as a master's degree is typically required to enter the profession as an NP. ACS data prior to 2010 were not used because prior to 2010 the occupation codes did not differentiate NPs from registered nurses. The [LEAD AUTHOR's] Institutional Review Board determined that this study does not constitute human-subjects research.

The initial sample included 12,865 NPs (Figure 1). We retained 11,023 NPs whose main job was in a health care delivery industry based on North American Standard Industry Classification System codes, including hospitals, nursing and residential care facilities, outpatient care (offices of physicians, dentists, chiropractors, and optometrists), and home and other health care services. Information from *The Nurse Practitioner* (Phillips, 2010, 2019) database, which uses the American Association of Nurse Practitioners practice environment classification system (AANP, 2018), was then used to classify all states and years in our sample into two NP state practice environment categories, either full practice (22 states and the District of Columbia) or restricted/reduced practice (28 states). Because our analysis examines changes in NP outcomes associated with implementation of full practice authority, 1,241 NPs who worked in 12 states that adopted full practice authority prior to 2010 were excluded, leaving a final sample of 9,782 NPs employed in health care delivery settings, of whom 1,019 (10.4%) worked in 10 states with full practice authority (CO, CT, MD, MN, NE, NV, ND, RI, SD, VT). The 1,241 excluded NPs differed from NPs in full practice authority states in that they were slightly older, were less likely to live in a metropolitan area, and were more likely to report Hispanic ethnicity ($p < .05$).

Measures

Dependent Variables.—The dependent variables were NP location in a primary care HPSA (1/0), NP selfemployment (1/0), and the natural logarithm of NPs' hourly earnings (log earnings). Primary care HPSAs in 2018 listed by zip code were obtained separately from the U.S. Health Resources and Services Administration (Health Resources & Services Administration, 2018), and then matched to the ACS dataset using the NP's reported residence. As the ACS does not report participants' zip codes, the presence or absence of a HPSA in the same Public Use Microdata Area (PUMA) as the NP was coded at the PUMA level in ACS. PUMAs are geographically contiguous areas containing at least 100,000 persons that are built on census tracts and counties. Primary care HPSAs were coded by assigning zip codes first to census tracts and then by assigning a HPSA status to each PUMA based on whether the PUMA contained a census tract in a shortage area. The ACS survey classifies an individual as self-employed if their main job type is "self-employment" defined as owning a "business, professional practice, or farm." In ACS, NPs reported either their wages or salary income over the past year. An hourly rate of earnings was calculated by

dividing reported annual earnings by annual hours of work, where annual hours were calculated using weekly hours multiplied by actual weeks of work. Hourly earnings were adjusted for annual inflation using the U.S. Consumer Price Index-All Urban Consumers and are reported in 2018 dollars (U.S. Bureau of Labor Statistics, 2019). In regressions, we estimated log earnings rather than actual earnings to improve estimation efficiency.

Covariates. Age and age squared were used to control for group differences in work experience and birth-cohort. Sex, race, Hispanic ethnicity and immigration to the U.S. (immigrated less than five years ago, five or more years ago, or born in U.S.) may influence job location decisions and opportunities. Metropolitan area status (Ruggles et al., 2019), state-level NPs per capita in 2010, state-level health care providers per capita in 2010, and state-level RNs with master's degrees per capita in 2010 are local area characteristics that may influence job opportunities and job location choices independent of full practice authority.

Statistical Analyses

A difference-in-differences regression model approach (Dimick & Ryan, 2014), similar to the approach used in a prior study of provider earnings by Kleiner et al. (2016), was used to model marginal associations between implementation of full practice authority and the three workforce outcomes for NPs. This longitudinal approach takes advantage of the natural experiment offered by state changes in practice environment, and should help isolate the influence of full practice policy implementation net of secular trends in the data, and net of time-persistent cross-sectional differences between NPs who practiced in the 10 restricted/reduced practice states that later adopted full practice and those who practiced in the 28 restricted/reduced practice states that did not adopt full practice.

