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# BMJ Open

## State Scope of Practice Laws and Employed Physician Assistants

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## State Scope of Practice Laws and Employed Physician Assistants

### Abstract

#### Objective

This study examined if the variation in Physician Assistant (PA) state Scope of Practice (SOP) laws across states are associated with number of employed PAs, PA demographics and PA/population ratio per state. The hypothesis was that less restrictive SOP laws will increase the demand for PAs and the number of PAs in a state.

#### Design

Retrospective cross-sectional analysis at three time points: 1998, 2008, 2017.

#### Setting

Fifty states and the District of Columbia.

#### Participants

Employed PAs from 1998-2017.

#### Methods

SOP laws were categorized as ideal, average and restrictive. Three national datasets were combined to allow for descriptive analysis of employed PAs by year and SOP categories. We used Mann-Whitney U test to analyze number of PAs by SOP categories and least-squares regression to compare PA/population ratio and SOP categories for each time point.

#### Results

There was a median PA/population ratio of 23 per 100,000 population in 1998 and 33 in 2017. A heterogeneous expansion of SOP laws was seen with 16 states defined as super expanders while 16 were never adopters. In 2017, comparing restrictive to ideal states showed that ideal SOP laws were associated with a 16.5 (p .01) increase in ratio of employed PAs per 100,000 population, demonstrating that states with ideal SOP laws have an increased PA density.

#### Conclusions

There has been steady growth in the mean PA/population ratio since the turn of the century. At the same time, PA scope of practice laws in the United States have expanded, with just ten states remaining in the restrictive category. Ideal SOP laws are associated with an increase in the ratio of employed PAs per state population. As states work to meet the projected physician need, SOP expansion may be an important policy consideration to increase the PA workforce.

#### Key Words

Physician Assistant, Scope of Practice Laws, Workforce, Employment

#### Strengths and Limitations

- Data from the Bureau of Labor and Statistics (BLS) provided employed Physician Assistants (PAs) census data for all employed PAs from 1998-2017 for all 50 states and the District of Columbia.
- Comprehensive state legislative SOP data from the American Academy of Physician Assistants (AAPA) was cross referenced and verified for each state and each year and then combined with the annual employment data from the BLS.
- This is the first study analyzing two decades of national PA employment for all 50 states and the District of Columbia across three time points to describe the effect of state SOP laws on PAs.
- The analysis did not include other possible confounding variables that may impact PA employment numbers, including physician or nurse practitioner employment numbers, or state and federal healthcare legislative policies.
- The analysis was not unable to account for lag time in terms of when the SOP laws were passed and the PA employment occurred.

## State Scope of Practice Laws and Employed Physician Assistants

### INTRODUCTION

The Association of American Medical Colleges projects a shortage of 46,900 to 121,900 physicians by 2032.<sup>1</sup> Analysis of workforce supply and demand at the state level reveals that this shortage will likely be distributed unequally; some states have a lower supply of providers than others, rural shortages tends to be worse than urban settings, and some specialties are in greater demand than others.<sup>2-4</sup> Increased use of Physician Assistants (PAs) is one potential solution that has been proffered to address the current and anticipated deficiency.<sup>5-7</sup> One important factor that can facilitate or restrict the capacity of PAs to fill the provider shortage is state scope of practice (SOP) laws.<sup>8,9</sup>

Research indicates that favorable SOP legislation is associated with an increase in the supply of healthcare providers.<sup>10</sup> A number of previous studies have demonstrated that the supply of PAs and Nurse Practitioners (NPs) within a state is inversely related with the restrictiveness of SOP laws.<sup>8,11-16</sup> In 2010, the Institute of Medicine report on the Future of Nursing recommended full SOP for nurses, which became the catalyst for SOP expansion for NPs.<sup>17</sup> While striving to work at the top of their license, NPs have shown that restrictions on SOP is associated with reduced growth and number of available NPs in communities.<sup>9</sup> One 2009 study of PAs noted that SOP laws may effect PA/population ratio by state but to date, the effect of SOP on PA employment has not been clearly delineated.<sup>8</sup>

Throughout the decades, PAs have worked at the state level to push for expansion of PA practice laws to decrease the barriers to providing patient care. These efforts occur state by state with, for example, 20 states in 2017 proposing legislation to amend SOP laws for PAs.<sup>18</sup> Despite this work, there remains wide variation in PA SOP laws in the United States, ranging from highly restrictive to top-of-license practice.<sup>8,19</sup> In support of top-of-license practice, in 2017, the American Academy of Physician Assistants (AAPA) moved to adopt Optimal Team Practice (OTP), this proposed practice act is intended to further increase the autonomy of PAs.<sup>20</sup> The tenets of OTP include eliminating a legal requirement for a specific relationship with a physician, creating a separate majority-PA board to regulate PAs, and authorize PAs to directly bill for services.<sup>21</sup>

Fifty years since the inception of the PA profession, there has been a demographic shift from predominantly male to majority female and from largely primary care providers to specialists.<sup>22,23</sup> At the same time, the profession remains young with the median age of employed PAs remaining steady at 38 years old since 2012.<sup>24</sup> It is unknown if this demographic shift is due, at least in part, to changes in SOP laws. The purpose of this study was to examine whether, and to what degree, variation in PA state SOP laws across states are associated with 1) number of employed PAs per state; 2) PA demographics and 3) PA/population ratio per state. The hypothesis was that restrictive SOP laws limit the demand for PAs,

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3 with subsequent impacts on the PA workforce, while less restrictive SOP laws will increase the demand  
4 for PAs and therefore the number of PAs in a state.  
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## 8 **METHODS**

9 Cross-sectional analysis at three time points (1998, 2008, 2017) was used to estimate the association of  
10 state scope of practice laws and the PA/population ratio, comparing states with restrictive SOP with  
11 average and ideal SOP laws. Three time points were used to demonstrate the change in SOP laws and  
12 impact over time. We used three SOP categories ideal, average and restrictive, based on the number of PA  
13 SOP Key Elements which builds upon prior work by Wing et al.<sup>16</sup>  
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### 18 Data sources and setting

19 Data were obtained from the Bureau of Labor and Statistics (BLS), AAPA census, and the AAPA  
20 database on PA legislative history for all fifty states and the District of Columbia from 1998 to 2017. The  
21 three datasets were combined to allow for analysis of the years of 1998, 2008 and 2017.<sup>25</sup> The University  
22 of Utah Institutional Review Board (IRB) determined that this project does not meet the definition of  
23 Human Subject Research.  
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### 29 Sample/Participants

30 The combined state/year dataset (N=153) included number of employed PAs in each state (51 states for 3  
31 time points) from the BLS, PA demographics from the AAPA census and state SOP laws from AAPA  
32 legislative history. Response rates for AAPA census report was unknown for 1998, 34.5% in 2008 and  
33 10.2% in 2017.  
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### 39 Variables

40 Data from BLS provided the number of clinically active PAs employed by state and by year.<sup>25</sup> PA ratio  
41 was then calculated as:  $[\text{employed PA in that year}/\text{state population in year}^{26-28}] * 100,000$ . When  
42 comparing PA/population ratio over time the researchers defined states as super expanders, contractors,  
43 slow expanders and never adopters. Super expanders are defined as states with at or above the median  
44 ratio in 1998 and remained at or above the median in 2017. Contractors are defined as states with at or  
45 above the median ratio in 1998 and fell below the median in 2017. Slow expanders are defined as states  
46 with below the median in 1998 and rose to at or above the median PA/population ratio by 2017. Never  
47 adopters are defined as states with below the median PA/population ratio in 1998 and remained below in  
48 2017.  
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3 The AAPA established the ideal PA practice act which includes the 6 Key Elements of a Modern  
4 PA Practice Act: 1) licensure as a regulatory term, 2) full prescriptive authority, 3) scope of practice  
5 determined at the practice level, 4) adaptable collaboration requirements, 5) co-signature requirements  
6 determined at the practice level and 6) number of PAs a physician may collaborate with determined at the  
7 practice level.<sup>29</sup> Data from AAPA included which six key elements were approved in each state by year  
8 and the total number of six key elements was calculated. Consistent with prior research, each state was  
9 categorized into one of three SOP groups based on the number of key elements adopted: ideal SOP (5-6  
10 elements), average SOP (3-4 elements) and restrictive SOP (0-2 elements).<sup>16</sup> The AAPA census provided  
11 mean age and mean female gender. Mean age and female gender was weighted by number of PAs  
12 employed in each state. There were no missing data for the number of key elements, mean age, or mean  
13 gender. For number of employed PAs in 2008 there was missing data for District of Columbia, California  
14 and Pennsylvania. Missing data for 2008 were imputed by taking the average of the number of PAs from  
15 2007 and 2009.

#### 25 Statistical analysis

26  
27 Descriptive statistics were used to demonstrate the geographic location and change in the number of states  
28 categorized as ideal, average, and restrictive SOP with the PA/population ratio for each state for the years  
29 of 1998 and 2017 and presented visually with maps. The change in PA/population ratio per state over the  
30 time period relative to the median PA/population ratio for the nation was determined and presented  
31 visually with a map. Descriptive statistics by year and SOP categories was determined including number  
32 of states, number of employed PAs, number of female PAs, and mean age of PAs.

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35 The Mann-Whitney U test was used to determine whether there was a statistically significant  
36 difference in the number of PAs by SOP categories for each of the years: 1998, 2008 and 2017. Mean age  
37 and number of female PAs for each scope of practice level were determined using least squares  
38 regression, incorporating weights to account for state-level differences in PA population demographics.  
39 Least-squares regression was used to compare PA/population ratio and SOP categories with restrictive as  
40 the reference for the years of 1998, 2008 and 2017. All analyses were conducted using SAS version 9.4.

#### 48 RESULTS

49 Over the study period, the number of states in the ideal SOP category increased, as did the PA ratio. The  
50 number of ideal states increased from 2 in 1998 to 7 in 2008 and 16 by 2017, while the restrictive states  
51 went from 30 in 1998 to 20 in 2008 and 10 in 2017. (See Figure 1 and 2) In 1998 the median  
52 PA/population ratio was 23 PAs per 100,000 population and 33 per 100,000 in 2017. Figure 3 shows that  
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3 16 states are defined as super expanders while 10 states are contractors, 9 are slow expanders, and 16 are  
4 never adopters. (See supplemental table for PA/population ratio of each state)

5  
6 There is an association between SOP laws and number of employed PAs seen only in 1998, with  
7 employed PAs more likely to be in restrictive states compared to average states (p 0.03). Since 1998, the  
8 number of PAs in the US has grown from 61,980 employed PAs to 109,200 in 2017. (See Table 1) Of  
9 interest, in 1998 73.4% of PAs were employed in a restrictive SOP state which decreased to 39.7% in  
10 2008 and 15.1% by 2017. As of 2017, the majority of PAs (51.7%) are employed in average states with  
11 33% employed in ideal states.

12  
13 There is an association between PA gender and SOP categories in 1998, with a per state mean of  
14 female PAs higher in restrictive states compared to average (p 0.02) and ideal (p 0.048). Over the study  
15 period, the state total mean number of PAs increased, while the mean number of female PAs in ideal  
16 states increase from 792.4 in 1998 to 4,145.3 in 2017. No association is seen between SOP categories and  
17 age. (See Table 1) Meanwhile, the mean age of employed PAs remained steady at 40–41 years old across  
18 all time points.

19  
20 Table 2 presents the associations between PA/population ratio and SOP categories. States with  
21 ideal and average SOP laws compared to restrictive states in 1998 did not differ significantly in their  
22 PA/population ratio. However, in 2008, comparing restrictive to average, and restrictive to ideal states  
23 was associated with 10.2 (p 0.03), and 14.8 (p 0.03) increase in ratio of employed PAs per 100,000  
24 population. In the year 2017, comparing restrictive to average, and restrictive to ideal states was  
25 associated with 11.1 (p 0.049), and 16.5 (p 0.01) increase in ratio of employed PAs per 100,000  
26 population.  
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**Table 1** Demographics of employed PAs by state scope of practice categories in 2017, 2008, and 1998

	2017				2008				1998			
	Ideal	Average	Restrictive	Total	Ideal	Average	Restrictive	Total	Ideal	Average	Restrictive	Total
State #	16	25	10	51	7	24	20	51	2	19	30	51
Practicing PA # (%)	36,080 (33.0)	56,630 (51.9)	16,490 (15.1)	<b>109,200</b>	8,200 (11.5)	34,935 (48.8)	28,400 (39.7)	<b>71,535</b>	2,510 (4.0)	13,950 (22.5)	45,520 (73.4)	<b>61,980</b>
Min (state)	220 (WY)	240 (VT)	250 (MS)	<b>220 (WY)</b>	210 (WY)	110 (AR)	180 (VT)	<b>110 (AR)</b>	570 (ME)	100 (WY)	170 (ND)	<b>100 (WY)</b>
Max (state)	12,150 (NY)	11,110 (CA)	6,080 (PA)	<b>12,150 (NY)</b>	3,060 (NC)	7,890 (NY)	4,010 (FL)	<b>7,890 (NY)</b>	1,940 (NC)	2,180 (IL)	5,660 (CA)	<b>5,660 (CA)</b>
Mean # of Employed female PA per state <sup>a</sup> (95% CI)	4,145.3 (1,250.7, 7,039.8)	3,338.0 (1,648.5, 5,027.5)	2,676.4 (1,051.4, 4,301.4)	<b>3,504.8</b> <b>(2,123.3, 4,886.3)</b>	1,488.8 (961.8, 2,015.9)	2,737.1 (1,221.8, 4,252.4)	1,527.9 (1,017.8, 2,038.0)	<b>2,114.0</b> <b>(1,196.6, 3,031.3)</b>	792.4 (458.5, 1,126.4)	736.2 (490.0, 982.3)	1,391.5 (900.9, 1,882.1)	<b>1,219.7</b> <b>(816.5, 1,622.9)</b>
									<i>I vs R</i> <i>P=0.048</i>	<i>A vs R</i> <i>P=0.02</i>	Reference	
Mean age <sup>a</sup> (95% CI)	39.6 (38.8, 40.5)	40.1 (39.1, 41.0)	38.6 (37.3, 39.9)	<b>39.7</b> <b>(39.0, 40.4)</b>	42.9 (41.2, 44.6)	41.2 (40.1, 42.4)	41.0 (39.9, 42.2)	<b>41.3</b> <b>(40.6, 42.1)</b>	40.9 (40.2, 41.7)	40.7 (39.8, 41.6)	41.0 (40.2, 41.8)	<b>40.9</b> <b>(40.3, 41.5)</b>

CI: Confidence Interval, R: Restrictive, A: Average, I: Ideal, Min: Minimum, Max: Maximum

Restrictive is defined as 0-2 key elements, average 3-4, ideal 5-6

P-value <0.05, statistically significant

<sup>a</sup> Mean number of female PAs and mean age is weighted by number of employed PAs by state

**Table 2** Ratio of employed PAs by state scope of practice categories, 2017, 2008, and 1998

	2017				2008				1998			
	Ideal	Average	Restrictive	Total	Ideal	Average	Restrictive	Total	Ideal	Average	Restrictive	Total
<b>Mean ratio of employed PAs per 100,000 population</b>												
Mean (95% CI)	42.6 (35.3, 49.9)	36.7 (30.9, 42.6)	26.1 (16.8, 35.3)	<b>36.5</b> <b>(32.2, 40.8)</b>	36.2 (24.7, 47.7)	31.7 (25.5, 37.9)	21.1 (14.3, 27.9)	<b>28.2</b> <b>(23.7, 32.7)</b>	35.1 (21.2, 48.9)	25.2 (20.7, 29.7)	23.9 (20.4, 27.5)	<b>24.9</b> <b>(22.1, 27.6)</b>
P-value	<b>0.01</b> <b>I vs R</b>	<b>0.055</b> <b>A vs R</b>	- Reference		<b>0.03</b> <b>I vs R</b>	<b>0.03</b> <b>A vs R</b>	- Reference		0.12 I vs R	0.65 A vs R	- Reference	

CI: Confidence Interval, R: Restrictive, A: Average, I: Ideal, Min: Minimum, Max: Maximum

Restrictive is defined as 0-2 key elements, average 3-4, ideal 5-6

P-value <0.05, statistically significant

Ratio = [employed PA in that year / state population in year] \* 100,000

## DISCUSSION

This is the first study to demonstrate that states with ideal SOP laws have an increased PA density. In 2017, states with ideal SOP had 43 PAs per 100,000 population while restrictive states had 26 PAs per 100,000 people. The PA/population ratio remained higher in ideal states compared to restrictive at each time point with this difference in ratio increasing over time from 11.2 in 1998 to 16.5 in 2017. This finding suggests that restrictive SOP laws limit demand for PAs and therefore limit supply. This outcome is similar to research on nurse practitioners where restrictions on SOP have been noted to affect productive capacity and provider supply.<sup>14</sup> This study shows a decrease in PA supply in states with restrictive SOP laws compared to states with ideal SOP laws, which may be from a lack of demand but this is not clear. Further investigation is needed to determine if a specific SOP key element is associated with PA employment numbers. Also, future research at the state level is needed to understand the possible interplay of state SOP laws and organizational policy.

