

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<u>http://bmjopen.bmj.com</u>).

If you have any questions on BMJ Open's open peer review process please email <u>info.bmjopen@bmj.com</u>

BMJ Open

Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997–2017: A Longitudinal Analysis

Journal:	BMJ Open
Manuscript ID	bmjopen-2021-052849
Article Type:	Original research
Date Submitted by the Author:	28-Apr-2021
Complete List of Authors:	Valentin, Virginia; University of Utah, Department of Family and Preventive Medicine Najmabadi, Shahpar; University of Utah, Department of Family and Preventive Medicine Honda, Trenton; Northeastern University
Keywords:	HEALTH ECONOMICS, HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, MEDICAL LAW





I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our <u>licence</u>.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which <u>Creative Commons</u> licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

R. O.

Title Page

Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997-2017: A Longitudinal Analysis

Corresponding Author

Shahpar Najmabadi, PhD, MPH Post-Doc Research Associate University of Utah Department of Family and Preventive Medicine **Division of Physician Assistant Studies** 375 Chipeta Way Suite 200 Salt Lake City, UT 84108, USA 801-708-1684 s.najmabadi@utah.edu

Authors

1 2 3

4 5

6

7 8

9

10

11

12

13

14

15

16 17

18

19 20

21

22

23

24

25

26

27

28

29

30 31

32

33

34

35

36 37

38

39

40

41 42

43

44

45

46

47

48

49

50 51 52

53 54

59

60

Virginia L. Valentin, DrPH, PA-C Associate Professor University of Utah Department of Family and Preventive Medicine Division of Physician Assistant Studies 375 Chipeta Way Suite 200 Salt Lake City, UT 84108, USA 801-585-0038 vvalentin@utah.edu

re Shahpar Najmabadi, PhD, MPH Post-Doc Research Associate University of Utah Department of Family and Preventive Medicine **Division of Physician Assistant Studies** 375 Chipeta Way Suite 200 Salt Lake City, UT 84108, USA 801-708-1684 s.najmabadi@utah.edu

Trenton Honda, PhD, MMS, PA-C **Clinical Professor** Northeastern University 202 Robinson Hall 360 Huntington Avenue Boston, MA 02115, USA 617-373-3195 t.honda@northeastern.edu

Word Count

2,574

Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997– 2017: A Longitudinal Analysis

ABSTRACT

Objective

The purpose of this study is to determine whether, and to what degree, variation in Physician Assistant (PA) state scope of practice (SOP) laws across states are associated with 1) PA median wage over time, and 2) if a specific SOP key element has a greater impact on PA median wage than others. We

hypothesize that expanded SOP laws would be associated with higher PA wage.

Design

Longitudinal analysis from 1997 to 2017.

Setting

Fifty states and the District of Columbia.

Participants

Employed PAs from 1997 to 2017.

Methods

Four national data sets were combined to allow for longitudinal analysis of state level annual PA wage with state SOP laws. We used linear regression models to explore the predicting effect of SOP elements on PA wage in 5-year intervals and individual growth models to assess the change in PA annual wage over the study period.

Results

There was a 220% increase in weighted PA annual wage over two-decades. There was a positive linear correlation between annual wage and age in 2012 and 2017 (r=0.52, P <0.01; r=0.29, P=0.04, respectively). The adjusted R² for individual SOP elements in the selected years were all small (Range: 0.0-0.29), with no appreciable pattern across time for any SOP element. In 1997, several SOP laws show association with median wage but this impact disappears over time.

Conclusions

PA median wage has risen over two-fold in the past two decades with the rise in PA wage mainly explained by time and the age of providers. In 1997 some SOP elements were associated with increased average wage, however, the impact of this increase diminished over time in all such instances. Future research needs to realize the impact specialty practice has on wage as we look to fill the gaps in our health care system.

Key Words

Physician assistant, annual wage, scope of practice laws, health policy, organization of health services

Page 4 of 22

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

Strengths and Limitations

- Data from the Bureau of Labor and Statistics (BLS) provided employed Physician Assistants (PAs) census data for all employed PAs from 1997 to 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 wage data from the BLS.
- This is the first study analysing two decades of national PA wage data for all 50 states and the District of Columbia longitudinally to describe the effect of state SOP laws on wage.
- The analysis did not include other possible confounding variables that may impact PA wage including PA specialty, physician or nurse practitioner employment numbers, or state and federal healthcare legislative policies.

or of the terms only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997– 2017: A Longitudinal Analysis

INTRODUCTION

Despite the increase in supply of Physician Assistants (PAs) over the last twenty years, PA salaries have continued to rise.^{1, 2} The number of employed PAs has risen from 13,500 in 1992 to 140,000 in 2019.^{3, 4} Meanwhile, the median salary has continued to rise to a reported \$105,000 in 2019.⁵ Nonetheless, demand remains strong with an estimated five job postings per PA graduate.¹ Due to this demand, a survey of 26 academic medical centers reported a range of 3.5 to 63 weeks to fill an open PA position.⁶

This high employer demand continues to draw large numbers of students to the PA profession, with a reported 2.95 applicants per 1 PA program seat.⁷ An analysis of American Academy of Physician Assistants (AAPA) student surveys indicated that upon entering PA school, a majority of students expect to amass student loan debt of \$75,000–\$124,999 and earn salaries between \$80,000 and \$89,999.⁸ Prior research on PA wages indicates that wage is impacted by gender, specialty, geographic region, years of practice, cost of living, local economy, and population density.² An analysis by Morgan et al. demonstrated that a higher ratio of PAs to MDs was correlated with higher salaries, suggesting that restrictions around practice ratios may have an impact on salaries.⁹ Higher PA salaries have also been correlated with larger number of PAs employed in high-paid specialties.^{1, 2} Together, these prior studies suggest that scope of practice (SOP) may be associated with PA wages, however this relationship remains largely unexplored.^{1, 10, 11}

Prior research has demonstrated that there is an inverse relationship between the supply of PAs and NPs and the level of restrictiveness of scope of practice laws.¹²⁻¹⁷ An analysis of 2018 AAPA Salary Report data found a statistically significant difference in PA salary in states that passed the following three scope of practice (SOP) key elements: scope determined at practice site; adaptable supervision requirements; and no chart co-signature requirement.¹⁸ Despite the legislative work at the state level over the decades, there remains wide variation in PA SOP laws in the United States (US), ranging from restrictive to permissive.¹⁷ The purpose of this study is to determine whether, and to what degree, variation in PA state SOP laws across states are associated with 1) PA median wage over time, and 2) if a specific SOP key element has a greater impact on PA median wage than others. We hypothesize that expanded PA scope of practice would be associated with higher PA wage.

METHODS

Data

Data were obtained from the Bureau of Labor and Statistics (BLS), AAPA census, and the AAPA database on PA legislative history. Census data were obtained from the U.S. Census Bureau to estimate

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

PA/population ratio by state.¹⁹⁻²² These four datasets were linked to allow for evaluation of annual PA demographics, SOP laws by state, and wage data from all 50 U.S. states and the District of Columbia (DC) during the 21-year period from 1997 to 2017. The combined state/year dataset included number of employed PAs and median wage in each state annually from the BLS, PA demographics from the AAPA census, state SOP laws from AAPA legislative history, and PA/population ratio by state from the U.S. Census Bureau.