Logistic regression was used for the two binary outcomes and an ordinary least squares regression model was used for log earnings. Regressions also included a binary indicator for NPs practicing in states that implemented full practice authority at some point during the study timeframe vs. NPs practicing in other states, a yearly time trend, a binary indicator for the year prior to full practice authority implementation, to account for anticipatory effects of the legislation change, and covariates (listed above). A double-selection covariate control function modeling approach developed by Belloni, Chernozhukov, and Hansen (2014) was used to select a sparse covariate specification from a flexible specification that included all the listed covariates and their two-way interactions. Under this approach, a machine learning technique called LASSO is used to select a sparse model specification using the identified covariates. The LASSO regressions were adjusted for a yearly trend, the year before full practice authority was implemented, whether the state had implemented full practice authority by 2018, nurse practitioners per capita in 2010, an interaction between sex and age squared (self-employed only), age squared (self-employed only), sex (HPSA and wage only), registered nurses with a master's degree in 2010 (HPSA and wage only), residence in a metropolitan area (HPSA only), immigration status (HPSA only), and interaction between Asian race and living in a metro area (HPSA only), an interaction between nurse practitioners per capita and a living in a metro area (HPSA only), and age (wage only). All models were estimated using survey estimation commands in STATA 16 (StataCorp, 2019)

and were weighted using the ACS sampling weights to account for the ACS survey design features.

In each outcome regression model, inferences were based on the estimated coefficient of a binary indicator that equaled 1 in states and years during which full practice authority was in effect and 0 otherwise, controlling for the average difference in outcomes for NPs between states that did and those that did not implement full practice. Statistical significance was tested at $P < 0.05$ using a two-sided test. The regression coefficients of interest were used to construct estimates of the marginal impacts of full practice authority implementation on NPs' outcomes. Duan's smearing technique was used to obtain predictions of impacts on actual earnings, rather than log earnings (Duan, 1983). We also considered that full-time NPs may be more responsive to full practice authority than part-time NPs. Consequently, all regression models and marginal impact estimates were repeated using data from full-time employed NPs ($n = 7,880$), defined as working at their primary job at least 35 hours per week.

Findings

Table 1 shows the sample demographic characteristics of ($n = 693$) NPs who were in practice in full practice authority states and of ($n = 9,089$) NPs who were in practice in restricted/reduced practice authority states. A higher percentage of NPs in full practice authority states reported White race and lower percentages reported Black and American Indian/Alaskan Native race. NPs in full practice authority states were also less likely to live in metropolitan areas and were less likely to have immigrated to the U.S. (all at $p < .05$).

First, we compared the unadjusted means of HPSA/non-HPSA location, self-employment, earnings, and log earnings before and after full practice authority was implemented, using only the observations from the 10 states that implemented full practice authority (Table 2). There was not a significant pre/post association with full practice authority in the unadjusted mean comparisons for HPSA location (pre 23.1%; post 28.1%, $p > .05$), self-employment (pre 1.4%; post 3.2%; $p > .05$), or hourly earnings. However, the average of log earnings increased 2.6% after vs. before implementation of full practice authority (pre 3.75; post 3.85; $F_{(1, 1018)} = 4.36$, $p = .037$), and mean real earnings for NPs were 8% higher on average (pre \$48.45/hour; post \$52.29/hour).

In the difference-in-differences adjusted models among all employed NPs (Table 3, upper panel), full practice authority implementation was associated with an increased probability of residing in a HPSA (aOR 1.94, 95% CI 1.05, 3.61), but did not have a statistically significant association with either the probability of being self-employed (aOR 2.86, 95% CI 0.9, 9.11) or with log earnings (Coef. 8%, 95% CI -2%, 19%). Among full-time employed NPs ($N = 7,880$, lower panel of Table 3), full practice authority implementation was again associated with an increased probability of living in a HPSA (aOR 2.34, 95% CI 1.14, 4.83). Full practice authority implementation also had a large and borderline significant ($p = .051$) association with the probability of self-employment (aOR 4.97, 95% CI 1.00, 24.86) but was again not associated with log earnings for NPs ($p = .201$).