Over the study period, there has been a decrease in the number of states with restrictive SOP laws, with a resulting change in the number of employed PAs from majority restrictive states to average and ideal states. These results expand the findings of Wing et al. (2004) and Gadbois et al. (2015) that PA SOP laws continue to expand and vary widely by state.<sup>16,30</sup> As of 2017, 16 states have ideal practice laws, but the majority of states remain with average SOP, while 10 still have restrictive. This leaves a heterogeneity in state SOP laws with only 15% of PAs employed in a restrictive SOP states as of 2017. It is unclear if PAs are moving away from restrictive SOP states or if there is a lack of demand to draw them to these states. With the majority of employed PAs in average or ideal states, it is understandable why the constituents of pushed for AAPA to change its policy to recommend Optimal Team Practice with a desire for increased practice autonomy. Research needs to focus on the impact that this expanded autonomy has on PA employment on both the expanded practice states and the restrictive practice states.

As there have been decades of SOP expansion and growth in the number of PAs, the median PA/population ratio has also risen. However, as of 2017 half of US states are defined as contractors or never adopters, with PA/population ratios below the national median. It is unclear if nurse practitioners or physicians are filling this provider gap. A recent study found that by expanding SOP laws for both PAs and NPs, the primary care workforce capacity increased particularly in rural areas, but that this change was limited.<sup>31</sup> As states work to address the projected physician shortage, the findings of this study are consistent with the hypothesis that SOP expansion will increase the PA workforce in a state. This finding allows for future research to examine the difference in patient access and health outcomes by state and PA/population ratio in the United States. This also highlights research that indicates that perhaps PA demand and daily work is not impacted as much by state SOP laws as organizational policies.<sup>32</sup> This study by Pittman et al. found that SOP laws were not associated with hospital privileges and that within

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2  
3 one state there was significant variation.<sup>32</sup> The findings of this study support our hypothesis that states  
4 with expanded SOP laws have a higher demand for PAs and therefore a higher number of employed PAs.  
5 This sheds some light on state to state variations in employment but more research is needed to  
6 understand the countless factors at play at the state level in the supply and demand for PAs.  
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### 10 11 Limitations

12 This study has a number of important limitations. First, we analyzed cross-section data at three  
13 timepoints, which may limit generalizability of the findings. However, to gain an understanding of  
14 causation, longitudinal analysis needs to be undertaken. Second, the low annual response rate for the  
15 AAPA data on PA demographics which was unknown in 1998 and ranged from 35-10% for the other  
16 timepoints may lead to a sampling bias towards or away from the null. Third, this analysis did not include  
17 other possible confounding variables that may impact PA employment numbers, including physician or  
18 nurse practitioner employment numbers, or state and federal healthcare legislative policies. Fourth, we  
19 were unable to account for lag time in terms of when the SOP laws were passed and the PA employment  
20 occurred. These limitations are counterbalanced by a number of important strengths, including the robust  
21 SOP data provided by AAPA that was cross referenced and verified for each state and each year  
22 combined with annual employment data from the Bureau of Labor and Statistics.  
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### 32 CONCLUSIONS

33 PA scope of practice laws in the United States have expanded since the turn of the century, with most  
34 states with average SOP, and ten states remaining in the restrictive category. Meanwhile, there has been  
35 steady growth in the mean PA/population ratio from 23 to 33 per 100,000 population over the same two  
36 decades. States with ideal SOP laws have an average of 16.5 more PAs per 100,000 population compared  
37 to a state with restrictive SOP laws. As states work to meet the projected physician shortage, this study  
38 supports the principle that SOP expansion may be an important lever to assist with increasing the PA  
39 workforce in a state. Future research needs to incorporate a longitudinal analysis with lag times to  
40 understand if specific key elements impact PA employment and the timeframe of that impact.  
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54 **Competing interests** None declared.  
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**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not required.

**Ethics approval** As we used publicly available BLS data, and the requested AAPA data does not contain identifying variables, this study was determined exempt from review by the University of Utah Institutional Review Board (IRB 00107271).

**Data availability statement** BLS has a public use linkage to access Labor Statistics data 1998–2017. The data from AAPA on PA census and legislative history was requested through AAPA research department.

## REFERENCES

1. AAMC. The complexities of physician supply and demand: projections from 2017-2032. [https://aamc-black.global.ssl.fastly.net/production/media/filer\\_public/31/13/3113ee5c-a038-4c16-89af-294a69826650/2019\\_update\\_-\\_the\\_complexities\\_of\\_physician\\_supply\\_and\\_demand\\_-\\_projections\\_from\\_2017-2032.pdf](https://aamc-black.global.ssl.fastly.net/production/media/filer_public/31/13/3113ee5c-a038-4c16-89af-294a69826650/2019_update_-_the_complexities_of_physician_supply_and_demand_-_projections_from_2017-2032.pdf). Published 2019. Accessed Aug 7, 2020.
2. HRSA. National and regional projections of supply and demand for internal medicine subspecialty practitioners: 2013-2025. <https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-analysis/research/projections/internal-medicine-subspecialty-report.pdf>. Published 2016. Accessed.
3. DHHS. State-level projections of supply and demand for primary care practitioners: 2013-2025. <https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-analysis/research/projections/primary-care-state-projections2013-2025.pdf>. Published 2016. Accessed.
4. Fraher E, Brandt B. Toward a system where workforce planning and interprofessional practice and education are designed around patients and populations not professions. *J Interprof Care*. 2019;33(4):389-397.
5. Auerbach DI, Chen PG, Friedberg MW, et al. Nurse-managed health centers and patient-centered medical homes could mitigate expected primary care physician shortage. *Health Aff (Millwood)*. 2013;32(11):1933-1941.
6. Fraher E, Machta R, Halladay J. The workforce transformations needed to staff value-based models of care. Sheps Center for Health Services Research. [http://www.shepscenter.unc.edu/wp-content/uploads/2015/12/DataBrief\\_ValueBasedWorkforce\\_FraherMachtaHalladay\\_final.pdf](http://www.shepscenter.unc.edu/wp-content/uploads/2015/12/DataBrief_ValueBasedWorkforce_FraherMachtaHalladay_final.pdf). Published 2015. Accessed June 20, 2020, 2020.



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7. KFF. Improving access to adult primary care in Medicaid: exploring the potential role of nurse practitioners and physician assistants. <https://www.kff.org/medicaid/issue-brief/improving-access-to-adult-primary-care-in/>. Published 2011. Accessed.
8. Sutton J, Ramos C, Lucado J. US physician assistant supply by state and county in 2009. *JAAPA*. 2010;23(9):E3-E8.
9. Wiler JL, Rooks SP, Ginde AA. Update on midlevel provider utilization in U.S. emergency departments, 2006 to 2009. *Acad Emerg Med*. 2012;19(8):986-989.
10. Sekscenski ES, Sansom S, Bazell C, Salmon ME, Mullan F. State practice environments and the supply of physician assistants, nurse practitioners, and certified nurse-midwives. *N Engl J Med*. 1994;331(19):1266-1271.
11. Glick AD, Miller AA. Physician assistants: from pipeline to practice. *Acad Med*. 2013;88(12):1883-1889.
12. Hing E, Chun-Ju H. In which states are physician assistants or nurse practitioners more likely to work in primary care? *JAAPA*. 2015;28(9):46-53.
13. Kuo YF, Loresto FL, Jr., Rounds LR, Goodwin JS. States with the least restrictive regulations experienced the largest increase in patients seen by nurse practitioners. *Health Aff (Millwood)*. 2013;32(7):1236-1243.
14. Reagan PB, Salsberry PJ. The effects of state-level scope-of-practice regulations on the number and growth of nurse practitioners. *Nurs Outlook*. 2013;61(6):392-399.
15. Willis J. Barriers to PA practice in primary care and rural medically underserved areas. *JAAPA*. 1993;6(6):418-422.
16. Wing P, Langelier MH, Salsberg ES, Hooker RS. The changing professional practice of physician assistants: 1992 to 2000. *Jaapa*. 2004;17(1):37-40, 42, 45-39.
17. IOM. The future of nursing: leading change, advancing health. In. Washington, DC: National Academies Press; 2011.
18. Walker C. 2016 was another banner year for PAs at the state level. <https://www.aapa.org/news-central/2017/02/2016-another-banner-year-pa-profession-state-level/>. Published 2019. Accessed.
19. Timmons EJ. The effects of expanded nurse practitioner and physician assistant scope of practice on the cost of Medicaid patient care. *Health Policy*. 2017;121(2):189-196.
20. Sobel J. Seven things you should know about optimal team practice. *Jaapa*. 2019;32(5):12-13.
21. AAPA. What is optimal team practice? <https://www.aapa.org/advocacy-central/optimal-team-practice/>. Published 2017. Accessed Aug 7, 2020.
22. Morgan P, Everett C, Humenick K, Valentin V. Specialty choice among US physician assistants: distribution, salaries, and comparison to physicians. *JAAPA*. 2016;29(7):46-52.
23. Smith DT, Jacobson CK. Racial and Gender Disparities in the Physician Assistant Profession. *Health Serv Res*. 2016;51(3):892-909.
24. NCCPA. Statistical profile of certified physician assistants: an annual report of the National Commission on Certification of Physician Assistants. <https://prodcmsstoragesa.blob.core.windows.net/uploads/files/2018StatisticalProfileofCertifiedPhysicianAssistantsbyState.pdf>. Published 2018. Accessed.

- 1
- 2
- 3
- 4 25. BLS. Occupational employment and wages, May 2018: 29-1071 Physician Assistants.  
5 <https://www.bls.gov/oes/current/oes291071.htm#st>. Published 2018. Accessed Aug 7,  
6 2020.
- 7 26. census.gov. Annual estimates of the resident population for the United States, regions,  
8 states, and Puerto Rico: April 1, 2010 to July 1, 2019 (NST-EST2019-01). 2019.
- 9 27. census.gov. Intercensal estimates of the resident population for the United States,  
10 regions, states, and Puerto Rico: April 1, 2000 to July 1, 2010 (ST-EST00INT-01). 2011.
- 11 28. census.gov. State and county intercensal tables: 1990-2000.  
12 [https://www.census.gov/data/tables/time-series/demo/popest/intercensal-1990-2000-](https://www.census.gov/data/tables/time-series/demo/popest/intercensal-1990-2000-state-and-county-totals.html)  
13 [state-and-county-totals.html](https://www.census.gov/data/tables/time-series/demo/popest/intercensal-1990-2000-state-and-county-totals.html). Published 2016. Accessed May 5, 2020.
- 14 29. AAPA. The six key elements of a modern PA practice act. [https://www.aapa.org/wp-](https://www.aapa.org/wp-content/uploads/2016/12/Issue_Brief_Six_Key_Elements.pdf)  
15 [content/uploads/2016/12/Issue\\_Brief\\_Six\\_Key\\_Elements.pdf](https://www.aapa.org/wp-content/uploads/2016/12/Issue_Brief_Six_Key_Elements.pdf). Published 2016. Accessed  
16 Aug 7, 2020.
- 17 30. Gadbois EA, Miller EA, Tyler D, Intrator O. Trends in state regulation of nurse  
18 practitioners and physician assistants, 2001 to 2010. *Med Care Res Rev*. 2015;72(2):200-  
19 219.
- 20 31. Graves JA, Mishra P, Dittus RS, Parikh R, Perloff J, Buerhaus PI. Role of Geography and  
21 Nurse Practitioner Scope-of-Practice in Efforts to Expand Primary Care System Capacity:  
22 Health Reform and the Primary Care Workforce. *Med Care*. 2016;54(1):81-89.
- 23 32. Pittman P, Leach B, Everett C, Han X, McElroy D. NP and PA Privileging in Acute Care  
24 Settings: Do Scope of Practice Laws Matter? *Med Care Res Rev*. 2020;77(2):112-120.  
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Figure 1: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories: United States, 1998

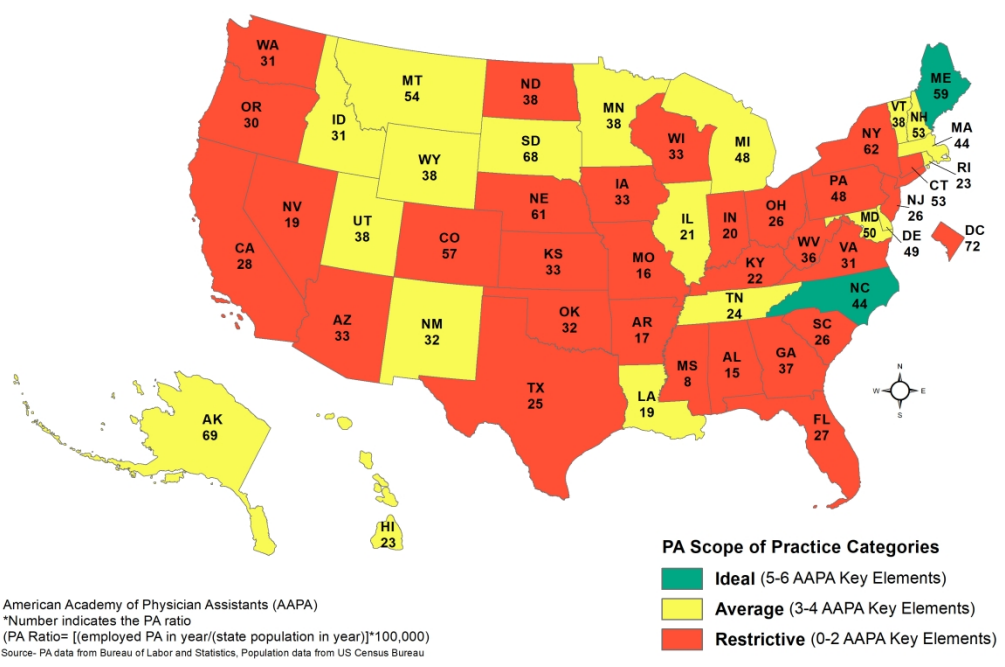
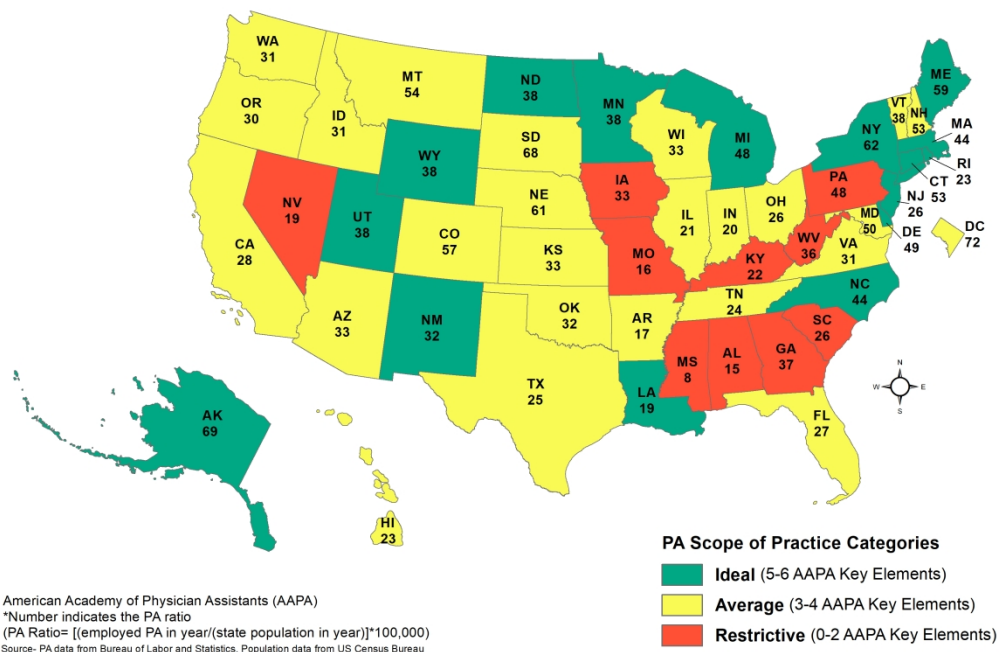
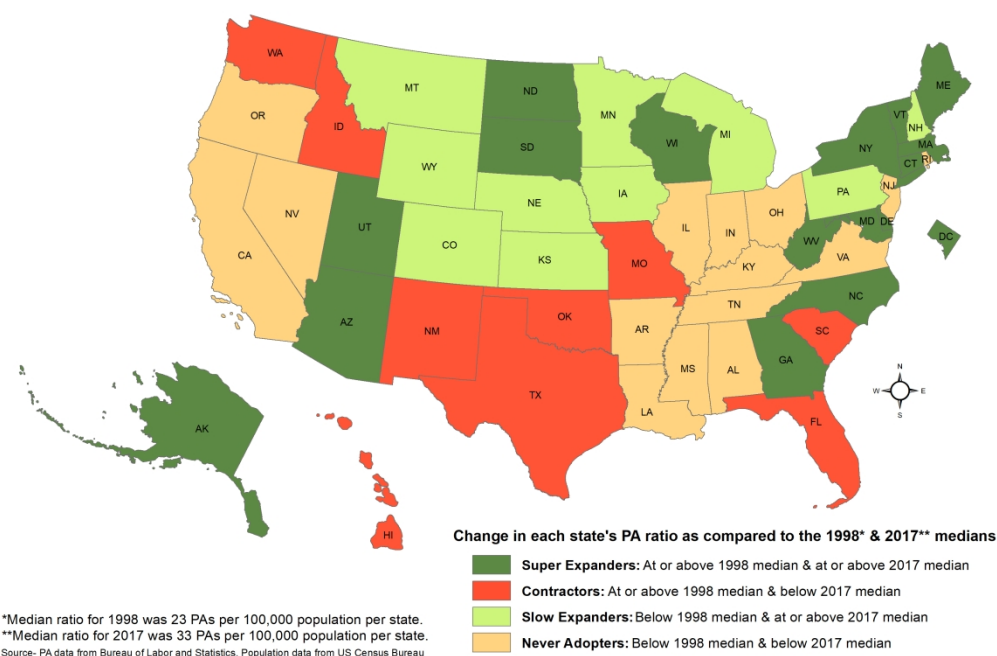