Independent Variables (IV), Dependent Variable (DV), and Covariates

<u>Scope of Practice (IV)</u>: The AAPA established the ideal PA practice act which includes the 6 Key Elements of a Modern PA Practice Act: 1) licensure as a regulatory term, 2) full prescriptive authority, 3) scope of practice determined at the practice level, 4) adaptable collaboration requirements, 5) co-signature requirements determined at the practice level, and 6) number of PAs a physician may collaborate with determined at the practice level.²³ Data from AAPA included which six key elements were approved in each state by year. From this, the total number of key elements in a given state in a given year was calculated. There were no missing data for the number of key elements.

<u>Annual Wage Estimates (DV)</u>: In the BLS occupational employment statistics (OES) survey, annual wage estimates are defined as straight-time, gross pay, exclusive of premium pay. Included in the collection of OES wage data are base rate, cost-of-living allowances, guaranteed pay, hazardous-duty pay, incentive pay including commissions and production bonuses, on-call pay, and tips. Excluded from the wage data are back pay, jury duty pay, overtime pay, severance pay, shift differentials, nonproduction bonuses, and tuition reimbursements.²⁴

<u>Covariates</u>: The AAPA census provided mean age and percent female gender for each state by year. There were no missing data for mean age or gender.

Statistical Analysis

We used descriptive statistics to summarize PA and states demographics. We conducted multiple linear regression models to explore the predicting effect of SOP elements in PA wage change in the selected years of 1997, 2002, 2007, 2012, and 2017. Multiple linear regression models were adjusted for age and percent female PA, and weighted for the PA population size in each state. To assess the change in PA annual wage over years 1997 to 2017, individual growth analyses were applied at the level of the state to examine the impact of presence or absence of a key element on wage growth over time. All growth models were adjusted for year, and the time-varying covariates of mean PA age, and percent female PAs within the state. As in our linear regression models, our individual growth models were additionally weighted for the PA population size in each state.

<u>Missing Data</u>: State-level missing values on the time-varying variables of PA annual wage (n=9, 0.8%), number of employed PAs (n=28, 2.6%), and PA age and percent female PAs (n=204, 19% per variable)

BMJ Open

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

were imputed with the average of the state's last known and next known observations. In case of 2 missing values in a row (i.e. PA age and percent female PAs in years 2011 and 2012 for all states and DC), the last observation carried forward (LOCF) and the next observation carried backward (NOCB) techniques were used, respectively. In two cases of 3 missing values in a row for employed PAs (Hawaii and Arkansas), after replacing the LOCF and NOCB for the 1st and 3rd missing values, respectively, the average of these replaced values was used for the middle (2nd) missing value.

All analyses were conducted using SAS version 9.4.

RESULTS

We analyzed 1.071 PA annual wage records from 50 states and DC over 21 years. Table 1 summarizes cross-sectional demographics of U.S. employed PAs, and states demographics for selected years of 1997, 2002, 2007, 2012, and 2017 (5-year intervals). Overall, weighted PA annual wage increased steadily with the minimum wage earned seen in Mississippi for all years measured except 1997. The median age of sampled PAs was stable across time at between 40 and 41 years. The median percent of female PAs showed a constant increase over the study timeframe, growing from 49% in 1997 to 69% in 2017. There was a positive linear correlation between annual wage and age in 2012 and 2017 (r=0.52, P <0.01; r=0.29, P=0.04, respectively). The negative linear correlation between annual wage and percent female PAs was only statistically significant in 2012 (r=-0.41, P < 0.01) (Supplementary Table 1). The weighted PA median ratio per 100,000 population increased monotonically from 23.4 PA in 1997 to 33.2 PA per 100,000 population in 2017. Likewise, the median number of PA SOP laws also increased monotonically over the study period, from 2 in 1997 to 4 in 2017. Figure 1 demonstrates the 220% increase in weighted PA annual wage over the observation period, from a median of \$47,060 in 1997 to \$103,480 in 2017. The number of states with adoption of each of the six AAPA Key Elements is displayed with Licensure accepted early by all states and PA to physician ratio determined at the practice level least adopted by states.

	Year				
	1997	2002	2007	2012	2017
	Physicia	n Assistants Demogra	phics		
Age ^a					
Mean (SD)	40.9 (1.8)	41.2 (1.8)	39.7 (2.1)	40.8 (2.1)	39.7 (2.1)
Median (IQR)	41 (3)	41 (2)	41 (3)	41 (3)	40 (2)
Minimum (state)	36 (NJ)	37 (NJ)	37 (NJ)	34 (DC)	33 (AR)
Maximum (state)	46 (AR)	48 (NM)	47 (AK, NM)	47 (WY)	47 (WY)
Percent female ^a					
Mean (SD)	48.2 (8.6)	58.4 (7.0)	63.9 (6.0)	67.0 (6.0)	69.2 (5.8)
Median (IQR)	49 (11)	60 (11)	64 (7)	68 (6)	69 (6)
Minimum (state)	20 (MS)	18 (MS)	38 (UT)	40 (WY)	44 (HI)
Maximum (state)	75 (ND)	75 (ND)	79 (ND)	77 (ND)	78 (IL, PA, WI)
Annual wage (USD) ^{ab}					
Mean (SD)	44,921 (8,315)	63,546 (9,545)	77,843 (7,231)	92,451 (7,579)	104,760 (7,886)
Median (IQR)	47,060 (12,250)	67,520 (11,270)	79,240 (5,560)	92,150 (10,800)	103,480 (12,150)
Minimum (state, # scope of practice laws)	22,700 (AR, 1)	37,490 (MS, 1)	42,160 (MS, 2)	50,200 (MS, 2)	70,190 (MS, 2)
Maximum (state, # scope of practice laws)	77,210 (DE, 3)	78,900 (AR, 4)	91,010 (CT, 2)	112,250 (RI, 6)	120,200 (WA, 3)
		State Demographi	cs		
Population density/square mile ^c					
Mean (SD)	245.4 (470.9)	253.4 (469.5)	257.1 (462.2)	266.3 (513.3)	274.2 (565.7)
Median (IQR)	173.5 (195.8)	177.2 (195.8)	187.2 (189.8)	200.3 (313.3) 200.1 (185.3)	214.2 (363.7) 210.8 (177.3)
Minimum (state)	1.1 (AK)	1.1 (AK)	1.2 (AK)	1.3 (AK)	1.3 (AK)
Maximum (state)	9,307.2 (DC)	9,396.0 (DC)	9,416.5 (DC)	10,408.6 (DC)	11,391.9 (DC)
	<i>),501.2</i> (DC)),590.0 (BC)),110.5 (DC)	10,100.0 (DC)	11,591.9 (DC)
Number of scope of practice laws ^d					
Mean (SD)	2.2 (1.4)	2.6 (1.4)	2.8 (1.4)	3.3 (1.4)	3.7 (1.4)
Median (IQR)	2 (2)	2 (2)	3 (2)	3 (2)	4 (2)
Minimum (state)	0 (MS,NV,OH,PA,SC,VA,WI)	0 (OH,PA)	0 (OH)	0 (OH)	1 (AL,IA,SC)
Maximum (state)	5 (ME, NC)	6 (RI)	6 (NM, RI)	6 (ND, NM, RI)	6 (ND,NM,MA,MI,MN,I
PA ratio/100,000 population ^e					
Mean (SD)	24.7 (7.6)	26.2 (11.4)	26.2 (10.8)	31.9 (12.6)	38.5 (14.0)
Median (IQR)	23.4 (9.5)	25.5 (19.8)	23.5 (14.7)	32.9 (21.9)	33.2 (20.5)
Minimum (state)	8.8 (RI)	3.2 (MS)	4.6 (AR)	4.4 (MS)	8.4 (MS)
Maximum (state)	47.9 (DE)	52.6 (SC)	80.1 (DC)	75.3 (AK)	72.0 (DC)
		7			

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright.