Estimates of the marginal policy impacts of full practice authority implementation on study outcomes are shown in Table 4. Marginal effects are the average differences in the predicted means of the outcomes before vs. after implementation of full practice authority, holding the values of the other covariates constant at their sample means. In adjusted models of employed NPs, implementation of full practice authority was associated with a marginal 30.5% increase in the probability of locating in a HPSA, from 22.0% to 29.0%, a 176.8% increase in NP self-employment, from 1.2% to 3.4%, and a 2.5% increase in adjusted hourly earnings, from \$49.75/hour to \$51.01/hour. The adjusted models for full-time employed NPs predicted slightly larger policy impacts of full practice authority (Table 4, lower panel). Among fulltime NPs, the probability of locating near an HPSA increased 46.5%, while the predicted probability of self-employment increased by 374.1%, and predicted hourly earnings increased by 5.4%.

Discussion

Health Professional Shortage Areas

Using data from a nationwide sample of U.S. NPs employed in health care delivery settings, we found that states' implementation of full practice authority legislation for NPs was associated with a higher probability that NPs reside in or near to a primary care HPSA or shortage area. Adjusted difference-in-differences model estimates of policy impacts suggest that full practice authority implementation is associated with a 30.5% increase in the proportion of NPs who reside either in or close to a primary care shortage area, from 22.0% of NPs in restricted/reduced practice states to 29.0% of NPs in full practice authority states, on average. This finding bolsters recent evidence from Xue et al. (2018) and others that full practice authority legislation fosters increased access to primary care providers in shortage areas. Other previous findings (Davis et al., 2018) suggest NPs are more likely than physicians to reside in shortage areas. Our difference-in-differences findings add to this evidence by demonstrating a longitudinal association between implementation of full practice authority and subsequent changes in the probability that NPs locate in a shortage area.

Self-employment

Among full-time employed NPs, state implementation of full practice authority was also associated with a predicted 374.1% increase in the probability of being self-employed, from 0.8% of NPs in restricted/reduced practice states to 3.9% once these states implemented full practice authority. NPs in this sample who were classified as self-employed were those whose principal job was owner of a health care delivery business or professional practice. Such NP-owned businesses include private individual and group practices and other clinic-based, often specialized, NP medical services. This result suggests that full practice authority implementation creates new opportunities for NPs to open medical practices. To our knowledge, ours is the first quantitative study to link full practice authority with greater self-employment among NPs employed in health care delivery. Thematic evidence obtained from a previous qualitative study conducted with ($N=17$) self-employed NPs suggests NPs often choose selfemployment to obtain greater control over their practice and career growth (Waite, 2019). Such motivations might help explain why full practice authority

implementation was associated with NP self-employment. However, we also found that self-employment was uncommon even in states with full practice authority. By contrast, nearly 46% of physicians included in a recent American Medical Association survey reported being self-employed (Kane, 2019). This discrepancy between self-employment of NPs and physicians suggests that practice ownership has remained comparatively uncommon among NPs, even with full practice authority in place.

Hourly Earnings

Evidence of positive associations between full practice authority implementation and NPs' hourly earnings (i.e., their rate of pay) was mixed. Although NPs received higher hourly earnings after full practice authority was implemented vs. prior to implementation, no significant marginal association with log earnings was found in difference-in-differences regression models. Previously, Kleiner et al. (2016) used 2001 to 2013 ACS data and found evidence of a 5% relative increase in NPs' wages after states adopted "independent practice authority" compared to states that maintained more restrictive practice policies. Although our analysis did not confirm this finding, estimated confidence intervals were wide and consequently did not rule out the possibility that full practice authority boosts NPs earnings by 5% or more. Our analysis might not have been sufficiently powered to detect a significant marginal association between full practice authority implementation and NPs' earnings.