Figure 2: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories: United States, 2017



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Figure 3: Change in State Ratio of Physician Assistants per 100,000 Population from 1998 - 2017



Supplemental Table 1: State Ratio<sup>a</sup> of Physician Assistants per 100,000 Population per State in 1998, 2008, and 2017

State	1998 <sup>b</sup> Ratio/100,000 Population	2008 Ratio/100,000 Population	2017 <sup>c</sup> Ratio/100,000 Population
<b>Super Expanders</b>			
Alaska (AK)	26	42	69
Arizona (AZ)	56	22	33
Connecticut (CT)	31	36	53
Delaware (DE)	39	29	49
District of Columbia (DC)	46	97	72
Georgia (GA)	24	25	37
Maine (ME)	45	55	59
Maryland (MD)	35	27	50
Massachusetts (MA)	26	39	44
New York (NY)	24	41	62
North Carolina (NC)	25	33	44
North Dakota (ND)	26	52	38
South Dakota (SD)	29	53	68
Utah (UT)	25	23	38
Vermont (VT)	47	29	38
West Virginia (WV)	39	35	36
Wisconsin (WI)	35	28	33
<b>Contractors</b>			
Florida (FL)	26	22	27
Hawaii (HI)	29	23	23
Idaho (ID)	27	31	31
Missouri (MO)	23	11	16
New Mexico (NM)	25	34	32
Oklahoma (OK)	38	30	32
South Carolina (SC)	24	13	26
Texas (TX)	24	16	25
Washington (WA)	27	28	31
<b>Slow Expanders</b>			
Colorado (CO)	21	27	57
Iowa (IA)	22	23	33
Kansas (KS)	19	23	33
Michigan (MI)	21	30	48
Minnesota (MN)	19	25	38
Montana (MT)	21	59	54
Nebraska (NE)	22	49	61
New Hampshire (NH)	17	38	53
Pennsylvania (PA)	19	30	48
Wyoming (WY)	20	38	38
<b>Never Adopters</b>			
Alabama (AL)	9	8	15
Arkansas (AR)	14	4	17
California (CA)	17	20	28
Illinois (IL)	18	20	21
Indiana (IN)	22	13	20
Kentucky (KY)	11	15	22
Louisiana (LA)	22	14	19
Mississippi (MS)	19	8	8
Nevada (NV)	13	18	19
New Jersey (NJ)	14	11	26
Ohio (OH)	15	14	26
Oregon (OR)	18	17	30
Rhode Island (RI)	13	21	23
Tennessee (TN)	20	21	24
Virginia (VA)	19	18	31

**Super Expanders:** At or above 1998 median & at or above 2017 median

**Contractors:** At or above 1998 median & below 2017 median

**Slow Expanders:** Below 1998 median & at or above 2017 median

**Never Adopters:** Below 1998 median & below 2017 median

<sup>a</sup> PA Ratio = (employed PA in year/state population in year) \* 100,000

<sup>b</sup> The median ratio for 1998 was 23 PAs per 100,000 population per state.

<sup>c</sup> The median ratio for 2017 was 33 PAs per 100,000 population per state.

## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	6
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	None

Continued on next page

<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-7
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Figures 1-3, Supplemental Table 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	6
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6-7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7
		(b) Report category boundaries when continuous variables were categorized	5-6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Supplemental Table 1
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	7-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	9

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely

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2 available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at  
3 <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is  
4 available at [www.strobe-statement.org](http://www.strobe-statement.org).  
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# BMJ Open

## Cross-sectional Analysis of United States Scope of Practice Laws and Employed Physician Assistants

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<b>Primary Subject Heading</b>:	Health policy
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Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Organisational development < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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**Word Count**

2,749

## Cross-sectional Analysis of United States Scope of Practice Laws and Employed Physician Assistants

### Abstract

#### Objective

This study examined if the variation in Physician Assistant (PA) state Scope of Practice (SOP) laws across states are associated with number of employed PAs, PA demographics and PA/population ratio per state. The hypothesis was that less restrictive SOP laws will increase the demand for PAs and the number of PAs in a state.

#### Design

Retrospective cross-sectional analysis at three time points: 1998, 2008, 2017.

#### Setting

Fifty states and the District of Columbia.

#### Participants

Employed PAs in 1998, 2008, 2017.

#### Methods

SOP laws were categorized as permissive, average and restrictive. Three national datasets were combined to allow for descriptive analysis of employed PAs by year and SOP categories. We used linear predictive models to generate and compare PA/population ratio least square means by SOP categories for each year. Models were adjusted for percent female PA and PAs mean age.

#### Results

There was a median PA/population ratio of 23 per 100,000 population in 1998 and 33 in 2017. A heterogeneous expansion of SOP laws was seen with 17 states defined as super expanders while 15 were never adopters. In 2017, comparing restrictive to permissive states showed that in adjusted models permissive SOP laws were associated with 11.7 (p .03) increase in ratio of employed PAs per 100,000 population, demonstrating that states with permissive SOP laws have an increased PA density.

#### Conclusions

There has been steady growth in the mean PA/population ratio since the turn of the century. At the same time, PA scope of practice laws in the United States have expanded, with just ten states remaining in the restrictive category. Permissive SOP laws are associated with an increase in the ratio of employed PAs per state population. As states work to meet the projected physician need, SOP expansion may be an important policy consideration to increase the PA workforce.

#### Key Words

Physician Assistant, Scope of Practice Laws, Workforce, Employment

#### Strengths and Limitations

- Data from the Bureau of Labor and Statistics (BLS) provided employed Physician Assistants (PAs) census data for all employed PAs from 1998, 2008 and 2017 for all 50 states and the District of Columbia.
- Comprehensive state legislative SOP data from the American Academy of Physician Assistants (AAPA) was cross referenced and verified for each state and each year and then combined with the annual employment data from the BLS.
- This is the first study analyzing two decades of national PA employment for all 50 states and the District of Columbia across three time points to describe the effect of state SOP laws on PAs.
- The analysis did not include other possible confounding variables that may impact PA employment numbers, including physician or nurse practitioner employment numbers, or state and federal healthcare legislative policies.
- The analysis was unable to account for lag time in terms of when the SOP laws were passed and the PA employment occurred.

## Cross-sectional Analysis of United States Scope of Practice Laws and Employed Physician Assistants

### INTRODUCTION

The Association of American Medical Colleges projects a shortage of 46,900 to 121,900 physicians by 2032.<sup>1</sup> Analysis of workforce supply and demand at the state level reveals that this shortage will likely be distributed unequally; some states have a lower supply of providers than others, rural shortages tends to be worse than urban settings, and some specialties are in greater demand than others.<sup>2-4</sup> Increased use of Physician Assistants (PAs) is one potential solution that has been proffered to address the current and anticipated deficiency.<sup>5-8</sup> One important factor that can facilitate or restrict the capacity of PAs to fill the provider shortage is state scope of practice (SOP) laws.<sup>9,10</sup>

Research indicates that favorable SOP legislation is associated with an increase in the supply of healthcare providers.<sup>11</sup> A number of previous studies have demonstrated that the supply of PAs and Nurse Practitioners (NPs) within a state is inversely related with the restrictiveness of SOP laws.<sup>9,12-17</sup> In 2010, the Institute of Medicine report on the Future of Nursing recommended full SOP for nurses, which became the catalyst for SOP expansion for NPs.<sup>18</sup> While striving to work at the top of their license, NPs have shown that restrictions on SOP is associated with reduced growth and number of available NPs in communities.<sup>10</sup> One 2009 study of PAs noted that SOP laws may effect PA/population ratio by state but to date, the effect of SOP on PA employment has not been clearly delineated.<sup>9</sup>

Throughout the decades, PAs have worked at the state level to push for expansion of PA practice laws to decrease the barriers to providing patient care. These efforts occur state by state with, for example, 20 states in 2017 proposing legislation to amend SOP laws for PAs.<sup>19</sup> Despite this work, there remains wide variation in PA SOP laws in the United States, ranging from highly restrictive to top-of-license practice.<sup>9,20</sup> In support of top-of-license practice, in 2017, the American Academy of Physician Assistants (AAPA) moved to adopt Optimal Team Practice (OTP), this proposed practice act is intended to further increase the autonomy of PAs.<sup>21</sup> The tenets of OTP include eliminating a legal requirement for a specific relationship with a physician, creating a separate majority-PA board to regulate PAs, and authorize PAs to directly bill for services.<sup>22</sup>

Fifty years since the inception of the PA profession, there has been a demographic shift from predominantly male to majority female and from largely primary care providers to specialists.<sup>23,24</sup> At the same time, the profession remains young with the median age of employed PAs remaining steady at 38 years old since 2012.<sup>25</sup> It is unknown if this demographic shift is due, at least in part, to changes in SOP laws. The purpose of this study was to examine whether, and to what degree, variation in PA state SOP laws across states are associated with 1) number of employed PAs per state; 2) PA demographics and 3)

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3 PA/population ratio per state. The hypothesis was that restrictive SOP laws limit the demand for PAs,  
4 with subsequent impacts on the PA workforce, while less restrictive SOP laws will increase the demand  
5 for PAs and therefore the number of PAs in a state.  
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## 10 **METHODS**

11 Cross-sectional analysis at three time points (1998, 2008, 2017) was used to estimate the association of  
12 state scope of practice laws and the PA/population ratio, comparing states with restrictive SOP with  
13 average and permissive SOP laws. Three time points were used to demonstrate the change in SOP laws  
14 and impact over time. We used three SOP categories permissive, average and restrictive, based on the  
15 number of PA SOP Key Elements which builds upon prior work by Wing et al.<sup>17</sup>  
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### 19 Data sources and setting

20 Data were obtained from the Bureau of Labor and Statistics (BLS), AAPA census, and the AAPA  
21 database on PA legislative history for all fifty states and the District of Columbia for the years 1998, 2008  
22 and 2017. The three datasets were combined to allow for analysis of the years of 1998, 2008 and 2017.<sup>26</sup>  
23 The University of Utah Institutional Review Board (IRB) determined that this project does not meet the  
24 definition of Human Subject Research.  
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### 29 Sample/Participants

30 The combined state/year dataset (N=153) included number of employed PAs in each state (50 states and  
31 District of Columbia for 3 time points) from the BLS, PA demographics from the AAPA census and state  
32 SOP laws from AAPA legislative history. Response rates for AAPA census report was unknown for  
33 1998, 34.5% in 2008 and 10.2% in 2017.  
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### 40 Variables

41 Data from BLS provided the number of PAs employed by state and by year.<sup>26</sup> PA ratio was then  
42 calculated as: [employed PA in that year/state population in year<sup>27-29</sup>]\*100,000. When comparing  
43 PA/population ratio over time the researchers defined states as super expanders, contractors, slow  
44 expanders and never adopters. Super expanders are defined as states with at or above the median ratio in  
45 1998 and remained at or above the median in 2017. Contractors are defined as states with at or above the  
46 median ratio in 1998 and fell below the median in 2017. Slow expanders are defined as states with below  
47 the median in 1998 and rose to at or above the median PA/population ratio by 2017. Never adopters are  
48 defined as states with below the median PA/population ratio in 1998 and remained below in 2017.  
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3 The AAPA established the permissive PA practice act which includes the 6 Key Elements of a  
4 Modern PA Practice Act: 1) licensure as a regulatory term, 2) full prescriptive authority, 3) scope of  
5 practice determined at the practice level, 4) adaptable collaboration requirements, 5) co-signature  
6 requirements determined at the practice level and 6) number of PAs a physician may collaborate with  
7 determined at the practice level.<sup>30</sup> Data from AAPA included which six key elements were approved in  
8 each state by year and the total number of six key elements was calculated. Consistent with prior research,  
9 each state was categorized into one of three SOP groups based on the number of key elements adopted:  
10 permissive SOP (5-6 elements), average SOP (3-4 elements) and restrictive SOP (0-2 elements).<sup>17</sup> The  
11 AAPA census provided mean age and mean female gender. Mean age and female gender was weighted  
12 by number of PAs employed in each state. There were no missing data for the number of key elements,  
13 mean age, or mean gender. For number of employed PAs in 2008 there was missing data for California  
14 and Pennsylvania. Missing data for 2008 were imputed by taking the average of the number of PAs from  
15 2007 and 2009.  
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#### 25 Statistical analysis

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27 Descriptive statistics were used to demonstrate the geographic location and change in the number of states  
28 categorized as permissive, average, and restrictive SOP with the PA/population ratio for each state for the  
29 years of 1998 and 2017 and presented visually with maps (Figures 1 and 2). The change in PA/population  
30 ratio per state over the time period relative to the median PA/population ratio for the nation was  
31 determined and presented visually with a map (Figure 3). Descriptive statistics by year and SOP  
32 categories was determined including number of states, number of employed PAs, percent of female PAs,  
33 and mean age of PAs.  
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38 We used unadjusted survey linear regression models to generate least squares mean (95% CI) of  
39 age and percent of female PAs for each scope of practice level, incorporating weights to account for state-  
40 level differences in PA population demographics. Linear mixed models were used to generate and  
41 compare least-squares mean of PA/population ratio by SOP categories, with restrictive as the reference  
42 for the years of 1998, 2008 and 2017. All analyses were conducted using SAS version 9.4.  
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#### 48 RESULTS

49 Over the study period, the number of states in the permissive SOP category increased, as did the PA ratio.  
50 The number of permissive states increased from 2 in 1998 to 7 in 2008 and 16 by 2017, while the  
51 restrictive states went from 30 in 1998 to 20 in 2008 and 10 in 2017. (See Figure 1 and 2) In 1998 the  
52 median PA/population ratio was 23 PAs per 100,000 population and 33 per 100,000 in 2017. Figure 3  
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3 shows that 17 states are defined as super expanders while 9 states are contractors, 10 are slow expanders,  
4 and 15 are never adopters. (See Supplemental Table 1 for PA/population ratio of each state)

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6 Since 1998, the number of PAs in the US has grown from 61,980 employed PAs to 109,200 in  
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8 2017. (See Table 1) Of interest, in 1998 73.4% of PAs were employed in a restrictive SOP state which  
9 decreased to 39.7% in 2008 and 15.1% by 2017. As of 2017, the majority of PAs (51.9%) are employed  
10 in average states with 33.0% employed in permissive states.  
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13 There is no association between percent PA gender and SOP categories in the selected years.  
14 Over the study period, the state total mean number of PAs increased, while the mean percent of female  
15 PAs in permissive states increased from 48.2% in 1998 to 68.3% in 2017. No association is seen between  
16 SOP categories and age. (See Table 1) Meanwhile, the mean age of employed PAs remained steady at  
17 40–41 years old across all time points.  
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20 Table 2 presents the associations between unadjusted and adjusted PA/population ratio and SOP  
21 categories. States with permissive and average SOP laws compared to restrictive states in 1998 did not  
22 differ significantly in their PA/population ratio. However, in 2008, in unadjusted models, comparing  
23 restrictive to average, and restrictive to permissive states was associated with 10.6 (p .03), and 15.1 (p  
24 .03) increase in ratio of employed PAs per 100,000 population. In the adjusted models still compared to  
25 restrictive states, the average states had 9.4 (p .04) higher ratio. In the year 2017, comparing restrictive to  
26 permissive states was associated with 16.5 (p .01) , and 11.7 (p .03) increase in ratio of employed PAs per  
27 100,000 population, in unadjusted and adjusted models, respectively.  
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**Table 1** Demographics of employed PAs by state scope of practice categories in 2017, 2008, and 1998