.tr

SD: Standard Deviation; IQR: Interquartile Range; USD: United States Dollar

For the states name, we used two-letter states abbreviations.

^a Weighted by states' PA population

^b See supplementary Table 1 for -linear correlation of PA annual wage with age and percent female PA in the respective year

^c Densities of 50 States + DC per square mile, weighted by the population of states and DC (state population in year/state area in square mile)¹⁹⁻²²

^d PA scope of practice laws are the 6 Key Elements of a Modern PA Practice Act ²³

^e (employed PA in year/state population in that year) * 100,000, weighted by states' PA population

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/bmjopen-2021-fo5849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyrigh

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

Supplementary Table 2 shows the adoption of SOP laws in the US for selected years of 1997, 2002, 2007, 2012, and 2017 (5-year intervals). SOP elements follow a similar pattern of increased adoption over time, including: scope of practice (71% in 2017 versus 49% in 1997); full prescriptive authority (65% in 2017 versus 25% in 1997); co-signature requirements (61% in 2017 versus 39% in 1997); adaptable collaboration requirements (55% in 2017 versus 35% in 1997); and number of PAs a physician may collaborate with (24% in 2017 versus 18% in 1997). There is also significant heterogeneity in SOP element adoption by state. For example, Alabama, Iowa, and South Carolina had adopted only one, while six states (North Dakota, New Mexico, Massachusetts, Michigan, Minnesota, and Rhode Island) had adopted all six key elements as of 2017 (**Table 1, Supplementary Table 2**).

In general, SOP elements did not appear to be significantly associated with PA wage within the selected years (**Supplementary Table 2**). While some significant associations were found (i.e., Adaptable Collaboration and Co-signature in 2002; Licensure in 2007; Adaptable Collaboration in 2017) there is no overall pattern within any SOP element over time. Likewise, the adjusted R² in regression models for individual SOP elements in the selected years were all small (Range: 0.0-0.29), with no appreciable pattern across time for any SOP element. This indicates that these variables do not explain a large amount of heterogeneity in the PA wage within the selected years.

Table 2 presents the results of our individual growth models showing the associations between the presence of individual SOP elements and PA wage over time. Model 3 shows that states with full prescriptive authority in 1997 had predicted annual wage of \$5,238 (CI \$2,794, \$7,682) higher than in states without this law. Each year since 1997 was associated with a mean wage growth of \$3,049, however, the wage growth over time among states with full prescriptive authority grew \$319 less (CI \$-522, \$-116) per year than in states without this SOP element. A similar pattern is observed in Model 6 where SOP at the practice level in 1997 had wages \$3,094 (CI \$388, \$5,800) higher compared to states without this SOP element. Each year since 1997 was associated with a mean wage growth of \$3,090, but wage growth was \$251 less among these states compared to those without SOP at the practice level (CI \$-448, \$-54). Interestingly, states with the Adaptable Collaboration SOP element had no significant difference in wage in 1997

1
2
3
4
5
6
7
/
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
44 45
46
47
48
49
50

(p=0.647), but again saw a decrease in wage growth over time compared to states without this element (β : \$286, 95% CI \$-485, \$-87).

to beer terien only

45,644 742 3,081 565 16 -142 46,132 296 2,946 631 11 76 44,538 5,238	1,465 $1,082$ 104 143 15 93 $1,301$ $1,963$ 76 138 15 130 $1,260$	42,702 -1381 2,873 285 -13 -325 43,519 -3,557 2,794 361 -17 -180	48,587 2,865 3,289 845 45 41 48,744 4,149 3,098 901 40 332	<0.0001 0.4931 <0.0001 0.2871 0.1272 <0.0001 0.8803 <0.0001 <0.0001 0.4352 0.5500
742 3,081 565 16 -142 46,132 296 2,946 631 11 76 44,538 5,238	1,082 104 143 15 93 1,301 1,963 76 138 15 130 1,260	-1381 2,873 285 -13 -325 43,519 -3,557 2,794 361 -17	2,865 3,289 845 45 41 48,744 4,149 3,098 901 40	$\begin{array}{c} 0.4931 \\ < 0.0001 \\ < 0.0001 \\ 0.2871 \\ 0.1272 \\ \\ < 0.0001 \\ 0.8803 \\ < 0.0001 \\ < 0.0001 \\ 0.4352 \end{array}$
742 3,081 565 16 -142 46,132 296 2,946 631 11 76 44,538 5,238	1,082 104 143 15 93 1,301 1,963 76 138 15 130 1,260	-1381 2,873 285 -13 -325 43,519 -3,557 2,794 361 -17	2,865 3,289 845 45 41 48,744 4,149 3,098 901 40	$\begin{array}{c} 0.4931 \\ < 0.0001 \\ < 0.0001 \\ 0.2871 \\ 0.1272 \\ \\ < 0.0001 \\ 0.8803 \\ < 0.0001 \\ < 0.0001 \\ 0.4352 \end{array}$
3,081 565 16 -142 46,132 296 2,946 631 11 76 44,538 5,238	104 143 15 93 1,301 1,963 76 138 15 130 1,260	2,873 285 -13 -325 43,519 -3,557 2,794 361 -17	3,289 845 45 41 48,744 4,149 3,098 901 40	<0.0001 <0.0001 0.2871 0.1272 <0.0001 0.8803 <0.0001 <0.0001 0.4352
565 16 -142 46,132 296 2,946 631 11 76 44,538 5,238	143 15 93 1,301 1,963 76 138 15 130 1,260	285 -13 -325 43,519 -3,557 2,794 361 -17	845 45 41 48,744 4,149 3,098 901 40	<0.0001 0.2871 0.1272 <0.0001 0.8803 <0.0001 <0.0001 0.4352
16 -142 46,132 296 2,946 631 11 76 44,538 5,238	15 93 1,301 1,963 76 138 15 130 1,260	-13 -325 43,519 -3,557 2,794 361 -17	45 41 48,744 4,149 3,098 901 40	0.2871 0.1272 <0.0001 0.8803 <0.0001 <0.0001 0.4352
-142 46,132 296 2,946 631 11 76 44,538 5,238	93 1,301 1,963 76 138 15 130 1,260	-325 43,519 -3,557 2,794 361 -17	41 48,744 4,149 3,098 901 40	0.1272 <0.0001 0.8803 <0.0001 <0.0001 0.4352
296 2,946 631 11 76 44,538 5,238	1,963 76 138 15 130	-3,557 2,794 361 -17	4,149 3,098 901 40	0.8803 <0.0001 <0.0001 0.4352
296 2,946 631 11 76 44,538 5,238	1,963 76 138 15 130	-3,557 2,794 361 -17	4,149 3,098 901 40	0.8803 <0.0001 <0.0001 0.4352
296 2,946 631 11 76 44,538 5,238	1,963 76 138 15 130	-3,557 2,794 361 -17	4,149 3,098 901 40	0.8803 <0.0001 <0.0001 0.4352
2,946 631 11 76 44,538 5,238	76 138 15 130	2,794 361 -17	3,098 901 40	<0.0001 <0.0001 0.4352
631 11 76 44,538 5,238	138 15 130 1,260	361 -17	901 40	<0.0001 0.4352
11 76 44,538 5,238	15 130 1,260	-17	40	0.4352
76 44,538 5,238	130 1,260			
5,238				0.5598
5,238				
5,238		42,007	47,069	< 0.0001
	1,246	2,794	7,682	< 0.0001
3,049	87	2,874	3,223	< 0.0001
526	139	254	797	0.0002
19	15	-10	48	0.2065
-319	103	-522	-116	0.0021
45,819	1,386	43,036	48,602	< 0.0001
		-2.373		0.6472
		2.912		< 0.0001
		242		0.0002
				0.2932
-286	102	-485	-87	0.0050
45,469	1,372	42,712	48,226	< 0.0001
1,541				0.2810
3,136	87			< 0.0001
				0.0008
				0.3743
-358	99	-552	-163	0.0003
	45,469 1,541 3,136 476 13	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/pmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright.