Implications

Alternatively, the overall low observed NP rate of selfemployment (i.e., practice ownership) and the lack of a robust association with NPs' hourly earnings may signal that the potential economic benefits of full practice authority laws are not being fully realized, perhaps due to other barriers to NP practice ownership. Such barriers might include limited access to start-up resources such as small business loans and insurance, complex regulatory requirements, lack of graduate-program training in health care business practices, and a relative scarcity of NPs who have successfully made the transition to practice ownership, and who therefore can serve as mentors and role models for clinical entrepreneurs (Lyden et al., 2018). Also, other institutional and economic barriers to fully independent practice, such as employer organization policies that require NP supervision by a physician, incident-to billing, malpractice insurance costs, and others could impede independent practice by NPs and mitigate the benefits of full practice authority. On the other hand, financial supports offered by the Health Resources & Services Administration (see <https://bhwh.hrsa.gov/grants/nursing>) and other federal programs that financially support NPs' postgraduate clinical training and preparation for independent primary care practice in shortage areas may remove barriers to NP independent practice.

Limitations

Limitations of our study include the fact that the ACS data do not differentiate between NPs and certified nurse midwives. These two advanced practice registered nurse providers ideally should be considered separately, as they likely would respond differently to full practice authority. However, the bias caused by this grouping may have been small because nurse midwives represent a small fraction of all advanced practice registered nurse providers. According to the Bureau of Labor Statistics in 2018 there were 6,250 employed nurse

midwives compared to 179,650 employed NPs (U.S. Bureau of Labor Statistics, 2018), which suggests that nurse midwives comprise less than 5% of our sample. Second, we were not able to link individuals to HPSAs at the zip-code level, because zip-code information is not available in the ACS dataset. Instead we linked individuals to HPSAs using public use microdata areas, which cover a larger region than would usually be covered by a zip code. As a result, we could have over-estimated the influence of full practice authority on NPs practicing in an HPSA by misattributing NPs to shortage area zip-codes. Finally, we cannot rule out the possibility that other unmeasured state-level economic trends or policy changes coincided with full practice authority implementation in the sampled states and consequently resulted in spurious associations among full practice authority implementation and workforce outcomes. However, unlike prior studies that have mostly relied only on cross-sectional variation to infer the effects of full practice authority, the results of this study are derived from differential changes over time in states that adopted full practice authority compared to states that did not, and thus are robust to such cross-sectional differences. In addition, the time period studied here was one of relative economic stability.

Conclusions

This study's results contribute to a growing body of evidence that full practice authority laws may help states address local area shortages of primary care providers. NPs are more likely to locate in primary care provider shortage areas in states that have implemented full practice authority for NPs than in restricted/reduced practice states. Full practice authority was also marginally associated with higher self-employment among full-time NPs, suggesting that full practice authority offers NPs expanded opportunities for business ownership and practice autonomy. However, we found that NP self-employment is still relatively uncommon even in full practice states and that full practice laws have had modest impacts on NPs' earnings. These results suggest that to maximize the workforce and population benefits of full practice authority, policy leaders should further examine economic barriers to independent practice and practice ownership by NPs and the potential need for additional policy changes above and beyond full practice authority only, including the need for clearer regulatory guidance, increased access to business loans and insurance, and post-graduate training and professional mentorship opportunities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