	2017				2008				1998			
	Permissive	Average	Restrictive	Total	Permissive	Average	Restrictive	Total	Permissive	Average	Restrictive	Total
State #	16	25	10	51	7	24	20	51	2	19	30	51
Total PA (%)	36,080 (33.0)	56,630 (51.9)	16,490 (15.1)	<b>109,200</b>	8,200 (11.5)	34,935 (48.8)	28,400 (39.7)	<b>71,535</b>	2,510 (4.0)	13,950 (22.5)	45,520 (73.4)	<b>61,980</b>
Minimum (state)	220 (WY)	240 (VT)	250 (MS)	<b>220 (WY)</b>	210 (WY)	110 (AR)	180 (VT)	<b>110 (AR)</b>	570 (ME)	100 (WY)	170 (ND)	<b>100 (WY)</b>
Maximum (state)	12,150 (NY)	11,110 (CA)	6,080 (PA)	<b>12,150 (NY)</b>	3,060 (NC)	7,890 (NY)	4,010 (FL)	<b>7,890 (NY)</b>	1,940 (NC)	2,180 (IL)	5,660 (CA)	<b>5,660 (CA)</b>
Mean percent female PA <sup>a</sup> (95% CI)	68.3 (66.1, 70.6)	68.5 (66.5, 70.6)	72.6 (67.8, 77.3)	<b>69.1 (67.4, 70.8)</b>	60.9 (56.3, 65.4)	65.7 (63.1, 68.4)	63.4 (60.0, 66.8)	<b>64.2 (62.1, 66.3)</b>	48.2 (46.9, 49.6)	51.2 (46.1, 56.3)	48.2 (44.7, 51.7)	<b>48.9 (46.0, 51.8)</b>
Mean age <sup>a</sup> (95% CI)	39.6 (38.8, 40.5)	40.1 (39.1, 41.0)	38.6 (37.3, 39.9)	<b>39.7 (39.0, 40.4)</b>	42.9 (41.2, 44.6)	41.2 (40.1, 42.4)	41.0 (39.9, 42.2)	<b>41.3 (40.6, 42.1)</b>	40.9 (40.2, 41.7)	40.7 (39.8, 41.6)	41.0 (40.2, 41.8)	<b>40.9 (40.3, 41.5)</b>

CI: Confidence Interval, R: Restrictive, A: Average, P: Permissive  
Restrictive is defined as 0-2 key elements, average 3-4, permissive 5-6

<sup>a</sup> Unadjusted survey linear regression models were used to generate least square means (95% CI), weighted by the states' population (none significant).

**Table 2** Ratio of employed PAs by state scope of practice categories, 2017, 2008, and 1998

	2017				2008				1998			
	Permissive	Average	Restrictive	Total	Permissive	Average	Restrictive	Total	Permissive	Average	Restrictive	Total
<b>Mean ratio of employed PAs per 100,000 population</b>												
Unadjusted (95% CI)	42.6	36.7	26.1	<b>36.5</b>	36.2	31.7	21.1	<b>28.2</b>	35.1	25.2	23.9	<b>24.8</b>
P-value	(35.3, 49.9)	(30.9, 42.6)	(16.8, 35.3)	<b>(32.2, 40.8)</b>	(24.7, 47.7)	(25.5, 37.9)	(14.3, 27.9)	<b>(23.7, 32.7)</b>	(21.2, 48.9)	(20.7, 29.7)	(20.4, 27.5)	<b>(22.1, 27.6)</b>
	<b>0.01</b>	0.055	-		<b>0.03</b>	<b>0.03</b>	-		0.12	0.65	-	
	<b>P vs R</b>	A vs R	Reference		<b>P vs R</b>	<b>A vs R</b>	Reference		P vs R	A vs R	Reference	
Adjusted <sup>a</sup> (95% CI)	40.9	36.5	29.2		32.4	31.8	22.4		35.1	24.8	24.2	
P-value	(34.7, 47.1)	(31.6, 41.5)	(21.3, 37.1)		(20.3, 44.6)	(25.9, 37.7)	(15.8, 28.9)		(21.3, 48.8)	(20.3, 29.3)	(20.6, 27.8)	
	<b>0.03</b>	0.12	-		0.16	<b>0.04</b>	-		0.13	0.84	-	
	<b>P vs R</b>	A vs R	Reference		P vs R	<b>A vs R</b>	Reference		P vs R	A vs R	Reference	

CI: Confidence Interval, R: Restrictive, A: Average, P: Permissive  
Restrictive is defined as 0-2 key elements, average 3-4, Permissive 5-6

P-value <0.05, statistically significant

Ratio = [employed PA in that year / state population in year] \* 100,000

Linear mixed models were used to generate least square means.

<sup>a</sup> Adjusted for percent female PA and mean age

## DISCUSSION

This is the first study to demonstrate that states with permissive SOP laws have an increased PA density. In 2017, states with permissive SOP had 43 PAs per 100,000 population while restrictive states had 26 PAs per 100,000 people. The PA/population ratio remained higher in permissive states compared to restrictive at each time point with this difference in ratio increasing over time from 11.2 in 1998 to 16.5 in 2017. This finding suggests that restrictive SOP laws limit demand for PAs and therefore limit supply. This outcome is similar to research on nurse practitioners where restrictions on SOP have been noted to affect productive capacity and provider supply.<sup>15</sup> This study shows a decrease in PA supply in states with restrictive SOP laws compared to states with permissive SOP laws, which may be from a lack of demand but this is not clear. Further investigation is needed to determine if a specific SOP key element is associated with PA employment numbers. Also, future research at the state level is needed to understand the possible interplay of state SOP laws and organizational policy.

Over the study period, there has been a decrease in the number of states with restrictive SOP laws, with a resulting change in the number of employed PAs from majority restrictive states to average and permissive states. These results expand the findings of Wing et al. (2004) and Gadbois et al. (2015) that PA SOP laws continue to expand and vary widely by state.<sup>17,31</sup> As of 2017, 16 states have permissive practice laws, but the majority of states remain with average SOP, while 10 still have restrictive. This leaves a heterogeneity in state SOP laws with only 15% of PAs employed in a restrictive SOP states as of 2017. It is unclear if PAs are moving away from restrictive SOP states or if there is a lack of demand to draw them to these states. With the majority of employed PAs in average or permissive states, it is understandable why the constituents of pushed for AAPA to change its policy to recommend Optimal Team Practice with a desire for increased practice autonomy. Research needs to focus on the impact that this expanded autonomy has on PA employment on both the expanded practice states and the restrictive practice states.

As there have been decades of SOP expansion and growth in the number of PAs, the median PA/population ratio has also risen. However, as of 2017 half of US states are defined as contractors or never adopters which demonstrates that PA policy makers still have a long road ahead to assure that all PAs are working within the full scope of their license. It is unclear if nurse practitioners or physicians are filling this provider gap. A recent study found that by expanding SOP laws for both PAs and NPs, the primary care workforce capacity increased particularly in rural areas, but that this change was limited.<sup>32</sup> As states work to address the projected physician shortage, the findings of this study are consistent with the hypothesis that SOP expansion will increase the PA workforce in a state. This finding allows for future research to examine the difference in patient access and health outcomes by state and PA/population ratio in the United States. Work by Pittman et al. argues that SOP laws were not associated

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3 with hospital privileges and that within one state there was significant variation.<sup>33</sup> The findings of this  
4 study support our hypothesis that states with expanded SOP laws have a higher demand for PAs and  
5 therefore a higher number of employed PAs. This sheds some light on state to state variations in  
6 employment but more research is needed to understand the countless factors at play at the state level in  
7 the supply and demand for PAs.  
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### 11 12 13 Limitations

14 This study has a number of important limitations. First, we analyzed cross-section data at three  
15 timepoints, which may limit generalizability of the findings. However, to gain an understanding of  
16 causation, longitudinal analysis needs to be undertaken. Second, the low annual response rate for the  
17 AAPA data on PA demographics which was unknown in 1998 and ranged from 35-10% for the other  
18 timepoints may lead to a sampling bias towards or away from the null. Third, this analysis did not include  
19 other possible confounding variables that may impact PA employment numbers, including physician or  
20 nurse practitioner employment numbers, or state and federal healthcare legislative policies. Fourth, we  
21 were unable to account for lag time in terms of when the SOP laws were passed and the PA employment  
22 occurred. Fifth, the categorization of SOP elements in three categories considers each element to be equal  
23 and interchangeable which is unlikely. Future research should consider each element individually and the  
24 impact on employment. These limitations are counterbalanced by a number of important strengths,  
25 including the robust SOP data provided by AAPA that was cross referenced and verified for each state  
26 and each year combined with annual employment data from the Bureau of Labor and Statistics.  
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### 37 CONCLUSIONS

38 PA scope of practice laws in the United States have expanded since the turn of the century, with most  
39 states with average SOP, and ten states remaining in the restrictive category. Meanwhile, there has been  
40 steady growth in the mean PA/population ratio from 23 to 33 per 100,000 population over the same two  
41 decades. States with permissive SOP laws have an average of 16.5 more PAs per 100,000 population  
42 compared to a state with restrictive SOP laws. As states work to meet the projected physician shortage,  
43 this study supports the principle that SOP expansion may be an important lever to assist with increasing  
44 the PA workforce in a state. Future research needs to incorporate a longitudinal analysis with lag times to  
45 understand if specific key elements impact PA employment and the timeframe of that impact.  
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52 **Contributorship Statement** VLV, SN, and CE were involved in the data analysis, interpretation, drafting  
53 the manuscript, and reviewed/edited the manuscript.  
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6 organization.  
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9 Grant number: N/A  
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13 **Competing interests** None declared.  
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16 **Patient and public involvement** Patients and/or the public were not involved in the design, or conduct,  
17 or reporting, or dissemination plans of this research.  
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21 **Patient consent for publication** Not required.  
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24 **Ethics approval** As we used publicly available BLS data, and the requested AAPA data does not contain  
25 identifying variables, this study was determined exempt from review by the University of Utah  
26 Institutional Review Board (IRB 00107271).  
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30 **Data availability statement** BLS has a public use linkage to access Labor Statistics data 1998–2017. The  
31 data from AAPA on PA census and legislative history was requested through AAPA research department.  
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### 33 34 **Figure legend/Caption**

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36 Figure 1: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories:  
37 United States, 1998  
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41 Figure 2: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories:  
42 United States, 2017  
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46 Figure 3: Change in State Ratio of Physician Assistants per 100,000 Population from 1998 - 2017  
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### 48 49 **REFERENCES**

- 50  
51  
52 1. AAMC. The complexities of physician supply and demand: projections from 2017-2032.  
53 [https://aamc-black.global.ssl.fastly.net/production/media/filer\\_public/31/13/3113ee5c-](https://aamc-black.global.ssl.fastly.net/production/media/filer_public/31/13/3113ee5c-a038-4c16-89af-294a69826650/2019_update_-)  
54 [a038-4c16-89af-294a69826650/2019\\_update\\_-](https://aamc-black.global.ssl.fastly.net/production/media/filer_public/31/13/3113ee5c-a038-4c16-89af-294a69826650/2019_update_-)  
55

- 1  
2  
3 [the complexities of physician supply and demand - projections from 2017-](#)  
4 [2032.pdf](#). Published 2019. Accessed Aug 7, 2020.
- 5  
6 2. HRSA. National and regional projections of supply and demand for internal medicine  
7 subspecialty practitioners: 2013-2025.  
8 <https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce->  
9 [analysis/research/projections/internal-medicine-subspecialty-report.pdf](https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-). Published  
10 2016. Accessed.
- 11  
12 3. DHHS. State-level projections of supply and demand for primary care practitioners:  
13 2013-2025. <https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce->  
14 [analysis/research/projections/primary-care-state-projections2013-2025.pdf](https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-). Published  
15 2016. Accessed.
- 16  
17 4. Fraher E, Brandt B. Toward a system where workforce planning and interprofessional  
18 practice and education are designed around patients and populations not professions. *J*  
19 *Interprof Care*. 2019;33(4):389-397.
- 20  
21 5. Auerbach DI, Chen PG, Friedberg MW, et al. Nurse-managed health centers and patient-  
22 centered medical homes could mitigate expected primary care physician shortage.  
23 *Health Aff (Millwood)*. 2013;32(11):1933-1941.
- 24  
25 6. Fraher E, Machta R, Halladay J. The workforce transformations needed to staff value-  
26 based models of care. Sheps Center for Health Services Research.  
27 <http://www.shepscenter.unc.edu/wp->  
28 [content/uploads/2015/12/DataBrief\\_ValueBasedWorkforce\\_FraherMachtaHalladay\\_fin](http://www.shepscenter.unc.edu/wp-)  
29 [al.pdf](http://www.shepscenter.unc.edu/wp-). Published 2015. Accessed June 20, 2020, 2020.
- 30  
31 7. KFF. Improving access to adult primary care in Medicaid: exploring the potential role of  
32 nurse practitioners and physician assistants. <https://www.kff.org/medicaid/issue->  
33 [brief/improving-access-to-adult-primary-care-in/](https://www.kff.org/medicaid/issue-). Published 2011. Accessed.
- 34  
35 8. McMichael B. Beyond Physicians: The Effect of Licensing and Liability Laws on the Supply  
36 of Nurse Practitioners and Physician Assistants. *Journal of Empirical Legal Studie*.  
37 2018;15(4):732-771.
- 38  
39 9. Sutton J, Ramos C, Lucado J. US physician assistant supply by state and county in 2009.  
40 *JAAPA*. 2010;23(9):E3-E8.
- 41  
42 10. Wiler JL, Rooks SP, Ginde AA. Update on midlevel provider utilization in U.S. emergency  
43 departments, 2006 to 2009. *Acad Emerg Med*. 2012;19(8):986-989.
- 44  
45 11. Sekscenski ES, Sansom S, Bazell C, Salmon ME, Mullan F. State practice environments  
46 and the supply of physician assistants, nurse practitioners, and certified nurse-midwives.  
47 *N Engl J Med*. 1994;331(19):1266-1271.
- 48  
49 12. Glick AD, Miller AA. Physician assistants: from pipeline to practice. *Acad Med*.  
50 2013;88(12):1883-1889.
- 51  
52 13. Hing E, Chun-Ju H. In which states are physician assistants or nurse practitioners more  
53 likely to work in primary care? *JAAPA*. 2015;28(9):46-53.
- 54  
55 14. Kuo YF, Loresto FL, Jr., Rounds LR, Goodwin JS. States with the least restrictive  
56 regulations experienced the largest increase in patients seen by nurse practitioners.  
57 *Health Aff (Millwood)*. 2013;32(7):1236-1243.
- 58  
59 15. Reagan PB, Salsberry PJ. The effects of state-level scope-of-practice regulations on the  
60 number and growth of nurse practitioners. *Nurs Outlook*. 2013;61(6):392-399.

16. Willis J. Barriers to PA practice in primary care and rural medically underserved areas. *JAAPA*. 1993;6(6):418-422.
17. Wing P, Langelier MH, Salsberg ES, Hooker RS. The changing professional practice of physician assistants: 1992 to 2000. *Jaapa*. 2004;17(1):37-40, 42, 45-39.
18. IOM. The future of nursing: leading change, advancing health. In. Washington, DC: National Academies Press; 2011.
19. Walker C. 2016 was another banner year for PAs at the state level. <https://www.aapa.org/news-central/2017/02/2016-another-banner-year-pa-profession-state-level/>. Published 2019. Accessed.
20. Timmons EJ. The effects of expanded nurse practitioner and physician assistant scope of practice on the cost of Medicaid patient care. *Health Policy*. 2017;121(2):189-196.
21. Sobel J. Seven things you should know about optimal team practice. *Jaapa*. 2019;32(5):12-13.
22. AAPA. What is optimal team practice? <https://www.aapa.org/advocacy-central/optimal-team-practice/>. Published 2017. Accessed Aug 7, 2020.
23. Morgan P, Everett C, Humenick K, Valentin V. Specialty choice among US physician assistants: distribution, salaries, and comparison to physicians. *JAAPA*. 2016;29(7):46-52.
24. Smith DT, Jacobson CK. Racial and Gender Disparities in the Physician Assistant Profession. *Health Serv Res*. 2016;51(3):892-909.
25. NCCPA. Statistical profile of certified physician assistants: an annual report of the National Commission on Certification of Physician Assistants. <https://prodcmsstoragesa.blob.core.windows.net/uploads/files/2018StatisticalProfileofCertifiedPhysicianAssistantsbyState.pdf>. Published 2018. Accessed.
26. BLS. Occupational employment and wages, May 2018: 29-1071 Physician Assistants. <https://www.bls.gov/oes/current/oes291071.htm#st>. Published 2018. Accessed Aug 7, 2020.
27. census.gov. Annual estimates of the resident population for the United States, regions, states, and Puerto Rico: April 1, 2010 to July 1, 2019 (NST-EST2019-01). 2019.
28. census.gov. Intercensal estimates of the resident population for the United States, regions, states, and Puerto Rico: April 1, 2000 to July 1, 2010 (ST-EST00INT-01). 2011.
29. census.gov. State and county intercensal tables: 1990-2000. <https://www.census.gov/data/tables/time-series/demo/popest/intercensal-1990-2000-state-and-county-totals.html>. Published 2016. Accessed May 5, 2020.
30. AAPA. The six key elements of a modern PA practice act. [https://www.aapa.org/wp-content/uploads/2016/12/Issue\\_Brief\\_Six\\_Key\\_Elements.pdf](https://www.aapa.org/wp-content/uploads/2016/12/Issue_Brief_Six_Key_Elements.pdf). Published 2016. Accessed Aug 7, 2020.
31. Gadbois EA, Miller EA, Tyler D, Intrator O. Trends in state regulation of nurse practitioners and physician assistants, 2001 to 2010. *Med Care Res Rev*. 2015;72(2):200-219.
32. Graves JA, Mishra P, Dittus RS, Parikh R, Perloff J, Buerhaus PI. Role of Geography and Nurse Practitioner Scope-of-Practice in Efforts to Expand Primary Care System Capacity: Health Reform and the Primary Care Workforce. *Med Care*. 2016;54(1):81-89.