BMJ Open

Intercept (year 1997)	44,660	1,416	41,816	47,505	< 0.0001
SOP at practice level	3,094	1,379	388	5,800	0.0251
Year	3,090	90	2,909	3,272	< 0.0001
Mean age	587	139	314	859	< 0.0001
Percent female	14	15	-15	43	0.3378
SOP*year	-251	100	-448	-54	0.0125

CI: Confidence Interval

^a Models were adjusted for PA mean-age and percent female PA. Weighted by PA number.

^b Linear mixed models were used to generate least square means.

^c See Supplementary Tables 3–9 for per state coefficients per SOP laws. All these models are weighted and adjusted by age and percent female.

beer teriew only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright.

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

DISCUSSION

Over the 20-year study period PA wages increased 2.2-fold with the change in wage primarily explained by time and not specific state scope of practice laws. It is clear that individual SOP laws are associated with increased wage, for example, full prescriptive authority was associated with a \$5,238 higher wage in 1997, but with a negative wage growth of \$319 for each subsequent year of the study. This is also seen with SOP at practice level, which is associated with a \$3,094 higher wage in 1997, but a \$251 lower wage growth for each subsequent year of the study. Together, this indicates that in the early period of this study, some SOP elements were associated with increased average wage, however, the impact of this increase diminished over time in all such instances. This suggests that the importance of these SOP elements on increasing wage decreased over time.

Throughout the decades there has been an expansion of state PA practice laws through the national moment of the AAPA Six Key Elements. This study supports previous literature showing that as of 2017 the majority of states have permissive practice laws and with this realisation, it is not surprising that the constituents of AAPA have pressed forward to expand practice autonomy further through Optimal Team Practice (OTP).^{17, 25} 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.²⁶ With this continued work to expand the role of physician assistants on the healthcare team, future research needs to determine if these proposed health policies have an impact on earnings.

With the average age of physician assistants at 40-year-old, we did find that age was strongly correlated with increased wage. As our profession becomes younger it has also has transitioned to a majority female occupation. Our study only found a negative linear correlation between annual wage and percent female PAs in 2012, but this was non-significant in our multivariable growth models. This may indicate that the increase in the percentage of female workforce is not negatively impacting annual wage growth, yet we know from AAPA annual salary report that females report earning an average of \$11,000 less than their male counterparts.¹⁸ Future research is needed to explore the influence of the feminization of the profession on salary growth.

As the PA profession has been anointed the "Best Job in America" by the US News and World Report for 2021, the Bureau of Labor and Statistics projects a 31% growth in employment

over the next 10 years.^{27, 28} This growth projection is due to the expected increase in demand for health care services and the ability to train PAs faster than physicians. With a projected shortage of 21,400 to 55,200 primary care physicians by 2033, PAs are often cited as one solution to meet this demand.²⁹ Research indicates that the supply of PAs is impacted by SOP laws with an increase the number of PAs per state population in states with permissive regulations.¹⁷ At the same time, the supply of PAs willing to work in primary care is likely restricted by the decreased earnings.⁹ Our study did not delineate by specialty which directly impacts PA wage. So, as our country continues to grapple with solutions to increase access to primary care, future research needs to better understand the levers that influence physician assistants' earnings, including specialty care.

This study has a number of important limitations. First, we analysed aggregate data at the state level; such ecological analyses are inherently limited and preclude drawing causal conclusions. Second, our analysis does not include other possible confounding variables that may impact PA wage, including specialty area of clinical employment, physician or nurse practitioner employment numbers, or state and federal healthcare legislative policies. Third, we were unable to account for lag time in terms of when the SOP laws were passed and the impact on wage. Fourth, the AAPA data on PA demographics is from a survey and the response rate ranged from 10-35% annually which may lead to a sampling bias towards or away from the null. These limitations are counterbalanced by a number of important strengths, including the robust SOP data provided by AAPA that was cross referenced and verified for each state and each year combined with annual wage data from the Bureau of Labor and Statistics.

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

CONCLUSIONS

Physician Assistant median wage has risen 220% in the past two decades. At the same time, there has been a significant expansion of state scope of practice laws where the majority of PAs today work in states with permissive regulations. This rise in physician assistant wage is mainly explained by time and the age of providers with minimal explanation earlier in the study period by state scope of practice laws. With the projected growth of the PA profession juxtaposed with the projected dearth of primary care physicians, health policy leaders need to look at implementing policy that will impact PA salary in areas of healthcare need.

Contributorship Statement

VLV, SN, and TJH were involved in the data analysis, interpretation, drafting the manuscript, and reviewed/edited the manuscript.

Funding

Funding was provided by the Don Pedersen Research Grant from Physician Assistant Education Association.

Grant number: N/A

Competing interests

None declared.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research. é lev

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 00115478).

Data availability statement

BLS and the United States Census Bureau have public use linkage to access Labor Statistics and population data, respectively. The data from AAPA on PA census and legislative history was requested through AAPA research department.

Figure 1 caption: Physician Assistant Annual Wage and Number of States with Each Practice Law from 1997 to 2017

REFERENCES

1. Morgan P, Leach B, Himmerick K, Everett C. Job openings for PAs by specialty. *Jaapa*. Jan 2018;31(1):45-47. doi:10.1097/01.Jaa.0000527701.08322.18

2. Quella A, Brock DM, Hooker RS. Physician assistant wages and employment, 2000-2025. *Jaapa*. Jun 2015;28(6):56-8, 60-3. doi:10.1097/01.JAA.0000465222.98395.0c

3. Clawson DK, Osterweis M. The Roles of Physician Assistants and Nurse Practitioners in Primary Care Washington, DC: Association of Academic Health Centers1993.