ACS	American community survey
HPSA	Health professional shortage area

NP	Nurse practitioner
PUMA	Public use microdata area

REFERENCES

- AANP. (2018). American Association of Nurse Practitioners: State Practice Environment. Retrieved from: <https://www.aanp.org/advocacy/state/state-practice-environment>
- Barnes H, Richards MR, McHugh MD, & Martsof G (2018). Rural and nonrural primary care physician practices increasingly rely on nurse practitioners. *Health Affairs*, 37(6), 908–914, doi:10.1377/hlthaff.2017.1158. [PubMed: 29863933]
- Bean M (2019). States ranked by shortage of primary care providers. Retrieved December 10, 2019, from Becker's Hospital Review website: <https://www.beckershospitalreview.com/rankings-and-ratings/states-ranked-by-shortage-of-primary-care-providers.html>
- Belloni A, Chernozhukov V, & Hansen C (2014). High-dimensional methods and inference on structural and treatment effects. *Journal of Economic Perspectives*, 28(2), 29–50, doi:10.1257/jep.28.2.29.
- Dall T, Reynolds R, Jones K, Chakrabarti R, & Iacobucci W (2019). The complexities of physician supply and demand: Projections from 2017 to 2032 Washington D.C.
- Davis MA, Anthopolos R, Tootoo J, Titler M, Bynum JPW, & Shipman SA (2018). Supply of healthcare providers in relation to county socioeconomic and health status. *Journal of General Internal Medicine*, 33(4), 412–414, doi:10.1007/s11606-017-4287-4. [PubMed: 29362958]
- Dimick JB, & Ryan AM (2014). Methods for evaluating changes in health care policy: The difference-in-differences approach. 312(22), 2401–2402. Doi: 10.1001/jama.2014
- Duan N (1983). Smearing estimate: A nonparametric retransformation method. *Journal of the American Statistical Association*, 78(383), 605–610, doi:10.1080/01621459.1983.10478017.
- Federal Trade Commission. (2014). Policy Perspectives Competition and the Regulation of Advanced Practice Nurses Federal Trade Commission I. Retrieved from: www.ftc.gov/policy/reports/policy-reports/commission-and-staff-reports
- Health Resources & Services Administration. (2018) Health Professional Shortage Areas- Primary Care. Retrieved from data.hrsa.gov/data/download?data=HSCD#HSCD.
- Kane CK (2019). Updated Data on Physician Practice Arrangements: For the First Time, Fewer Physicians are Owners Than Employees [internet]. In Policy Research Perspective (Vol. 2019–07). Retrieved from: <https://www.ama-assn.org/system/files/2019-07/prp-fewer-owners-benchmark-survey-2018.pdf>
- Kleiner MM, Marier A, Park KW, & Wing C (2016). Relaxing occupational licensing requirements: Analyzing wages and prices for a medical service. *Journal of Law and Economics*, 59(2), 261–291, doi:10.1086/688093.
- Knight V (2019). Numbers of doctors choosing primary care declining - The Washington Post. Retrieved December 10, 2019, from Washington Post website: https://www.washingtonpost.com/health/america-to-face-a-shortage-of-primary-care-physicians-within-a-decade-or-so/2019/07/12/0cf144d0-a27d-11e9-bd56-eac6bb02d01d_story.html
- Kuo Y-F, Loresto F Jr., Rounds L, & Goodwin J (2013). States with the least restrictive regulations experienced the largest increase in patients seen by nurse practitioners. *Health Affairs*, 32(7), 1236–1243, doi:10.1016/j.juro.2014.01.051. [PubMed: 23836739]
- Lyden C, Sekula LK, Higgins B, & Zoucha R (2018). Job satisfaction and empowerment of self-employed nurse practitioners: A mixed methods study. *Journal of the American Association of Nurse Practitioners*, 30(2), 78–91, doi:10.1097/JXX.000000000000007. [PubMed: 29757819]
- Neff DF, Yoon SH, Steiner RL, Bejleri I, Bumbach MD, Everhart D, & Harman JS (2018). The impact of nurse practitioner regulations on population access to care. *Nursing Outlook*, 66(4), 379–385, doi:10.1016/j.outlook.2018.03.001. [PubMed: 29703627]
- Phillips SJ (2010). 22nd annual legislative update: Regulatory and legislative successes for APNs. *Nurse Practitioner*, 35(1), 24–47, doi:10.1097/01.NPR.0000366130.98728.34.