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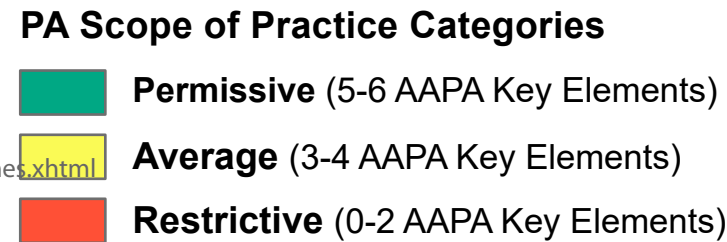
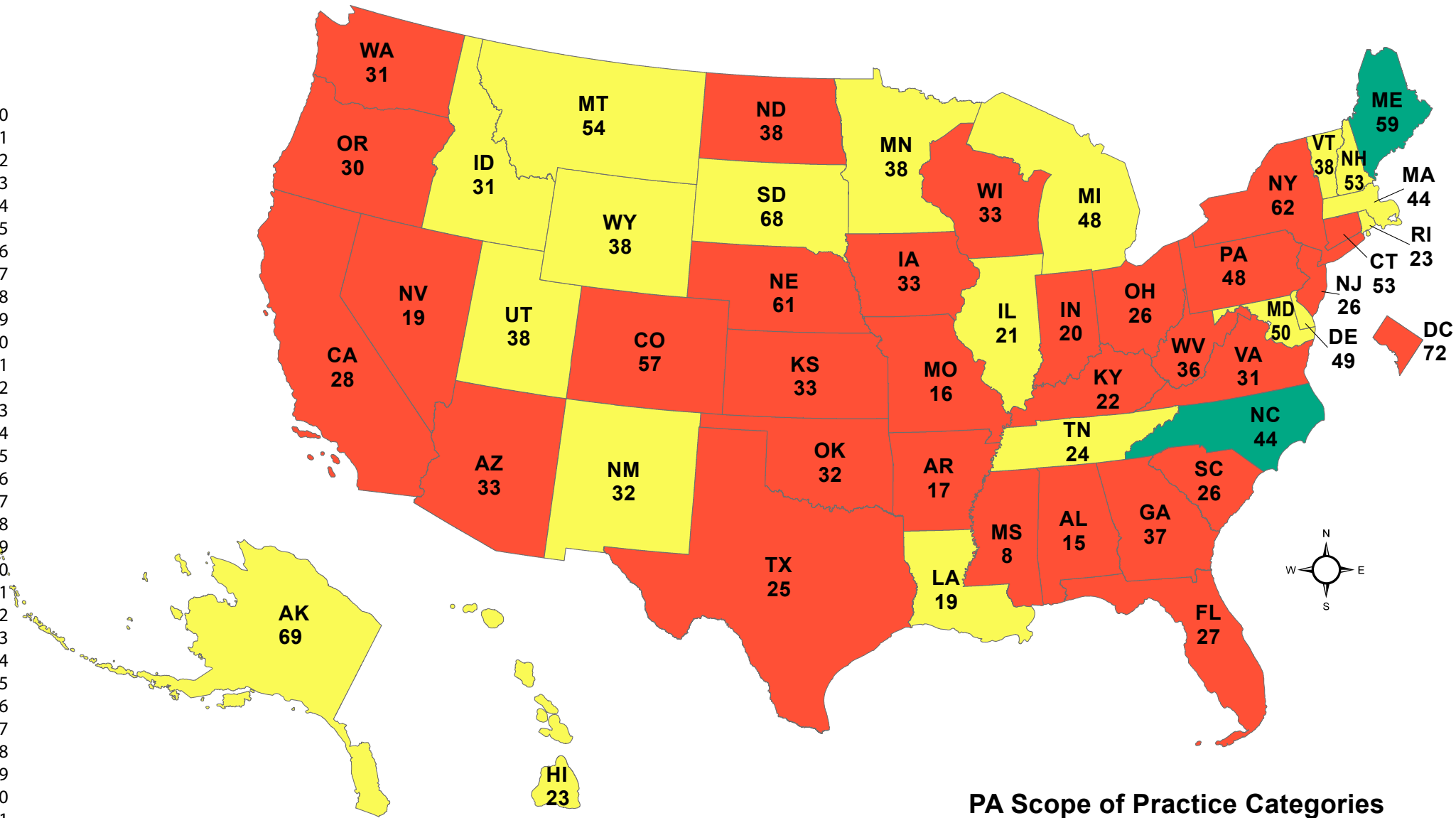
33. Pittman P, Leach B, Everett C, Han X, McElroy D. NP and PA Privileging in Acute Care Settings: Do Scope of Practice Laws Matter? *Med Care Res Rev.* 2020;77(2):112-120.

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# Figure 1: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories: United States, 1998

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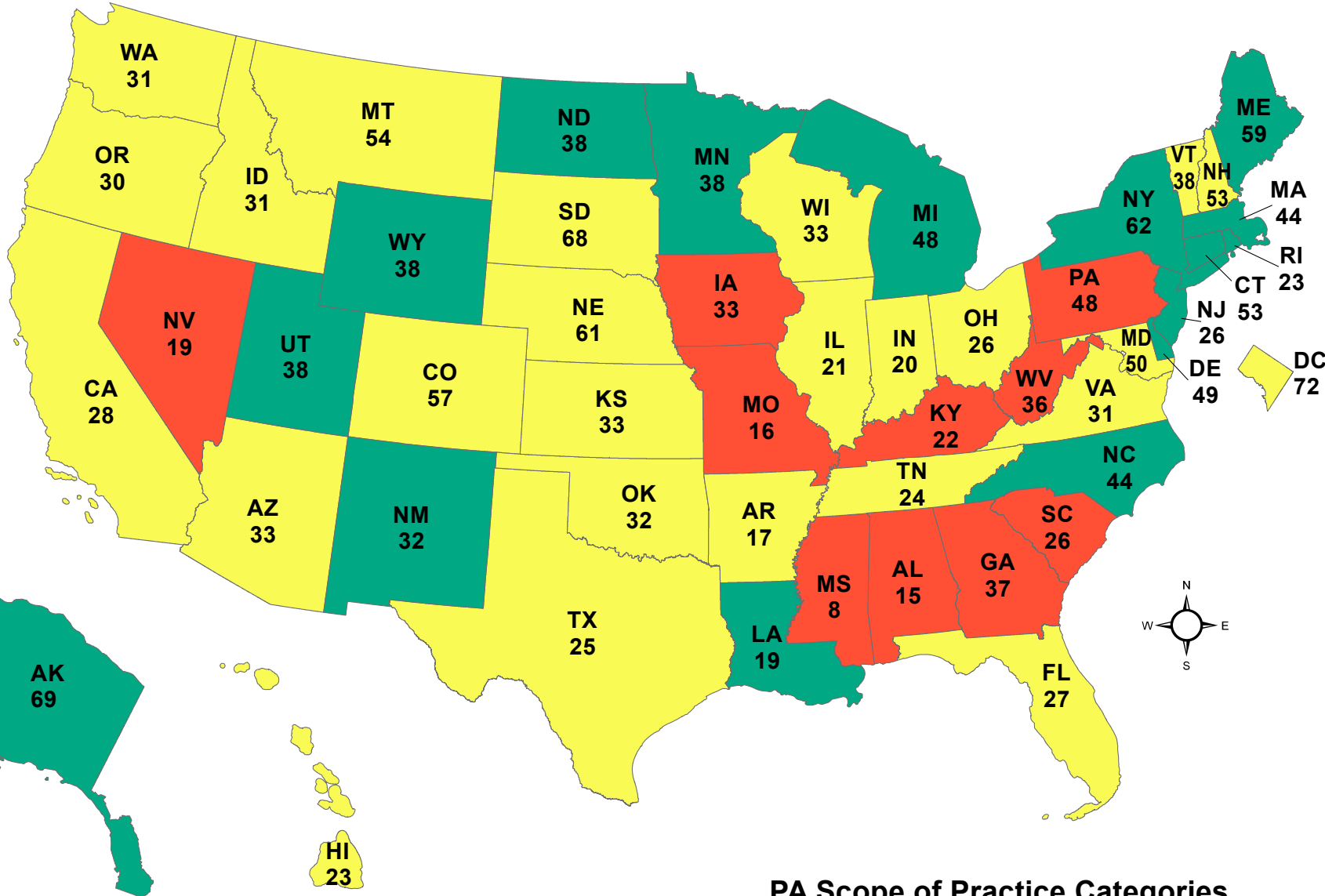


American Academy of Physician Assistants (AAPA)  
 \*Number indicates the PA ratio  
 (PA Ratio= [(employed PA in year)/(state population in year)]\*100,000)  
 Source- PA data from Bureau of Labor and Statistics, Population data from US Census Bureau



# Figure 2: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories: United States, 2017

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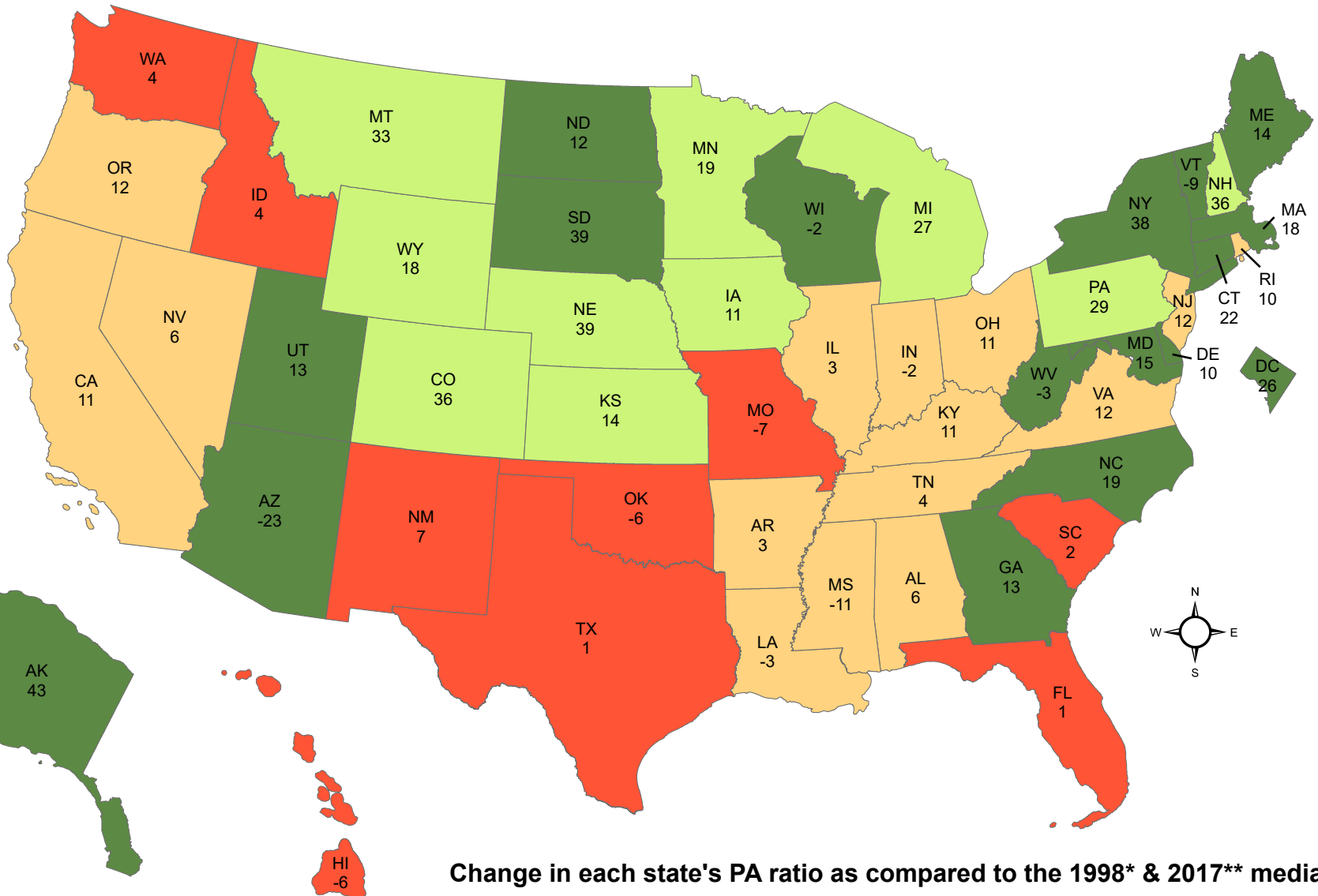
**PA Scope of Practice Categories**

- **Permissive** (5-6 AAPA Key Elements)
- **Average** (3-4 AAPA Key Elements)
- **Restrictive** (0-2 AAPA Key Elements)

American Academy of Physician Assistants (AAPA)  
 \*Number indicates the PA ratio  
 (PA Ratio= [(employed PA in year)/(state population in year)]\*100,000)  
 Source- PA data from Bureau of Labor and Statistics, Population data from US Census Bureau

# Figure 3: Change in State Ratio of Physician Assistants per 100,000 Population from 1998 - 2017

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Change in each state's PA ratio as compared to the 1998\* & 2017\*\* medians

- Super Expanders:** At or above 1998 median & at or above 2017 median
- Contractors:** At or above 1998 median & below 2017 median
- Slow Expanders:** Below 1998 median & at or above 2017 median
- Never Adopters:** Below 1998 median & below 2017 median

\*Median ratio for 1998 was 23 PAs per 100,000 population per state.

\*\*Median ratio for 2017 was 33 PAs per 100,000 population per state.

Source- PA data from Bureau of Labor and Statistics, Population data from US Census Bureau

Supplemental Table 1: Change in State Ratio<sup>a</sup> of Physician Assistants per 100,000 Population per State (1998, 2008, and 2017)

State	1998 <sup>b</sup> Ratio/100,000 Population	2008 Ratio/100,000 Population	2017 <sup>c</sup> Ratio/100,000 Population	Difference in PA ratio (2017 – 1998)
<b>Super Expanders</b>				
Alaska (AK)	26	42	69	43
Arizona (AZ)	56	22	33	-23
Connecticut (CT)	31	36	53	22
Delaware (DE)	39	29	49	10
District of Columbia (DC)	46	97	72	26
Georgia (GA)	24	25	37	13
Maine (ME)	45	55	59	14
Maryland (MD)	35	27	50	15
Massachusetts (MA)	26	39	44	18
New York (NY)	24	41	62	38
North Carolina (NC)	25	33	44	19
North Dakota (ND)	26	52	38	12
South Dakota (SD)	29	53	68	39
Utah (UT)	25	23	38	13
Vermont (VT)	47	29	38	-9
West Virginia (WV)	39	35	36	-3
Wisconsin (WI)	35	28	33	-2
<b>Contractors</b>				
Florida (FL)	26	22	27	1
Hawaii (HI)	29	23	23	-6
Idaho (ID)	27	31	31	4
Missouri (MO)	23	11	16	-7
New Mexico (NM)	25	34	32	7
Oklahoma (OK)	38	30	32	-6
South Carolina (SC)	24	13	26	2
Texas (TX)	24	16	25	1
Washington (WA)	27	28	31	4
<b>Slow Expanders</b>				
Colorado (CO)	21	27	57	36
Iowa (IA)	22	23	33	11
Kansas (KS)	19	23	33	14
Michigan (MI)	21	30	48	27
Minnesota (MN)	19	25	38	19
Montana (MT)	21	59	54	33
Nebraska (NE)	22	49	61	39
New Hampshire (NH)	17	38	53	36
Pennsylvania (PA)	19	30	48	29
Wyoming (WY)	20	38	38	18
<b>Never Adopters</b>				
Alabama (AL)	9	8	15	6
Arkansas (AR)	14	4	17	3
California (CA)	17	20	28	11
Illinois (IL)	18	20	21	3
Indiana (IN)	22	13	20	-2
Kentucky (KY)	11	15	22	11
Louisiana (LA)	22	14	19	-3
Mississippi (MS)	19	8	8	-11
Nevada (NV)	13	18	19	6
New Jersey (NJ)	14	11	26	12
Ohio (OH)	15	14	26	11
Oregon (OR)	18	17	30	12
Rhode Island (RI)	13	21	23	10
Tennessee (TN)	20	21	24	4
Virginia (VA)	19	18	31	12

**Super Expanders:** At or above 1998 median & at or above 2017 median

**Contractors:** At or above 1998 median & below 2017 median

**Slow Expanders:** Below 1998 median & at or above 2017 median

**Never Adopters:** Below 1998 median & below 2017 median

<sup>a</sup> PA Ratio = (employed PA in year/state population in year) \* 100,000

<sup>b</sup> The median ratio for 1998 was 23 PAs per 100,000 population per state.