4. National Commission on Certification of Physician Assistants (NCCPA). 2019 Statistical Profile of Certified Physician Assistants Fact Sheet. 11/25/2020, 2020. Accessed 11/25/2020, 2020.

https://www.nccpa.net/news/2019-statistical-profile-of-certified

5. National Commission on Certification of Physician Assistants (NCCPA). 2019 Statistical Profile of Certified Physician Assistants. 3/7/2021, 2021. Accessed 3/7/2021, 2021.

https://prodcmsstoragesa.blob.core.windows.net/uploads/files/2019StatisticalProfileofCertifiedPhysicia nAssistants.pdf

6. Moote M, Krsek C, Kleinpell R, Todd B. Physician assistant and nurse practitioner utilization in academic medical centers. *Am J Med Qual*. Nov-Dec 2011;26(6):452-60. doi:10.1177/1062860611402984

7. McDaniel MJ, Ruback TJ. Physician Assistant Applicant Pool: The First 50 Years. *J Physician Assist Educ*. Oct 2017;28 Suppl 1:S18-s23. doi:10.1097/jpa.00000000000145

8. Streilein A, Leach B, Everett C, Morgan P. Knowing Your Worth: Salary Expectations and Gender of Matriculating Physician Assistant Students. *J Physician Assist Educ*. Mar 2018;29(1):1-6. doi:10.1097/jpa.00000000000180

9. Morgan P, Everett CM, Humeniuk KM, Valentin VL. Physician assistant specialty choice: Distribution, salaries, and comparison with physicians. *Jaapa*. Jul 2016;29(7):46-52. doi:10.1097/01.Jaa.0000484301.35696.16

10. Dower C, Moore J, Langelier M. It is time to restructure health professions scope-of-practice regulations to remove barriers to care. *Health Aff (Millwood)*. Nov 2013;32(11):1971-6. doi:10.1377/hlthaff.2013.0537

11. Davis A, Radix SM, Cawley J, Hooker R, Walker CS. Access and innovation in a time of rapid change: physician assistant scope of practice. 2015:

12. Wing P, Langelier MH, Salsberg ES, Hooker RS. The changing professional practice of physician assistants: 1992 to 2000. *Jaapa*. Jan 2004;17(1):37-40, 42, 45-9.

13. Hing E, Hsiao CJ. In which states are physician assistants or nurse practitioners more likely to work in primary care? *Jaapa*. Sep 2015;28(9):46-53. doi:10.1097/01.Jaa.0000470436.69199.45

14. Glicken AD, Miller AA. Physician assistants: from pipeline to practice. *Acad Med*. Dec 2013;88(12):1883-9. doi:10.1097/acm.0000000000000009

15. Sutton JP, Ramos C, Lucado J. US Physician Assistant Supply by State and County in 2009. *JAAPA*. 2010;23(9):E3-E8.

16. Willis JB. Barriers to PA Practice in Primary Care and Rural Medically Underserved Areas. *JAAPA*. 1993;6(6):418-422.

17. Valentin VL, Najmabadi S, Everett CM. Cross-sectional Analysis of United States Scope of Practice Laws and Employed Physician Assistants. *BMJ Open, in press*. 2021;

American Academy of Physician Assistants. 2017 AAPA Salary Report. 11/25/2020, 2020.
 Accessed 7/30/2018, 2018. <u>https://www.aapa.org/download/22453</u>

 United States Census Bureau. State and County Intercensal Tables: 1990-2000. 11/25/2020,
 2020. Accessed 11/25/2020, 2020. <u>https://www.census.gov/data/tables/time-</u> series/demo/popest/intercensal-1990-2000-state-and-county-totals.html

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

BMJ Open

20. United States Census Bureau. 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;

21. United States Census Bureau. 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;

22. State Symbols USA. Size of States: National (U.S.) States: Size in Square Miles. 11/25/2020, 2020. Accessed 11/25/2020, 2020. <u>https://statesymbolsusa.org/symbol-official-item/national-us/uncategorized/states-size</u>

23. American Academy of Physician Assistants. The six key elements of a modern PA practice act. 8/7/2010, 2020. Accessed 8/7/2020, 2020.

https://www.aapa.org/wpcontent/uploads/2016/12/Issue_Brief_Six_Key_Elements.pdf

24. Bureau of Labor and Statistics. Frequently Asked Questions (FAQs): How are "wages" defined by the Occupational Employment Statistics (OES) survey? 10/2/2020, 2020. Accessed 10/2/2020, 2020. https://www.bls.gov/bls/faqs.htm

25. Sobel J. Seven things you should know about optimal team practice. *Jaapa*. May 2019;32(5):12-13. doi:10.1097/01.Jaa.0000554747.39429.94

26. American Academy of Physician Assistants. What is optimal team practice? 4/1/2021, 2021. Accessed 4/1/2021, 2021. <u>https://www.aapa.org/advocacy-central/optimal-team-practice/</u>

27. US Bureau of Labor Statistics. Occupational Outlook Handbook. Physician Assistants. 4/1/2021, 2021. Accessed 4/1/2021, 2021. <u>https://www.bls.gov/ooh/healthcare/physician-assistants.htm#tab-6</u>

28. US News and World Report. US News Best Job Rankings. 4/1/2021, 2021. Accessed 4/1/2021, 2021. https://money.usnews.com/careers/best-jobs/rankings

29. Association of American Medical Colleges. The complexities of physician supply and demand: projections from 2018 to 2033. 4/1/2021, 2021. Accessed 4/1/2021, 2021.

https://www.aamc.org/system/files/2020-06/stratcomm-aamc-physician-workforce-projections-june-2020.pdf

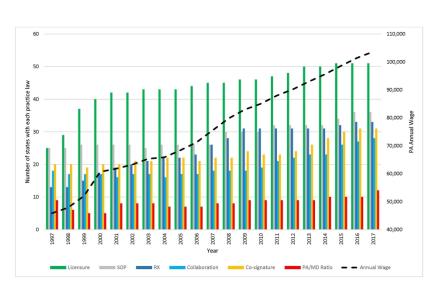


Figure 1 caption: Physician Assistant Annual Wage and Number of States with Each Practice Law from 1997 to 2017

Figure 1: Physician Assistant Annual Wage and Number of States with Each Practice Law from 1997 to 2017

279x215mm (300 x 300 DPI)

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BM.