- Phillips SJ (2019). Improving state practice authority and access to care. *Nurse Practitioner*, 44(1), 27–55, doi:10.1097/01.NPR.0000550248.81655.30.
- Ruggles S, Flood S, Goeken R, Meyer E, Pacas J, & Sobek M (2019). IPUMS USA. Doi:10.18128/D010.V9.0
- StataCorp. (2019). *Stata Statistical Software: Release 16*. College Station, TX: StataCorp LLC.
- Timmons EJ (2017). The effects of expanded nurse practitioner and physician assistant scope of practice on the cost of Medicaid patient care. *Health Policy*, 121(2), 189–196, doi:10.1016/j.healthpol.2016.12.002. [PubMed: 28041774]
- Traczynski J, & Udalova V (2018). Nurse practitioner independence, health care utilization, and health outcomes. *Journal of Health Economics*, 58, 90–109, doi:10.1016/j.jhealeco.2018.01.001. [PubMed: 29475093]
- U.S. Bureau of Labor Statistics. (2018). Occupational Employment Statistics. Retrieved from: https://www.bls.gov/oes/current/oes_nat.htm#29-0000
- U.S. Bureau of Labor Statistics. (2019). Consumer Price Index for All Urban Consumers: All Items in U.S. City Average [CPIAUCSL]. Retrieved from: <https://fred.stlouisfed.org/series/CPIAUCSL>
- U.S. Census Bureau. (2019). American Community Survey. Retrieved October 15, 2019, from: <https://www.census.gov/programs-surveys/acs/about/top-questions-about-the-survey.html>
- U.S. Department of Health and Human Services, & Health Resources & Services Administration. (2013). Projecting the Supply and Demand for Primary Care Practitioners Through 2020. Retrieved from: <http://bhpr.hrsa.gov/healthworkforce/index.html>.
- Venhuizen T, & Pritchard K (2017). Gov. Daugaard Signs Nurse Practitioner Bill. Retrieved from: <https://news.sd.gov/newsitem.aspx?id=21534>
- Waite A (2019). Highlighting the lived experience of nurse practitioners in independent practice. *Journal for Nurse Practitioners*, 15(10), 787–791, doi:10.1016/j.nurpra.2019.07.020.
- Xue Y, Kannan V, Greener E, Smith JA, Brasch J, Johnson BA, & Spetz J (2018). Full scope-of-practice regulation is associated with higher supply of nurse practitioners in rural and primary care health professional shortage counties. *Journal of Nursing Regulation*, 8 (4), 5–13, doi:10.1016/S2155-8256(17)30176-X.
- Yang BK, Johantgen ME, Trinkoff AM, Idzik SR, Wince J, & Tomlinson C (2020). State nurse practitioner practice regulations and U.S. health care delivery outcomes: A systematic review. *Medical Care Research and Review*, doi:10.1177/1077558719901216.