<sup>c</sup> The median ratio for 2017 was 33 PAs per 100,000 population per state.

## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	6
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	None

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60**Results**

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-7
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Figures 1-3, Supplemental Table 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	6
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6-7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7
		(b) Report category boundaries when continuous variables were categorized	5-6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Supplemental Table 1

**Discussion**

Key results	18	Summarise key results with reference to study objectives	7-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8

**Other information**

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	9
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\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely

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2 available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at  
3 <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is  
4 available at [www.strobe-statement.org](http://www.strobe-statement.org).  
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# BMJ Open

## Cross-sectional Analysis of United States Scope of Practice Laws and Employed Physician Assistants

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**Word Count**

2,777

## Cross-sectional Analysis of United States Scope of Practice Laws and Employed Physician Assistants

### Abstract

#### Objective

This study examined if the variation in Physician Assistant (PA) state Scope of Practice (SOP) laws across states are associated with number of employed PAs, PA demographics and PA/population ratio per state. The hypothesis was that less restrictive SOP laws will increase the demand for PAs and the number of PAs in a state.

#### Design

Retrospective cross-sectional analysis at three time points: 1998, 2008, 2017.

#### Setting

Fifty states and the District of Columbia.

#### Participants

Employed PAs in 1998, 2008, 2017.

#### Methods

SOP laws were categorized as permissive, average and restrictive. Three national datasets were combined to allow for descriptive analysis of employed PAs by year and SOP categories. We used linear predictive models to generate and compare PA/population ratio least square means by SOP categories for each year. Models were adjusted for percent female PA and PAs mean age.

#### Results

There was a median PA/population ratio of 23 per 100,000 population in 1998 and 33 in 2017. A heterogeneous expansion of SOP laws was seen with 17 states defined as super expanders while 15 were never adopters. In 2017, comparing restrictive to permissive states showed that in adjusted models permissive SOP laws were associated with 11.7 (p .03) increase in ratio of employed PAs per 100,000 population, demonstrating that states with permissive SOP laws have an increased PA density.

#### Conclusions

There has been steady growth in the mean PA/population ratio since the turn of the century. At the same time, PA scope of practice laws in the United States have expanded, with just ten states remaining in the restrictive category. Permissive SOP laws are associated with an increase in the ratio of employed PAs per state population. As states work to meet the projected physician need, SOP expansion may be an important policy consideration to increase the PA workforce.

#### Key Words

Physician Assistant, Scope of Practice Laws, Workforce, Employment

#### Strengths and Limitations

- Data from the Bureau of Labor and Statistics (BLS) provided employed Physician Assistants (PAs) census data for all employed PAs from 1998, 2008 and 2017 for all 50 states and the District of Columbia.
- Comprehensive state legislative SOP data from the American Academy of Physician Assistants (AAPA) was cross referenced and verified for each state and each year and then combined with the annual employment data from the BLS.
- This is the first study analyzing two decades of national PA employment for all 50 states and the District of Columbia across three time points to describe the effect of state SOP laws on PAs.
- The analysis did not include other possible confounding variables that may impact PA employment numbers, including physician or nurse practitioner employment numbers, or state and federal healthcare legislative policies.
- The analysis was unable to account for lag time in terms of when the SOP laws were passed and the PA employment occurred.

## Cross-sectional Analysis of United States Scope of Practice Laws and Employed Physician Assistants

### INTRODUCTION

The Association of American Medical Colleges projects a shortage of 46,900 to 121,900 physicians by 2032.<sup>1</sup> Analysis of workforce supply and demand at the state level reveals that this shortage will likely be distributed unequally; some states have a lower supply of providers than others, rural shortages tends to be worse than urban settings, and some specialties are in greater demand than others.<sup>2-4</sup> Increased use of Physician Assistants (PAs) is one potential solution that has been proffered to address the current and anticipated deficiency.<sup>5-8</sup> One important factor that can facilitate or restrict the capacity of PAs to fill the provider shortage is state scope of practice (SOP) laws.<sup>9,10</sup>

Research indicates that favorable SOP legislation is associated with an increase in the supply of healthcare providers.<sup>11</sup> A number of previous studies have demonstrated that the supply of PAs and Nurse Practitioners (NPs) within a state is inversely related with the restrictiveness of SOP laws.<sup>9,12-17</sup> In 2010, the Institute of Medicine report on the Future of Nursing recommended full SOP for nurses, which became the catalyst for SOP expansion for NPs.<sup>18</sup> While striving to work at the top of their license, NPs have shown that restrictions on SOP is associated with reduced growth and number of available NPs in communities.<sup>10</sup> One 2009 study of PAs noted that SOP laws may effect PA/population ratio by state but to date, the effect of SOP on PA employment has not been clearly delineated.<sup>9</sup>

Throughout the decades, PAs have worked at the state level to push for expansion of PA practice laws to decrease the barriers to providing patient care. These efforts occur state by state with, for example, 20 states in 2017 proposing legislation to amend SOP laws for PAs.<sup>19</sup> Despite this work, there remains wide variation in PA SOP laws in the United States, ranging from highly restrictive to top-of-license practice.<sup>9,20</sup> In support of top-of-license practice, in 2017, the American Academy of Physician Assistants (AAPA) moved to adopt Optimal Team Practice (OTP), this proposed practice act is intended to further increase the autonomy of PAs.<sup>21</sup> The tenets of OTP include eliminating a legal requirement for a specific relationship with a physician, creating a separate majority-PA board to regulate PAs, and authorize PAs to directly bill for services.<sup>22</sup>

Fifty years since the inception of the PA profession, there has been a demographic shift from predominantly male to majority female and from largely primary care providers to specialists.<sup>23,24</sup> At the same time, the profession remains young with the median age of employed PAs remaining steady at 38 years old since 2012.<sup>25</sup> It is unknown if this demographic shift is due, at least in part, to changes in SOP laws. The purpose of this study was to examine whether, and to what degree, variation in PA state SOP laws across states are associated with 1) number of employed PAs per state; 2) PA demographics and 3)

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3 PA/population ratio per state. The hypothesis was that restrictive SOP laws limit the demand for PAs,  
4 with subsequent impacts on the PA workforce, while less restrictive SOP laws will increase the demand  
5 for PAs and therefore the number of PAs in a state.  
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## 10 **METHODS**

11 To assess the association of state scope of practice laws and PA/population ratio, we used a cross-  
12 sectional design to demonstrate the change over a 20 year period through providing 10-year snapshots at  
13 three time points of 1998, 2008, and 2017. This work builds upon previous work by Valentin et  
14 al., assessing the impact of PA SOP laws on PA education.<sup>26</sup> We used three SOP categories permissive,  
15 average and restrictive, based on the number of PA SOP Key Elements which builds upon prior work by  
16 Wing et al.<sup>17,26</sup>  
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### 23 **Data sources and setting**

24 Data were obtained from the Bureau of Labor and Statistics (BLS), AAPA census, and the AAPA  
25 database on PA legislative history for all fifty states and the District of Columbia for the years 1998, 2008  
26 and 2017. The three datasets were combined to allow for analysis of the years of 1998, 2008 and 2017.<sup>27</sup>  
27  
28 The University of Utah Institutional Review Board (IRB) determined that this project does not meet the  
29 definition of Human Subject Research.  
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### 33 **Sample/Participants**

34 The combined state/year dataset (N=153) included number of employed PAs in each state (50 states and  
35 District of Columbia for 3 time points) from the BLS, PA demographics from the AAPA census and state  
36 SOP laws from AAPA legislative history. Response rates for AAPA census report was unknown for  
37 1998, 34.5% in 2008 and 10.2% in 2017.  
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### 43 **Variables**

44 Data from BLS provided the number of PAs employed by state and by year.<sup>27</sup> PA ratio was then  
45 calculated as: [employed PA in that year/state population in year<sup>28-30</sup>]\*100,000. When comparing  
46 PA/population ratio over time the researchers defined states as super expanders, contractors, slow  
47 expanders and never adopters. Super expanders are defined as states with at or above the median ratio in  
48 1998 and remained at or above the median in 2017. Contractors are defined as states with at or above the  
49 median ratio in 1998 and fell below the median in 2017. Slow expanders are defined as states with below  
50 the median in 1998 and rose to at or above the median PA/population ratio by 2017. Never adopters are  
51 defined as states with below the median PA/population ratio in 1998 and remained below in 2017.  
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3 The AAPA established the permissive PA practice act which includes the 6 Key Elements of a  
4 Modern PA Practice Act: 1) licensure as a regulatory term, 2) full prescriptive authority, 3) scope of  
5 practice determined at the practice level, 4) adaptable collaboration requirements, 5) co-signature  
6 requirements determined at the practice level and 6) number of PAs a physician may collaborate with  
7 determined at the practice level.<sup>31</sup> Data from AAPA included which six key elements were approved in  
8 each state by year and the total number of six key elements was calculated. Consistent with prior research,  
9 each state was categorized into one of three SOP groups based on the number of key elements adopted:  
10 permissive SOP (5-6 elements), average SOP (3-4 elements) and restrictive SOP (0-2 elements).<sup>17</sup> The  
11 AAPA census provided mean age and mean female gender. Mean age and female gender was weighted  
12 by number of PAs employed in each state. There were no missing data for the number of key elements,  
13 mean age, or mean gender. For number of employed PAs in 2008 there was missing data for California  
14 and Pennsylvania. Missing data for 2008 were imputed by taking the average of the number of PAs from  
15 2007 and 2009.

#### 25 Statistical analysis

26  
27 Descriptive statistics were used to demonstrate the geographic location and change in the number of states  
28 categorized as permissive, average, and restrictive SOP with the PA/population ratio for each state for the  
29 years of 1998 and 2017 and presented visually with maps (Figures 1 and 2). The change in PA/population  
30 ratio per state over the time period relative to the median PA/population ratio for the nation was  
31 determined and presented visually with a map (Figure 3). Descriptive statistics by year and SOP  
32 categories was determined including number of states, number of employed PAs, percent of female PAs,  
33 and mean age of PAs.

34  
35 We used unadjusted survey linear regression models to generate least squares mean (95% CI) of  
36 age and percent of female PAs for each scope of practice level, incorporating weights to account for state-  
37 level differences in PA population demographics. Linear mixed models were used to generate and  
38 compare least-squares mean of PA/population ratio by SOP categories, with restrictive as the reference  
39 for the years of 1998, 2008 and 2017. All analyses were conducted using SAS version 9.4.

#### 48 RESULTS

49 Over the study period, the number of states in the permissive SOP category increased, as did the PA ratio.  
50 The number of permissive states increased from 2 in 1998 to 7 in 2008 and 16 by 2017, while the  
51 restrictive states went from 30 in 1998 to 20 in 2008 and 10 in 2017. (See Figure 1 and 2) In 1998 the  
52 median PA/population ratio was 23 PAs per 100,000 population and 33 per 100,000 in 2017. Figure 3  
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3 shows that 17 states are defined as super expanders while 9 states are contractors, 10 are slow expanders,  
4 and 15 are never adopters. (See Supplemental Table 1 for PA/population ratio of each state)

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6 Since 1998, the number of PAs in the US has grown from 61,980 employed PAs to 109,200 in  
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8 2017. (See Table 1) Of interest, in 1998 73.4% of PAs were employed in a restrictive SOP state which  
9  
10 decreased to 39.7% in 2008 and 15.1% by 2017. As of 2017, the majority of PAs (51.9%) are employed  
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12 in average states with 33.0% employed in permissive states.

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14 There is no association between percent PA gender and SOP categories in the selected years.  
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16 Over the study period, the state total mean number of PAs increased, while the mean percent of female  
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18 PAs in permissive states increased from 48.2% in 1998 to 68.3% in 2017. No association is seen between  
19  
20 SOP categories and age. (See Table 1) Meanwhile, the mean age of employed PAs remained steady at  
21  
22 40–41 years old across all time points.

23  
24 Table 2 presents the associations between unadjusted and adjusted PA/population ratio and SOP  
25  
26 categories. States with permissive and average SOP laws compared to restrictive states in 1998 did not  
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28 differ significantly in their PA/population ratio. However, in 2008, in unadjusted models, comparing  
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30 restrictive to average, and restrictive to permissive states was associated with 10.6 (p .03), and 15.1 (p  
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32 .03) increase in ratio of employed PAs per 100,000 population. In the adjusted models still compared to  
33  
34 restrictive states, the average states had 9.4 (p .04) higher ratio. In the year 2017, comparing restrictive to  
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36 permissive states was associated with 16.5 (p .01) , and 11.7 (p .03) increase in ratio of employed PAs per  
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38 100,000 population, in unadjusted and adjusted models, respectively.  
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**Table 1** Demographics of employed PAs by state scope of practice categories in 2017, 2008, and 1998

	2017				2008				1998			
	Permissive	Average	Restrictive	Total	Permissive	Average	Restrictive	Total	Permissive	Average	Restrictive	Total
State #	16	25	10	51	7	24	20	51	2	19	30	51
Total PA (%)	36,080 (33.0)	56,630 (51.9)	16,490 (15.1)	<b>109,200</b>	8,200 (11.5)	34,935 (48.8)	28,400 (39.7)	<b>71,535</b>	2,510 (4.0)	13,950 (22.5)	45,520 (73.4)	<b>61,980</b>
Minimum (state)	220 (WY)	240 (VT)	250 (MS)	<b>220 (WY)</b>	210 (WY)	110 (AR)	180 (VT)	<b>110 (AR)</b>	570 (ME)	100 (WY)	170 (ND)	<b>100 (WY)</b>
Maximum (state)	12,150 (NY)	11,110 (CA)	6,080 (PA)	<b>12,150 (NY)</b>	3,060 (NC)	7,890 (NY)	4,010 (FL)	<b>7,890 (NY)</b>	1,940 (NC)	2,180 (IL)	5,660 (CA)	<b>5,660 (CA)</b>
Mean percent female PA <sup>a</sup> (95% CI)	68.3 (66.1, 70.6)	68.5 (66.5, 70.6)	72.6 (67.8, 77.3)	<b>69.1 (67.4, 70.8)</b>	60.9 (56.3, 65.4)	65.7 (63.1, 68.4)	63.4 (60.0, 66.8)	<b>64.2 (62.1, 66.3)</b>	48.2 (46.9, 49.6)	51.2 (46.1, 56.3)	48.2 (44.7, 51.7)	<b>48.9 (46.0, 51.8)</b>
Mean age <sup>a</sup> (95% CI)	39.6 (38.8, 40.5)	40.1 (39.1, 41.0)	38.6 (37.3, 39.9)	<b>39.7 (39.0, 40.4)</b>	42.9 (41.2, 44.6)	41.2 (40.1, 42.4)	41.0 (39.9, 42.2)	<b>41.3 (40.6, 42.1)</b>	40.9 (40.2, 41.7)	40.7 (39.8, 41.6)	41.0 (40.2, 41.8)	<b>40.9 (40.3, 41.5)</b>

CI: Confidence Interval, R: Restrictive, A: Average, P: Permissive

Restrictive is defined as 0-2 key elements, average 3-4, permissive 5-6

<sup>a</sup> Unadjusted survey linear regression models were used to generate least square means (95% CI), weighted by the states' population (none significant).