٤
0
MJ Open: fir
<u>n</u>
firs
rst published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from htt
ŭ
olis
ň
ŏ
as
1
ω
6
Ř
흘
ĕ
P.
õ
12
ġ
ž
<u>4</u>
0 0
Ĕ
d as 10.1136/bmjopen-2021-052849 on 18 August
₽
ğ
SI
$\overline{\mathbf{N}}$
22
t 2021. Down
ĭ
<u> </u>
ă
ğ
Ŧ
g
-
http://b
1
ttp://bmjopen.l
omjopen
Б
<u>n</u> .
Ĕ
6
n
く
ĭ
₽
ź.
17
N
02
4
ž
gu
es
Ţ
5
ĭę
cte
ď
Š
8
ğ
ſïg
ħt.
-

		Year			
A	1997	2002	2007	2012	2017
Age					
Pearson's correlation coefficient ^a P	-0.08 0.600	0.31 0.028	0.22 0.129	0.52 <0.001	0.29 0.042
r	0.000	0.028	0.129	<0.001	0.042
Percent female PA					
Pearson's correlation coefficient ^a	0.41	-0.21	-0.03	-0.41	-0.15
Р	0.003	0.134	0.822	0.003	0.296
Weighted by states' PA population	2				
For peer review only - http	1				

Supplementary Table 1 Correlation between PA Annual Wage and Mean PA Age and Percent Female PA in 1997, 2002, 2007, 2012, and 2017

Scope of practice laws	1997	2002	2007	2012 4	2017
		Phy	vsician Assistants Annual	_	
Licensure				18 /	
β (# of states)	\$172 (25)	-\$4878 (42)	-\$7007 (45)	-\$4600 (48Ĕ	N/A (51)
95% CI	(-4,229,4,573)	(-11,271, 1,515)	(-11,978, -2,036)**	(-10,054 , 85∰)	
Adjusted R ²	0.1471	0.0879	0.1412	0.2755	
PA to physician collaboration ratio					
β (# of states)	-\$243 (9)	\$2572 (8)	-\$5212 (8)	-\$5828 (9)2	-\$2413 (12)
95% CI	(-7,367,6,881)	(-7,866,13,010)	(-12,790, 2,365)	(-12.351, 69 5)	(-8,196, 3,370
Adjusted \mathbb{R}^2	0.1471	0.0472	0.0336	0.2805	0.0382
Aujusteu K				0.2805 Q	
Full prescriptive authority				d f	
	\$5940 (13)	\$3310 (20)	-\$2991 (26)	-\$1833 (31)	\$2699 (33)
β (# of states)	(-139, 12,019)	(-2,486, 9,107)	(-7,104, 1,122)	(-5,730, 2,064)	(-1,737, 7,135
95% CI	0.2118	0.0683	0.0380	0.2455	0.0539
Adjusted R ²				0.2455	
Adaptable collaboration				<u> </u>	
β (# of states)	\$3865 (18)	\$7290 (17)	\$1581 (18)	\$3081 (22)	\$4497 (28)
95% CI	(-626 , 8,356)	(2,125, 12,455)**	(-2,842 , 6,004)	(-600, 6,763)	(36, 8,957)*
Adjusted R ²	0.1982	0.1824	0.0052	0.2748	0.1023
Co-signature)mo	
β (# of states)	-\$3520 (20)	-\$8187 (21)	-\$133 (22)	-\$211 (24)9	\$1438 (31)
95% CI	(-8,510, 1,471)	(-13,582 , -2,792)**	(-4,441 , 4,175)	(-4,008, 3,58)	(-3,175,6,051
Adjusted R ²	0.1821	0.2007	-0.0057	0.2313 E	0.0319
SOP at practice level				7, 2	
β (# of states)	\$4141 (25)	-\$1152 (26)	\$1444 (26)	\$2850 (32)	\$3714 (36)
95% CI	(-155, 8,436)	(-6,541, 4,238)	(-2,681, 5,568)	(1010 6700)	(-1,534, 8,963
Adjusted R^2	0.2102	0.0459	0.0047	0.2654 g	0.0641
CI: Confidence Interval				uest.	
N/A: Not applicable, as all states and DC in year				פ	
^a Models were adjusted for PA mean-age and per	rcent female PA. Weighted	by PA number.		rot	
* 0.01 < p <0.05				ect	
** p <0.01				ed	
				by	
				CO	
				руп	
		2		Protected by copyright	
				•	

 BMJ Open
 BMJ Open

 Supplementary Table 2 Cross-sectional Associations between Presence of Individual Scope of Practice Laws and Physician Assistants Annual 2012, and 2017^a
 BMJ Open

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

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or	2
		the abstract	
		(b) Provide in the abstract an informative and balanced summary of what	2
		was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation	4
		being reported	
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of	4-5
5		recruitment, exposure, follow-up, and data collection	
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and	4-5
F		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	
			N/A
		(b) Cohort study—For matched studies, give matching criteria and	IN/A
		number of exposed and unexposed	
		<i>Case-control study</i> —For matched studies, give matching criteria and the	
		number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders,	5
		and effect modifiers. Give diagnostic criteria, if applicable	
Data sources/	8*	For each variable of interest, give sources of data and details of methods	4-5
measurement		of assessment (measurement). Describe comparability of assessment	
		methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	5-6,
			14
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If	5-6
		applicable, describe which groupings were chosen and why	
Statistical methods	12	(a) Describe all statistical methods, including those used to control for	5-6
		confounding	
		(b) Describe any methods used to examine subgroups and interactions	5-6
		(c) Explain how missing data were addressed	5-6
		(d) Cohort study—If applicable, explain how loss to follow-up was	4-5
		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	
		(e) Describe any sensitivity analyses	Non
		(E) Deserve any sensitivity analyses	

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
11 12	
13	
13	
14 15	
15	
16	
17	
18	
19	
20	
21	
22	
20 21 22 23 24 25 26 27 28 29 30 31	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
34 35	
35	
36	
37 38	
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
55 54	
54 55	
56	
57	
58	
59	
60	

Participants	13*	(a) Report numbers of individuals at each stage of study-eg numbers potentially	4-5
		eligible, examined for eligibility, confirmed eligible, included in the study,	
		completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and	6-7
data		information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	5-6
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	9-12
Outcome data	15*	Cohort study-Report numbers of outcome events or summary measures over time	9-1.
		Case-control study—Report numbers in each exposure category, or summary	
		measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	6-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and	6-1
		their precision (eg, 95% confidence interval). Make clear which confounders were	
		adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a	N/A
		meaningful time period	
Other analyses	17	Report other analyses done-eg analyses of subgroups and interactions, and	N/A
		sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-
			14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or	14
		imprecision. Discuss both direction and magnitude of any potential bias	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations,	13-
		multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other informati	on		
Funding	22	Give the source of funding and the role of the funders for the present study and, if	15
-		applicable, for the original study on which the present article is based	1

*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 available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997–2017: A Longitudinal Analysis

	1
Journal:	BMJ Open
Manuscript ID	bmjopen-2021-052849.R1
Article Type:	Original research
Date Submitted by the Author:	30-Jun-2021
Complete List of Authors:	Valentin, Virginia; University of Utah, Department of Family and Preventive Medicine Najmabadi, Shahpar; University of Utah, Department of Family and Preventive Medicine Honda, Trenton; Northeastern University, School of Clinical and Rehabilitation Sciences
Primary Subject Heading :	Health policy
Secondary Subject Heading:	Health economics
Keywords:	HEALTH ECONOMICS, HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, MEDICAL LAW