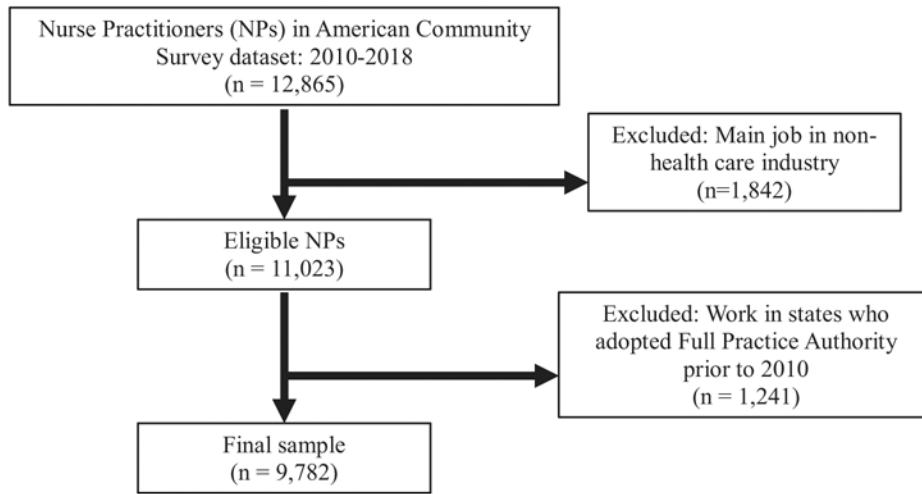


Figure 1 –
Study sample selection flow chart.

Table 1 –
Sample Characteristics of Nurse Practitioners, by State Practice Authority Grouping

Characteristics	Overall (n = 9,782) n (%)	Restricted/Reduced Practice* (n = 9,089) n (%)	Full Practicery† (n = 693) n (%)	F (1, 9781)	p
Female	8,955 (91.4)	8,308 (91.3)	647 (91.8)	0.09	.764
Race					
White	8,631 (86.3)	7,994 (85.8)	637 (91.8)	20.0	<.001
Black	466 (6.5)	447 (6.7)	19 (3.1)	9.9	<.001
American Indian/Alaskan Native	21 (0.2)	20 (0.2)	1 (0.4)	2.0	.049
Asian	491 (5.2)	463 (5.3)	28 (4.0)	2.2	.139
Other Race	173 (1.9)	165 (1.9)	8 (1.1)	3.4	.065
Ethnicity					
Hispanic	394 (4.3)	374 (4.4)	20 (3.2)	1.70	.193
Age, mean (SD)	44.8 (11.2)	44.7 (11.2)	45.5 (11.2)	2.49	.115
Metropolitan area‡	7,569 (81.3)	7,068 (81.6)	501 (77.0)	5.20	.023
Immigrant	956 (10.4)	910 (10.6)	46 (7.8)	4.46	.035
Immigrant<5yrs ago	18 (0.2)	16 (0.2)	2 (0.2)	0.25	.617

* Restricted/Reduced practice states are classified according to the American Association of Nurse Practitioners as preventing nurse practitioners from independently engaging in one or more domains of nurse practitioner practice (AANP, 2018).

† Full practice states have laws that permit all nurse practitioners to independently evaluate patients; to diagnose, order and interpret diagnostic tests; and to initiate and manage treatments, including prescribing medications and controlled substances under the exclusive licensure authority of the state board of nursing (AANP, 2018). Nurse practitioners are assigned to state practice authority group based on the practice authority laws in their state of employment during their survey year.

‡ Metropolitan area is defined based on the delineations produced by the Office of Management and Budget (Ruggles et al., 2019) and calculated based on an individual's residence.

Means Before and After Implementing Full Practice Authority Among Employed Nurse Practitioners in Ten States[†] (N = 1,019)

Table 2 –

Workforce Outcome	Before Full Practice Authority (n = 326)	Full Practice Authority (n = 693)	F (1,1018)	p
Located in/near HPSA, [‡] n (%)	93 (23.1)	223 (28.1)	1.91	.166
Self-employed, n (%)	7(1.4)	19 (3.2)	2.55	.110
Hourly earnings, [§] mean \$ (SD)	48.45 (38.74)	52.29 (37.48)	1.39	.239
Log hourly earnings, [§] mean (SD)	3.75 (0.50)	3.85 (0.47)	4.36	.037

[†]States were CO, CT, MD, MN, NE, NV, ND, RI, SD, and VT.

[‡]Health professional shortage area (HPSA) is defined by criteria from the U.S. Health Resources and Services Administration to determine which zip-codes are in primary care health professional shortage areas. This data was linked to everyone's residence.