**Table 2** Ratio of employed PAs by state scope of practice categories, 2017, 2008, and 1998

	2017				2008				1998			
	Permissive	Average	Restrictive	Total	Permissive	Average	Restrictive	Total	Permissive	Average	Restrictive	Total
<b>Mean ratio of employed PAs per 100,000 population</b>												
Unadjusted (95% CI)	42.6	36.7	26.1	<b>36.5</b>	36.2	31.7	21.1	<b>28.2</b>	35.1	25.2	23.9	<b>24.8</b>
P-value	(35.3, 49.9)	(30.9, 42.6)	(16.8, 35.3)	<b>(32.2, 40.8)</b>	(24.7, 47.7)	(25.5, 37.9)	(14.3, 27.9)	<b>(23.7, 32.7)</b>	(21.2, 48.9)	(20.7, 29.7)	(20.4, 27.5)	<b>(22.1, 27.6)</b>
	<b>0.01</b>	0.055	-		<b>0.03</b>	<b>0.03</b>	-		0.12	0.65	-	
	<b>P vs R</b>	A vs R	Reference		<b>P vs R</b>	<b>A vs R</b>	Reference		P vs R	A vs R	Reference	
Adjusted <sup>a</sup> (95% CI)	40.9	36.5	29.2		32.4	31.8	22.4		35.1	24.8	24.2	
P-value	(34.7, 47.1)	(31.6, 41.5)	(21.3, 37.1)		(20.3, 44.6)	(25.9, 37.7)	(15.8, 28.9)		(21.3, 48.8)	(20.3, 29.3)	(20.6, 27.8)	
	<b>0.03</b>	0.12	-		0.16	<b>0.04</b>	-		0.13	0.84	-	
	<b>P vs R</b>	A vs R	Reference		P vs R	<b>A vs R</b>	Reference		P vs R	A vs R	Reference	

CI: Confidence Interval, R: Restrictive, A: Average, P: Permissive

Restrictive is defined as 0-2 key elements, average 3-4, Permissive 5-6

P-value <0.05, statistically significant

Ratio = [employed PA in that year / state population in year] \* 100,000

Linear mixed models were used to generate least square means.

<sup>a</sup> Adjusted for percent female PA and mean age



## DISCUSSION

This is the first study to demonstrate that states with permissive SOP laws have an increased PA density. In 2017, states with permissive SOP had 43 PAs per 100,000 population while restrictive states had 26 PAs per 100,000 people. The PA/population ratio remained higher in permissive states compared to restrictive at each time point with this difference in ratio increasing over time from 11.2 in 1998 to 16.5 in 2017. This finding suggests that restrictive SOP laws limit demand for PAs and therefore limit supply. This outcome is similar to research on nurse practitioners where restrictions on SOP have been noted to affect productive capacity and provider supply.<sup>15</sup> This study shows a decrease in PA supply in states with restrictive SOP laws compared to states with permissive SOP laws, which may be from a lack of demand but this is not clear. Further investigation is needed to determine if a specific SOP key element is associated with PA employment numbers. Also, future research at the state level is needed to understand the possible interplay of state SOP laws and organizational policy.

Over the study period, there has been a decrease in the number of states with restrictive SOP laws, with a resulting change in the number of employed PAs from majority restrictive states to average and permissive states. These results expand the findings of Wing et al. (2004) and Gadbois et al. (2015) that PA SOP laws continue to expand and vary widely by state.<sup>17,32</sup> As of 2017, 16 states have permissive practice laws, but the majority of states remain with average SOP, while 10 still have restrictive. This leaves a heterogeneity in state SOP laws with only 15% of PAs employed in a restrictive SOP states as of 2017. It is unclear if PAs are moving away from restrictive SOP states or if there is a lack of demand to draw them to these states. With the majority of employed PAs in average or permissive states, it is understandable why the constituents of pushed for AAPA to change its policy to recommend Optimal Team Practice with a desire for increased practice autonomy. Research needs to focus on the impact that this expanded autonomy has on PA employment on both the expanded practice states and the restrictive practice states.

As there have been decades of SOP expansion and growth in the number of PAs, the median PA/population ratio has also risen. However, as of 2017 half of US states are defined as contractors or never adopters which demonstrates that PA policy makers still have a long road ahead to assure that all PAs are working within the full scope of their license. It is unclear if nurse practitioners or physicians are filling this provider gap. A recent study found that by expanding SOP laws for both PAs and NPs, the primary care workforce capacity increased particularly in rural areas, but that this change was limited.<sup>33</sup> As states work to address the projected physician shortage, the findings of this study are consistent with the hypothesis that SOP expansion will increase the PA workforce in a state. This finding allows for future research to examine the difference in patient access and health outcomes by state and PA/population ratio in the United States. Work by Pittman et al. argues that SOP laws were not associated

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3 with hospital privileges and that within one state there was significant variation.<sup>34</sup> The findings of this  
4 study support our hypothesis that states with expanded SOP laws have a higher demand for PAs and  
5 therefore a higher number of employed PAs. This sheds some light on state to state variations in  
6 employment but more research is needed to understand the countless factors at play at the state level in  
7 the supply and demand for PAs.  
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### 11 12 13 Limitations

14 This study has a number of important limitations. First, we analyzed cross-section data at three  
15 timepoints, which may limit generalizability of the findings. However, to gain an understanding of  
16 causation, longitudinal analysis needs to be undertaken. Second, the low annual response rate for the  
17 AAPA data on PA demographics which was unknown in 1998 and ranged from 35-10% for the other  
18 timepoints may lead to a sampling bias towards or away from the null. Third, this analysis did not include  
19 other possible confounding variables that may impact PA employment numbers, including physician or  
20 nurse practitioner employment numbers, or state and federal healthcare legislative policies. Fourth, we  
21 were unable to account for lag time in terms of when the SOP laws were passed and the PA employment  
22 occurred. Fifth, the categorization of SOP elements in three categories considers each element to be equal  
23 and interchangeable which is unlikely. Future research should consider each element individually and the  
24 impact on employment. These limitations are counterbalanced by a number of important strengths,  
25 including the robust SOP data provided by AAPA that was cross referenced and verified for each state  
26 and each year combined with annual employment data from the Bureau of Labor and Statistics.  
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### 37 CONCLUSIONS

38 PA scope of practice laws in the United States have expanded since the turn of the century, with most  
39 states with average SOP, and ten states remaining in the restrictive category. Meanwhile, there has been  
40 steady growth in the mean PA/population ratio from 23 to 33 per 100,000 population over the same two  
41 decades. States with permissive SOP laws have an average of 16.5 more PAs per 100,000 population  
42 compared to a state with restrictive SOP laws. As states work to meet the projected physician shortage,  
43 this study supports the principle that SOP expansion may be an important lever to assist with increasing  
44 the PA workforce in a state. Future research needs to incorporate a longitudinal analysis with lag times to  
45 understand if specific key elements impact PA employment and the timeframe of that impact.  
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52 **Contributorship Statement** VLV, SN, and CE were involved in the data analysis, interpretation, drafting  
53 the manuscript, and reviewed/edited the manuscript.  
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6 organization.  
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9 Grant number: N/A  
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13 **Competing interests** None declared.  
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15  
16 **Patient and public involvement** Patients and/or the public were not involved in the design, or conduct,  
17 or reporting, or dissemination plans of this research.  
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19  
20 **Patient consent for publication** Not required.  
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23 **Ethics approval** As we used publicly available BLS data, and the requested AAPA data does not contain  
24 identifying variables, this study was determined exempt from review by the University of Utah  
25 Institutional Review Board (IRB 00107271).  
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30 **Data availability statement** BLS has a public use linkage to access Labor Statistics data 1998–2017. The  
31 data from AAPA on PA census and legislative history was requested through AAPA research department.  
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### 34 **Figure legend/Caption**

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36 Figure 1: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories:  
37 United States, 1998  
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41 Figure 2: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories:  
42 United States, 2017  
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46 Figure 3: Change in State Ratio of Physician Assistants per 100,000 Population from 1998 - 2017  
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### 49 **REFERENCES**

- 50  
51  
52 1. AAMC. The complexities of physician supply and demand: projections from 2017-2032.  
53 [https://aamc-black.global.ssl.fastly.net/production/media/filer\\_public/31/13/3113ee5c-](https://aamc-black.global.ssl.fastly.net/production/media/filer_public/31/13/3113ee5c-a038-4c16-89af-294a69826650/2019_update_-)  
54 [a038-4c16-89af-294a69826650/2019\\_update\\_-](https://aamc-black.global.ssl.fastly.net/production/media/filer_public/31/13/3113ee5c-a038-4c16-89af-294a69826650/2019_update_-)  
55  
56  
57

- 1  
2  
3 [the complexities of physician supply and demand - projections from 2017-](#)
- 4 [2032.pdf](#). Published 2019. Accessed Aug 7, 2020.
- 5
- 6 2. HRSA. National and regional projections of supply and demand for internal medicine
- 7 subspecialty practitioners: 2013-2025.
- 8 [https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-](https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-analysis/research/projections/internal-medicine-subspecialty-report.pdf)
- 9 [analysis/research/projections/internal-medicine-subspecialty-report.pdf](https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-analysis/research/projections/internal-medicine-subspecialty-report.pdf). Published
- 10 2016. Accessed.
- 11
- 12 3. DHHS. State-level projections of supply and demand for primary care practitioners:
- 13 2013-2025. [https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-](https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-analysis/research/projections/primary-care-state-projections2013-2025.pdf)
- 14 [analysis/research/projections/primary-care-state-projections2013-2025.pdf](https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-analysis/research/projections/primary-care-state-projections2013-2025.pdf). Published
- 15 2016. Accessed.
- 16
- 17 4. Fraher E, Brandt B. Toward a system where workforce planning and interprofessional
- 18 practice and education are designed around patients and populations not professions. *J*
- 19 *Interprof Care*. 2019;33(4):389-397.
- 20
- 21 5. Auerbach DI, Chen PG, Friedberg MW, et al. Nurse-managed health centers and patient-
- 22 centered medical homes could mitigate expected primary care physician shortage.
- 23 *Health Aff (Millwood)*. 2013;32(11):1933-1941.
- 24
- 25 6. Fraher E, Machta R, Halladay J. The workforce transformations needed to staff value-
- 26 based models of care. Sheps Center for Health Services Research.
- 27 [http://www.shepscenter.unc.edu/wp-](http://www.shepscenter.unc.edu/wp-content/uploads/2015/12/DataBrief_ValueBasedWorkforce_FraherMachtaHalladay_fina.pdf)
- 28 [content/uploads/2015/12/DataBrief\\_ValueBasedWorkforce\\_FraherMachtaHalladay\\_fi](http://www.shepscenter.unc.edu/wp-content/uploads/2015/12/DataBrief_ValueBasedWorkforce_FraherMachtaHalladay_fina.pdf)
- 29 [al.pdf](http://www.shepscenter.unc.edu/wp-content/uploads/2015/12/DataBrief_ValueBasedWorkforce_FraherMachtaHalladay_fina.pdf). Published 2015. Accessed June 20, 2020, 2020.
- 30
- 31 7. KFF. Improving access to adult primary care in Medicaid: exploring the potential role of
- 32 nurse practitioners and physician assistants. [https://www.kff.org/medicaid/issue-](https://www.kff.org/medicaid/issue-brief/improving-access-to-adult-primary-care-in/)
- 33 [brief/improving-access-to-adult-primary-care-in/](https://www.kff.org/medicaid/issue-brief/improving-access-to-adult-primary-care-in/). Published 2011. Accessed.
- 34
- 35 8. McMichael B. Beyond Physicians: The Effect of Licensing and Liability Laws on the Supply
- 36 of Nurse Practitioners and Physician Assistants. *Journal of Empirical Legal Studie*.
- 37 2018;15(4):732-771.
- 38
- 39 9. Sutton J, Ramos C, Lucado J. US physician assistant supply by state and county in 2009.
- 40 *JAAPA*. 2010;23(9):E3-E8.
- 41
- 42 10. Wiler JL, Rooks SP, Ginde AA. Update on midlevel provider utilization in U.S. emergency
- 43 departments, 2006 to 2009. *Acad Emerg Med*. 2012;19(8):986-989.
- 44
- 45 11. Sekscenski ES, Sansom S, Bazell C, Salmon ME, Mullan F. State practice environments
- 46 and the supply of physician assistants, nurse practitioners, and certified nurse-midwives.
- 47 *N Engl J Med*. 1994;331(19):1266-1271.
- 48
- 49 12. Glicken AD, Miller AA. Physician assistants: from pipeline to practice. *Acad Med*.
- 50 2013;88(12):1883-1889.
- 51
- 52 13. Hing E, Chun-Ju H. In which states are physician assistants or nurse practitioners more
- 53 likely to work in primary care? *JAAPA*. 2015;28(9):46-53.
- 54
- 55 14. Kuo YF, Loresto FL, Jr., Rounds LR, Goodwin JS. States with the least restrictive
- 56 regulations experienced the largest increase in patients seen by nurse practitioners.
- 57 *Health Aff (Millwood)*. 2013;32(7):1236-1243.
- 58
- 59 15. Reagan PB, Salsberry PJ. The effects of state-level scope-of-practice regulations on the
- 60 number and growth of nurse practitioners. *Nurs Outlook*. 2013;61(6):392-399.

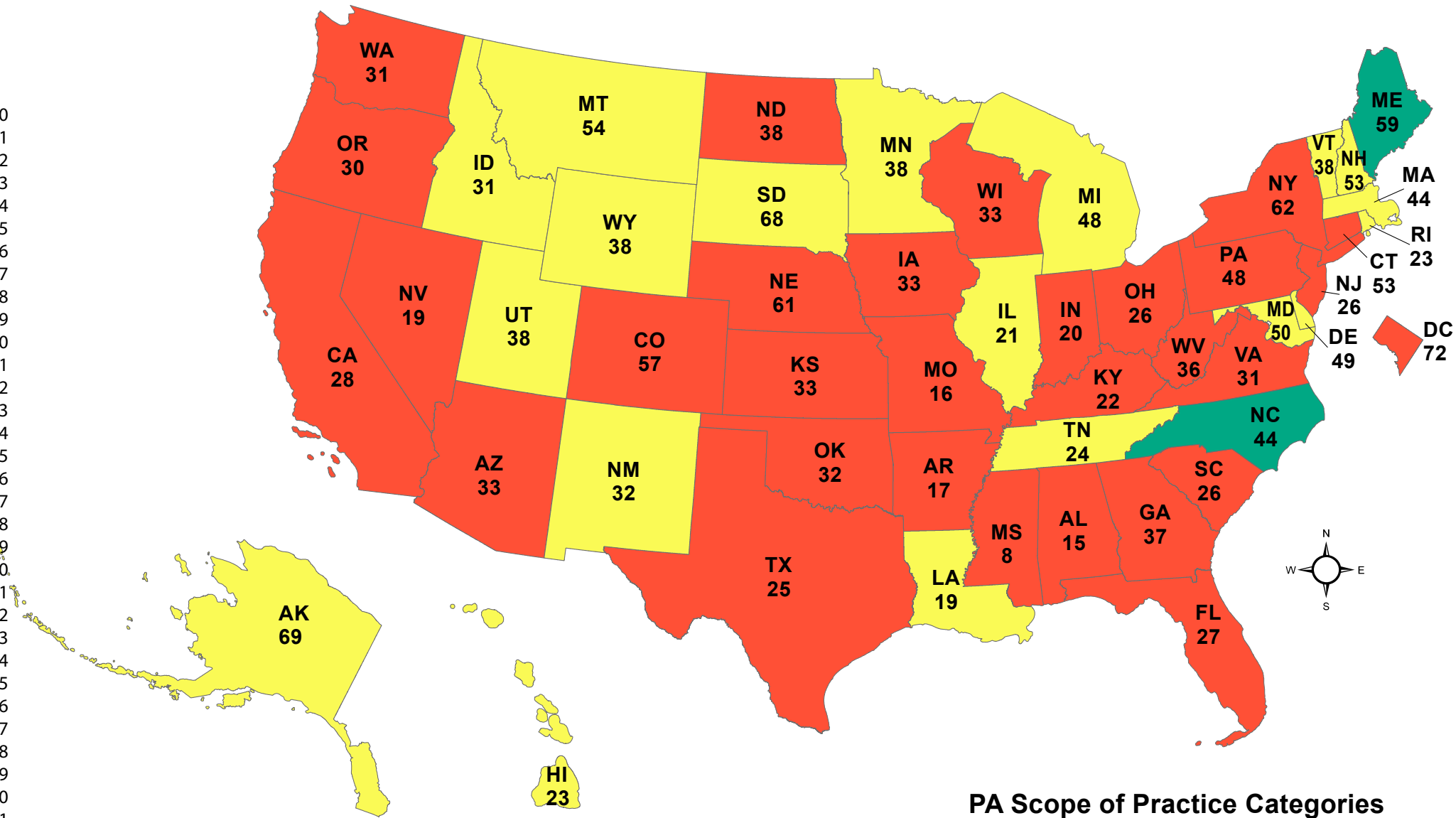
16. Willis J. Barriers to PA practice in primary care and rural medically underserved areas. *JAAPA*. 1993;6(6):418-422.
17. Wing P, Langelier MH, Salsberg ES, Hooker RS. The changing professional practice of physician assistants: 1992 to 2000. *Jaapa*. 2004;17(1):37-40, 42, 45-39.
18. IOM. The future of nursing: leading change, advancing health. In. Washington, DC: National Academies Press; 2011.
19. Walker C. 2016 was another banner year for PAs at the state level. <https://www.aapa.org/news-central/2017/02/2016-another-banner-year-pa-profession-state-level/>. Published 2019. Accessed.
20. Timmons EJ. The effects of expanded nurse practitioner and physician assistant scope of practice on the cost of Medicaid patient care. *Health Policy*. 2017;121(2):189-196.
21. Sobel J. Seven things you should know about optimal team practice. *Jaapa*. 2019;32(5):12-13.
22. AAPA. What is optimal team practice? <https://www.aapa.org/advocacy-central/optimal-team-practice/>. Published 2017. Accessed Aug 7, 2020.
23. Morgan P, Everett C, Humenick K, Valentin V. Specialty choice among US physician assistants: distribution, salaries, and comparison to physicians. *JAAPA*. 2016;29(7):46-52.
24. Smith DT, Jacobson CK. Racial and Gender Disparities in the Physician Assistant Profession. *Health Serv Res*. 2016;51(3):892-909.
25. NCCPA. Statistical profile of certified physician assistants: an annual report of the National Commission on Certification of Physician Assistants. <https://prodcmststorage.blob.core.windows.net/uploads/files/2018StatisticalProfileofCertifiedPhysicianAssistantsbyState.pdf>. Published 2018. Accessed.
26. Valentin VL, Najmabadi S, Jones J, Everett CM. State Scope of Practice Laws: An Analysis of Physician Assistant Programs and Graduates. *J Physician Assist Educ*. 2020;31(4):179-184.
27. BLS. Occupational employment and wages, May 2018: 29-1071 Physician Assistants. <https://www.bls.gov/oes/current/oes291071.htm#st>. Published 2018. Accessed Aug 7, 2020.
28. census.gov. Annual estimates of the resident population for the United States, regions, states, and Puerto Rico: April 1, 2010 to July 1, 2019 (NST-EST2019-01). 2019.
29. census.gov. Intercensal estimates of the resident population for the United States, regions, states, and Puerto Rico: April 1, 2000 to July 1, 2010 (ST-EST00INT-01). 2011.
30. census.gov. State and county intercensal tables: 1990-2000. <https://www.census.gov/data/tables/time-series/demo/pepopt/intercensal-1990-2000-state-and-county-totals.html>. Published 2016. Accessed May 5, 2020.
31. AAPA. The six key elements of a modern PA practice act. [https://www.aapa.org/wp-content/uploads/2016/12/Issue\\_Brief\\_Six\\_Key\\_Elements.pdf](https://www.aapa.org/wp-content/uploads/2016/12/Issue_Brief_Six_Key_Elements.pdf). Published 2016. Accessed Aug 7, 2020.
32. Gadbois EA, Miller EA, Tyler D, Intrator O. Trends in state regulation of nurse practitioners and physician assistants, 2001 to 2010. *Med Care Res Rev*. 2015;72(2):200-219.