I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our <u>licence</u>.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which <u>Creative Commons</u> licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

reliez on

2		
3	1	Title Page
4	2	
5	3	Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997–
6	4	2017: A Longitudinal Analysis
7	5	8 6
8	6	Corresponding Author
9	7	Shahpar Najmabadi, PhD, MPH
10	8	Post-Doc Research Associate
11	9	University of Utah
12	10	Department of Family and Preventive Medicine
13	11	Division of Physician Assistant Studies
14 15	12	375 Chipeta Way Suite 200
15 16	13	Salt Lake City, UT 84108, USA
17	13	801-708-1684
18	14	s.najmabadi@utah.edu
19	15	<u>s.najmabadi@ditan.edu</u>
20	10	Authors
20		
22	18	Virginia L. Valentin, DrPH, PA-C
23	19	Associate Professor
24	20	University of Utah
25	21	Department of Family and Preventive Medicine
26	22	Division of Physician Assistant Studies
27	23	375 Chipeta Way Suite 200
28	24	Salt Lake City, UT 84108, USA
29	25	801-585-0038
30	26	<u>vvalentin@utah.edu</u>
31	27	
32	28	Salt Lake City, UT 84108, USA 801-585-0038 vvalentin@utah.edu Shahpar Najmabadi, PhD, MPH Post-Doc Research Associate University of Utah Department of Family and Preventive Medicine Division of Physician Assistant Studies 375 Chipeta Way Suite 200
33	29	Post-Doc Research Associate
34	30	University of Utah
35	31	Department of Family and Preventive Medicine
36	32	Division of Physician Assistant Studies
37	33	
38	34	Salt Lake City, UT 84108, USA
39	35	801-708-1684 <u>s.najmabadi@utah.edu</u> Trenton Honda PhD MMS PA-C
40	36	<u>s.najmabadi@utah.edu</u>
41 42	37	
42 43	38	Trenton Hondu, ThD, White, TTY C
43 44	39	Clinical Professor
44	40	Northeastern University
46	41	202 Robinson Hall
47	42	360 Huntington Avenue
48	43	Boston, MA 02115, USA
49	44	617-373-3195
50	45	t.honda@northeastern.edu
51	46	
52	47	
53	48	Word Count
54	49	2,926
55	50	
56		
57		
58		1
59		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml
60		i or peer review only - nttp.//binjopen.binj.com/site/about/guidelines.xittini

1						
2 3	1	Associations between State Seens of Duratics Laws and US Develoien Assistant Wages from 1007				
4	1 2	Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997– 2017: A Longitudinal Analysis				
5 6	3	ABSTRACT				
7	4	Objective				
8 9	5	The purpose of this study is to determine whether, and to what degree, variation in Physician Assistant				
10	6	(PA) state scope of practice (SOP) laws across states are associated with 1) PA median wage over time,				
11 12	7	and 2) if a specific SOP key element has a greater impact on PA median wage than others. We				
13 14	8	hypothesize that expanded SOP laws would be associated with higher PA wage.				
14	9	Design				
16 17	10	Longitudinal analysis from 1997 to 2017.				
18	11	Setting				
19 20	12	Fifty states and the District of Columbia (US Capital region).				
21	13	Participants				
22 23	14	Employed PAs from 1997 to 2017.				
24 25	15	Methods				
26	16	Four national data sets were combined to allow for longitudinal analysis of state level annual PA wage				
27 28	17	with state SOP laws. We used linear regression models to explore the predicting effect of SOP elements				
29	18	on PA wage in 5-year intervals and individual growth models to assess the change in PA annual wage				
30 31	19	over the study period.				
32 33	20	Results				
33 34 35 36	21	There was a 220% increase in weighted PA annual wage over two-decades. There was a positive linear				
	22	correlation between annual wage and age in 2012 and 2017 (r=0.52, P <0.01; r=0.29, P=0.04,				
37	23	respectively). The adjusted R ² for individual SOP elements in the selected years were all small (Range:				
38 39	24	0.0-0.29), with no appreciable pattern across time for any SOP element. In 1997, several SOP laws show				
40 41	25	association with median wage but this impact disappears over time.				
42	26	Conclusions				
43 44	27	PA median wage has risen over two-fold in the past two decades with the rise in PA wage mainly				
45	28	explained by time and the age of providers. In 1997 some SOP elements were associated with increased				
46 47	29	average wage, however, the impact of this increase diminished over time in all such instances. As the PA				
48 49	30	profession moves towards Optimal Team Practice, future research should examine if this move				
50	31	towards greater autonomy impacts wage.				
51 52	32	Key Words				
53	33	Physician assistant, annual wage, scope of practice laws, health policy, organization of health services				
54 55						
56 57						
58		2				
59 60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml				

Page 4 of 24

Strengths and Limitations

- Data from the Bureau of Labor and Statistics (BLS) provided employed Physician Assistants (PAs) census data for all employed PAs from 1997 to 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 wage data from the BLS.
- This is the first study analysing two decades of national PA wage data for all 50 states and the • District of Columbia longitudinally to describe the effect of state SOP laws on wage.
- The analysis did not include other possible confounding variables that may impact PA wage including PA specialty, physician or nurse practitioner employment numbers, or state and federal healthcare legislative policies. βSiar-- ,

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

BMJ Open

Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997-**2017: A Longitudinal Analysis INTRODUCTION** Despite the increase in supply of Physician Assistants (PAs) over the last twenty years, PA salaries have continued to rise.^{1,2} The number of employed PAs has risen from 13,500 in 1992 to 140,000 in 2019.^{3,4} Meanwhile, the median salary has continued to rise to a reported \$105,000 in 2019.⁵ Nonetheless, demand remains strong with an estimated five job postings per PA graduate.¹ Due to this demand, a survey of 26 academic medical centers reported a range of 3.5 to 63 weeks to fill an open PA position.⁶ This high employer demand continues to draw large numbers of students to the PA profession, with a reported 2.95 applicants per 1 PA program seat.⁷ An analysis of American Academy of Physician Assistants (AAPA) student surveys indicated that upon entering PA school, a majority of students expect to amass student loan debt of \$75,000-\$124,999 and earn salaries between \$80,000 and \$89,999.8 Prior research on PA wages indicates that wage is impacted by gender, specialty, geographic region, years of practice, cost of living, local economy, and population density.² An analysis by Morgan et al. demonstrated that a higher ratio of PAs to MDs was correlated with higher salaries, suggesting that restrictions around practice ratios may have an impact on salaries.⁹ Higher PA salaries have also been correlated with larger number of PAs employed in high-paid specialties.^{1,2} Together, these prior studies suggest that scope of practice (SOP) may be associated with PA wages, however this relationship remains largely unexplored.1, 10-12 In the United States (US) physician assistant scope of practice is determined at the state level and includes six key elements. The AAPA's Modern PA Practice Act includes: licensure as a regulatory term, full prescriptive authority, scope of practice determined at the practice level, adaptable collaboration requirements, co-signature requirements determined at the practice level, and number of PAs a physician may collaborate with determined at the practice level.¹³ Prior research has shown that as of 2017 the majority of PAs work in states with permissive SOP regulations, defined as 5-6 of the six key elements.¹⁴ Prior research has demonstrated that there is an inverse relationship between the supply of PAs and NPs and the level of restrictiveness of scope of practice laws. An analysis of 2018 AAPA Salary Report data found a statistically significant difference in PA salary in states that passed the following three scope of practice (SOP) key elements: scope determined at practice site; adaptable supervision requirements; and no chart co-signature requirement.¹⁴⁻²⁰ Whereas, past analysis of the impact of SOP laws from 1994-2005 showed no impact on PA wage.¹² Over the past two decades there has been significant legislative work at the state level, but there remains wide variation in PA SOP laws in the US, ranging from restrictive to permissive.²¹ The purpose of this study is to determine whether, and to what degree, variation in PA state SOP laws across states are associated with 1) PA median wage over time,