[§]Hourly and log hourly earnings are adjusted to 2018 dollars using the U.S. Consumer Price Index-All Urban Consumers (U.S. Bureau of Labor Statistics, 2019)

Difference-in-Difference Marginal Associations Between Implementation of Full Practice Authority and Outcome for All Employed and Full-Time Nurse Practitioners

Table 3 –

<i>Dependent variable</i>	<u>Marginal Association with Implementation of FPA</u>		
	AOR/Coef[†]	95% CI	t p
All Employed (N = 9,782)			
Located in/near HPSA	1.94	1.05	3.61 2.10 .036
Self-employed	2.86	0.90	9.11 1.77 .076
Log hourly earnings	0.08	-0.02	0.19 1.51 .132
Full-time employed (N = 7,880)	AOR/Coef[†]	95% CI	t p
Located in/near HPSA	2.34	1.14	4.83 2.30 .021
Self-employed	4.97	1.00	24.86 1.95 .051
Log hourly earnings	0.08	-0.04	0.20 1.28 .201

[†]The adjusted odds ratio is the coefficient of the interaction of being in a full practice authority state during the post implementation period.

Health professional shortage area (HPSA) is defined by criteria from the U.S. Health Resources and Services Administration to determine which zip-codes are in primary care health professional shortage areas. This data was linked to everyone's residence.

Log hourly earnings are adjusted to 2018 dollars using the U.S. Consumer Price Index-All Urban Consumers (U.S. Bureau of Labor Statistics, 2019)

The LASSO regressions were adjusted for a yearly trend, the year before full practice authority was implemented, whether the state had implemented full practice authority by 2018, nurse practitioners per capita in 2010, an interaction between sex and age squared (self-employed only), sex (HPSA and wage only), registered nurses with a master's degree in 2010 (HPSA only), residence in a metropolitan area (HPSA only), immigration status (HPSA only), an interaction between Asian race and living in a metro area (HPSA only), an interaction between nurse practitioners per capita and a living in a metro area (HPSA only), Asian race (HPSA only) and age (wage only).

Table 4 – Predicted Marginal Impacts* of Full Practice Authority Implementation in 10 States, 2010-2018

Workforce Outcome	Before Full Practice Authority		Full Practice Authority		Policy Impact (Mean)	
	Mean ± 95%CI	Diff.	Mean ± 95%CI	Diff.	% Diff.	
All employed NPs						
Located in/near HPSA%	22.0 ± 5.4	7.0	29.0 ± 4.2		30.5	
Self-employed %	1.2 ± 1.1	2.2	3.4 ± 2.2		176.8	
Hourly earnings (\$)	49.75 ± 0.4	1.3	51.01 ± 0.3		2.5	
All full-time employed NPs Located in/near HPSA %	21.6 ± 6.1	10.0	31.6 ± 5.2		46.5	
Self-employed %	0.8 ± 1.0	3.0 //	3.9 ± 3.1		374.1	
Hourly earnings (\$)	47.40 ± 0.4	2.6	49.97 ± 0.2		5.4	

* Marginal impacts represent the sample-based mean differences in an outcome associated with exposure to full vs. restricted/reduced practice authority, holding other covariate factors constant at their sample mean values. NPs were assigned to either full or restricted/reduced practice authority based on the practice authority laws current in their state of employment as of the survey year. (AANP, 2018).

States were CO, CT, MD, MN, NE, NV, ND, RI, SD, and VT.

Health professional shortage area (HPSA) is defined by criteria from the U.S. Health Resources and Services Administration to determine which zip-codes are in primary care health professional shortage areas. This data was linked to everyone's residence.

Hourly earnings are adjusted to 2018 dollars using the U.S. Consumer Price Index-All Urban Consumers (U.S. Bureau of Labor Statistics, 2019)

// Rounding may result in a slight discrepancy between the marginal impact estimates and corresponding mean outcomes for the pre-full practice authority and full practice authority groups.