- 1  
2  
3 33. Graves JA, Mishra P, Dittus RS, Parikh R, Perloff J, Buerhaus PI. Role of Geography and  
4 Nurse Practitioner Scope-of-Practice in Efforts to Expand Primary Care System Capacity:  
5 Health Reform and the Primary Care Workforce. *Med Care*. 2016;54(1):81-89.  
6  
7 34. Pittman P, Leach B, Everett C, Han X, McElroy D. NP and PA Privileging in Acute Care  
8 Settings: Do Scope of Practice Laws Matter? *Med Care Res Rev*. 2020;77(2):112-120.  
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# Figure 1: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories: United States, 1998

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### PA Scope of Practice Categories

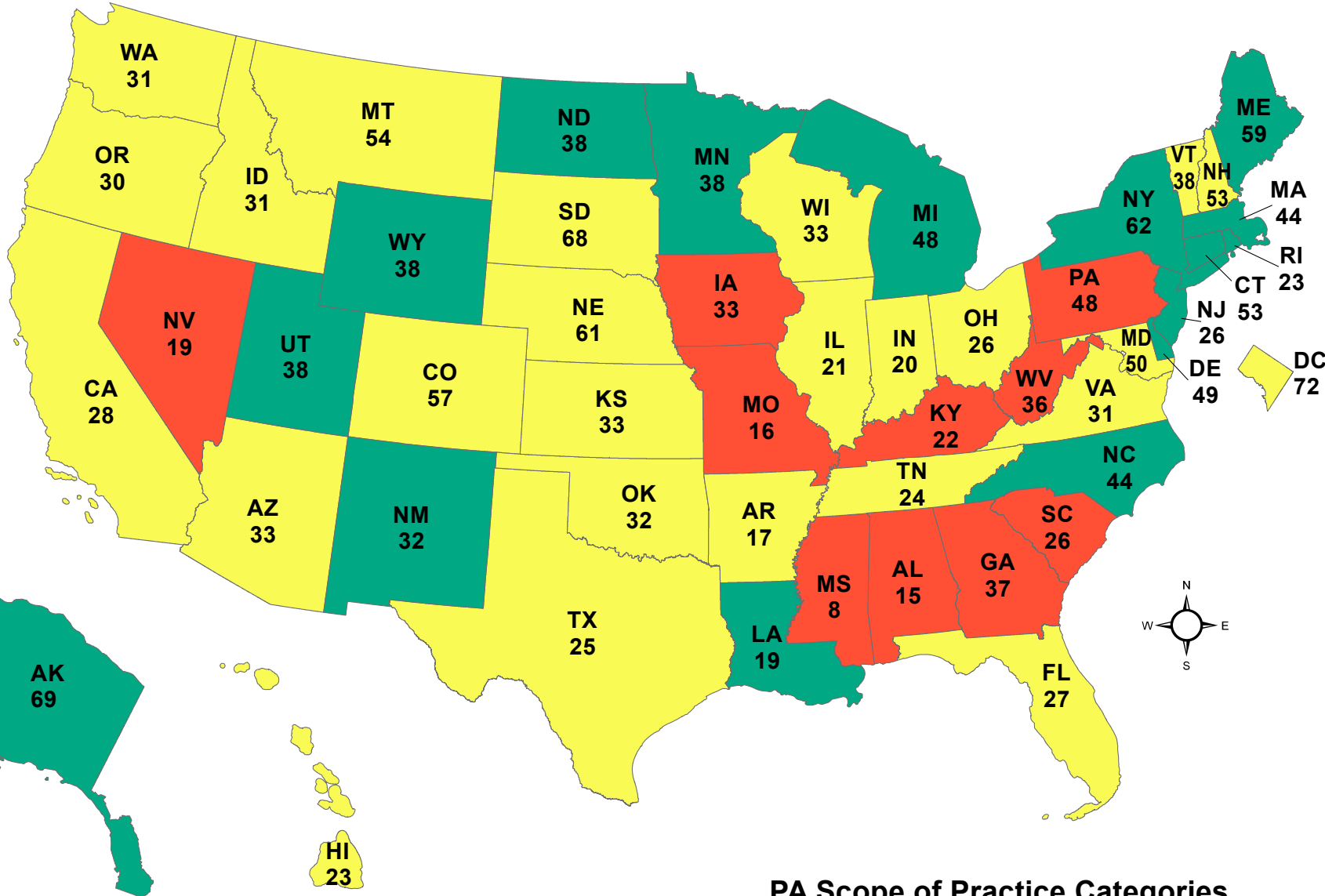
- Permissive** (5-6 AAPA Key Elements)
- Average** (3-4 AAPA Key Elements)
- Restrictive** (0-2 AAPA Key Elements)

American Academy of Physician Assistants (AAPA)  
 \*Number indicates the PA ratio  
 (PA Ratio= [(employed PA in year)/(state population in year)]\*100,000)  
 Source- PA data from Bureau of Labor and Statistics, Population data from US Census Bureau



# Figure 2: Number of Physician Assistants per 100,000 Population and PA Scope of Practice Categories: United States, 2017

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**PA Scope of Practice Categories**

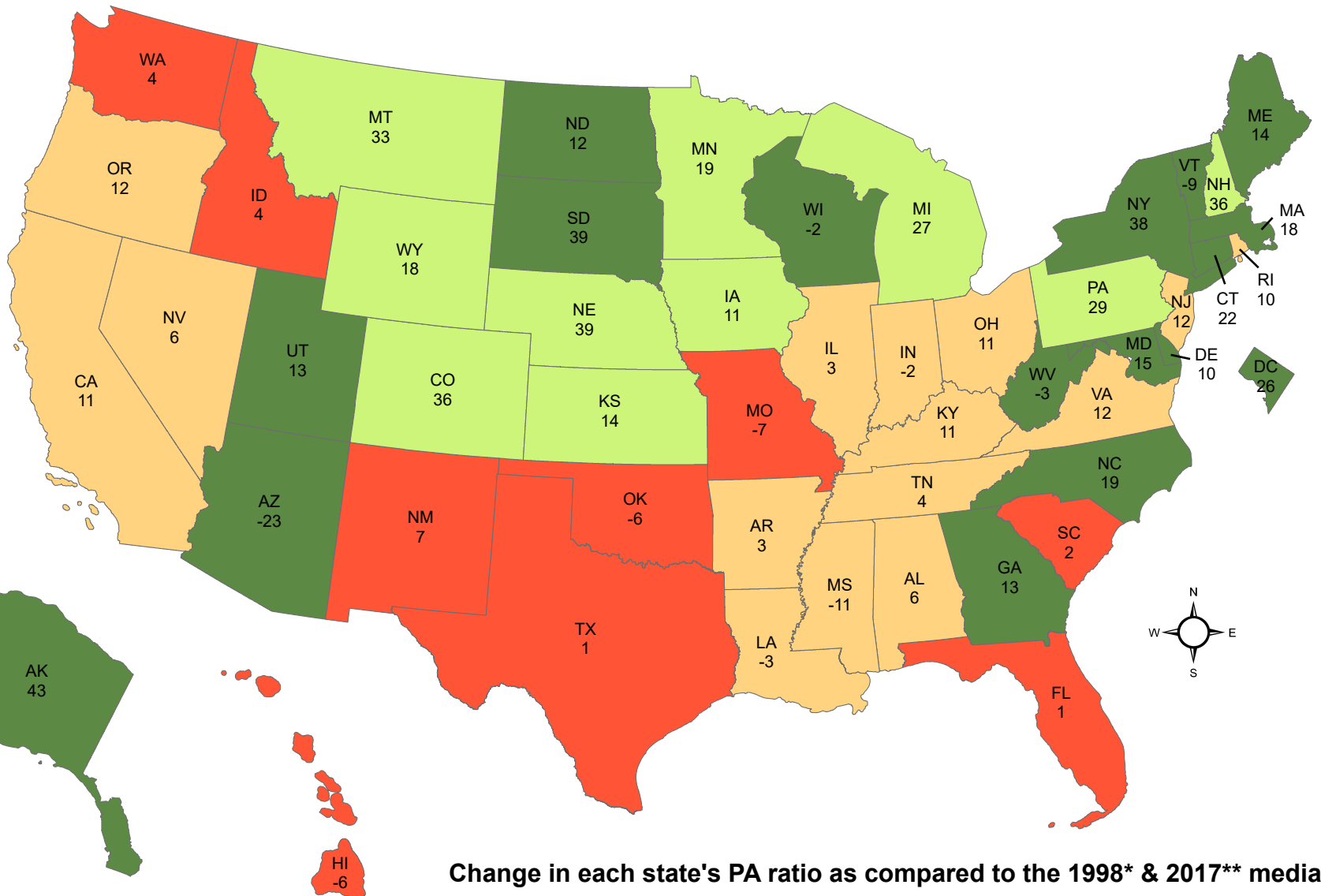
- **Permissive** (5-6 AAPA Key Elements)
- **Average** (3-4 AAPA Key Elements)
- **Restrictive** (0-2 AAPA Key Elements)

American Academy of Physician Assistants (AAPA)  
 \*Number indicates the PA ratio  
 (PA Ratio= [(employed PA in year)/(state population in year)]\*100,000)  
 Source- PA data from Bureau of Labor and Statistics, Population data from US Census Bureau



# Figure 3: Change in State Ratio of Physician Assistants per 100,000 Population from 1998 - 2017

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Change in each state's PA ratio as compared to the 1998\* & 2017\*\* medians

- Super Expanders:** At or above 1998 median & at or above 2017 median
- Contractors:** At or above 1998 median & below 2017 median
- Slow Expanders:** Below 1998 median & at or above 2017 median
- Never Adopters:** Below 1998 median & below 2017 median

\*Median ratio for 1998 was 23 PAs per 100,000 population per state.

\*\*Median ratio for 2017 was 33 PAs per 100,000 population per state.

Source- PA data from Bureau of Labor and Statistics, Population data from US Census Bureau

Supplemental Table 1: Change in State Ratio<sup>a</sup> of Physician Assistants per 100,000 Population per State (1998, 2008, and 2017)

State	1998 <sup>b</sup> Ratio/100,000 Population	2008 Ratio/100,000 Population	2017 <sup>c</sup> Ratio/100,000 Population	Difference in PA ratio (2017 – 1998)
<b>Super Expanders</b>				
Alaska (AK)	26	42	69	43
Arizona (AZ)	56	22	33	-23
Connecticut (CT)	31	36	53	22
Delaware (DE)	39	29	49	10
District of Columbia (DC)	46	97	72	26
Georgia (GA)	24	25	37	13
Maine (ME)	45	55	59	14
Maryland (MD)	35	27	50	15
Massachusetts (MA)	26	39	44	18
New York (NY)	24	41	62	38
North Carolina (NC)	25	33	44	19
North Dakota (ND)	26	52	38	12
South Dakota (SD)	29	53	68	39
Utah (UT)	25	23	38	13
Vermont (VT)	47	29	38	-9
West Virginia (WV)	39	35	36	-3
Wisconsin (WI)	35	28	33	-2
<b>Contractors</b>				
Florida (FL)	26	22	27	1
Hawaii (HI)	29	23	23	-6
Idaho (ID)	27	31	31	4
Missouri (MO)	23	11	16	-7
New Mexico (NM)	25	34	32	7
Oklahoma (OK)	38	30	32	-6
South Carolina (SC)	24	13	26	2
Texas (TX)	24	16	25	1
Washington (WA)	27	28	31	4
<b>Slow Expanders</b>				
Colorado (CO)	21	27	57	36
Iowa (IA)	22	23	33	11
Kansas (KS)	19	23	33	14
Michigan (MI)	21	30	48	27
Minnesota (MN)	19	25	38	19
Montana (MT)	21	59	54	33
Nebraska (NE)	22	49	61	39
New Hampshire (NH)	17	38	53	36
Pennsylvania (PA)	19	30	48	29
Wyoming (WY)	20	38	38	18
<b>Never Adopters</b>				
Alabama (AL)	9	8	15	6
Arkansas (AR)	14	4	17	3
California (CA)	17	20	28	11
Illinois (IL)	18	20	21	3
Indiana (IN)	22	13	20	-2
Kentucky (KY)	11	15	22	11
Louisiana (LA)	22	14	19	-3
Mississippi (MS)	19	8	8	-11
Nevada (NV)	13	18	19	6
New Jersey (NJ)	14	11	26	12
Ohio (OH)	15	14	26	11
Oregon (OR)	18	17	30	12
Rhode Island (RI)	13	21	23	10
Tennessee (TN)	20	21	24	4
Virginia (VA)	19	18	31	12

**Super Expanders:** At or above 1998 median & at or above 2017 median

**Contractors:** At or above 1998 median & below 2017 median

**Slow Expanders:** Below 1998 median & at or above 2017 median

**Never Adopters:** Below 1998 median & below 2017 median

<sup>a</sup> PA Ratio = (employed PA in year/state population in year) \* 100,000

<sup>b</sup> The median ratio for 1998 was 23 PAs per 100,000 population per state.

<sup>c</sup> The median ratio for 2017 was 33 PAs per 100,000 population per state.

## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	6
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	None

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60**Results**

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-7
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Figures 1-3, Supplemental Table 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	6
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6-7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7
		(b) Report category boundaries when continuous variables were categorized	5-6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Supplemental Table 1

**Discussion**

Key results	18	Summarise key results with reference to study objectives	7-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8

**Other information**

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	9
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\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely

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2 available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at  
3 <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is  
4 available at [www.strobe-statement.org](http://www.strobe-statement.org).  
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