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

1 2					
3	1	and 2) if a specific SOP key element has a greater impact on PA median wage than others. We			
4 5	2	hypothesize that expanded PA scope of practice would be associated with higher PA wage.			
6 7	3				
8	4	METHODS			
9 10 11 12 13	5	Data			
	6	Data were obtained from the Bureau of Labor and Statistics (BLS), AAPA census, and the AAPA			
	7	database on PA legislative history. Census data were obtained from the U.S. Census Bureau to estimate			
14 15	8	PA/population ratio by state. ²²⁻²⁵ These four datasets were linked to allow for evaluation of annual PA			
15 16 17 18	9	demographics, SOP laws by state, and wage data from all 50 U.S. states and the District of Columbia			
	10	(DC) during the 21-year period from 1997 to 2017. The combined state/year dataset included number of			
19	11	employed PAs and median wage in each state annually from the BLS, PA demographics from the AA			
20 21	12	census, state SOP laws from AAPA legislative history, and PA/population ratio by state from the U.S.			
22	13	Census Bureau.			
23 24	14	Independent Variables (IV), Dependent Variable (DV), and Covariates			
25 26	15	Scope of Practice (IV): The AAPA established the ideal PA practice act which includes the 6 Key			
27	16	Elements of a Modern PA Practice Act: 1) licensure as a regulatory term, 2) full prescriptive authority, 3)			
28 29	17	scope of practice determined at the practice level, 4) adaptable collaboration requirements, 5) co-signature			
30	18	requirements determined at the practice level, and 6) number of PAs a physician may collaborate with			
31 32	19	determined at the practice level. ¹³ Data compiled by the AAPA legislative staff were obtained from			
33 34	20	AAPA and included which six key elements were approved in each state by year. From this, the total			
35	21	number of key elements in a given state in a given year was calculated. There were no missing data for			
36 37	22	the number of key elements.			
38	23	Annual Wage Estimates (DV): In the BLS occupational employment statistics (OES) survey, annual wage			
39 40	24	estimates are defined as straight-time, gross pay, exclusive of premium pay. Included in the collection of			
41 42	25	OES wage data are base rate, cost-of-living allowances, guaranteed pay, hazardous-duty pay, incentive			
43	26	pay including commissions and production bonuses, on-call pay, and tips. Excluded from the wage data			
44 45	27	are back pay, jury duty pay, overtime pay, severance pay, shift differentials, nonproduction bonuses, and			
46	28	tuition reimbursements. ²⁶			
47 48	29	Covariates: The AAPA census provided mean age and percent female gender for each state by year.			
49 50	30	There were no missing data for mean age or gender. To adjust for the inflation over years 1997–2017, US			
51	31	consumer price index (CPI) percent change was used. ²⁷			
52 53 54	32	Statistical Analysis			
	33	We used descriptive statistics to summarize PA and states demographics. We conducted multiple linear			
55 56	34	regression models to explore the predicting effect of SOP elements in PA wage change in the selected			
57 58		5			
59 60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml			

Page 7 of 24

BMJ Open

vears of 1997, 2002, 2007, 2012, and 2017. Multiple linear regression models were adjusted for age and percent female PA, and weighted for the PA population size in each state. To assess the change in PA annual wage over years 1997 to 2017, individual growth analyses were applied at the level of the state to examine the impact of presence or absence of a key element on wage growth over time. All growth models were adjusted for year, and the time-varying covariates of mean PA age, and percent female PAs within the state. As in our linear regression models, our individual growth models were additionally weighted for the PA population size in each state. Missing Data: State-level missing values on the time-varying variables of PA annual wage (n=9, 0.8%), number of employed PAs (n=28, 2.6%), and PA age and percent female PAs (n=204, 19% per variable) were imputed with the average of the state's last known and next known observations. In case of 2 missing values in a row (i.e. PA age and percent female PAs in years 2011 and 2012 for all states and DC), the last observation carried forward (LOCF) and the next observation carried backward (NOCB) techniques were used, respectively. In two cases of 3 missing values in a row for employed PAs (Hawaii and Arkansas), after replacing the LOCF and NOCB for the 1st and 3rd missing values, respectively, the average of these replaced values was used for the middle (2nd) missing value. All analyses were conducted using SAS version 9.4. **RESULTS** We analyzed 1,071 PA annual wage records from 50 states and DC over 21 years. Table 1 summarizes cross-sectional demographics of US employed PAs, and states demographics for selected years of 1997, 2002, 2007, 2012, and 2017 (5-year intervals). Overall, weighted PA annual wage increased steadily with the minimum wage earned seen in Mississippi for all years measured except 1997. The median age of sampled PAs was stable across time at between 40 and 41 years. The median percent of female PAs showed a constant increase over the study time frame, growing from 49% in 1997 to 69% in 2017. There was a positive linear correlation between annual wage and age in 2012 and 2017 (r = 0.52, P < 0.01; r =0.29, P = 0.04, respectively). The negative linear correlation between annual wage and percent female PAs was only statistically significant in 2012 (r = -0.41, P < 0.01) (Supplementary Table 1). The weighted PA median ratio per 100,000 population increased almost monotonically from 23.4 PA in 1997 to 33.2 PA per 100,000 population in 2017. Likewise, the median number of PA SOP laws also increased monotonically over the study period, from 2 in 1997 to 4 in 2017. Figure 1 demonstrates the 220% increase in weighted PA annual wage over the observation period, from a median of \$47,060 in 1997 to \$103,480 in 2017.

		BMJ Open		136/bmjopen-2021-(5284	
Sable 1 Physician Assistant and State Demograp	hics and Median Wage in 1997-2	002 2007 2012 and 20	17	2021-	
-		002, 2007, 2012, und 20	Year	0528	
	1997	2002	2007	2002	2017
	Physicia	n Assistants Demograp	ohics	n 18	
Age ^a				40.8 5 2.1)	
Mean (SD)	40.9 (1.8)	41.2 (1.8)	39.7 (2.1)	40.8 4 2 1)	39.7 (2.1)
Median (IQR)	41 (3)	41 (2)	41 (3)	4173)	40 (2)
Minimum (state)	36 (NJ)	37 (NJ)	37 (NJ)	34 (P C)	33 (AR)
Maximum (state)	46 (AR)	48 (NM)	47 (AK, NM)	47 (₩Y)	47 (WY)
				Dow	
Percent female ^a					
Mean (SD)	48.2 (8.6)	58.4 (7.0)	63.9 (6.0)	67.0 ₹ 6.0)	69.2 (5.8)
Median (IQR)	49 (11)	60 (11)	64 (7)	6886)	69 (6)
Minimum (state)	20 (MS)	18 (MS)	38 (UT)	40 (W Y)	44 (HI)
Maximum (state)	75 (ND)	75 (ND)	79 (ND)	77 (ND)	78 (IL, PA, WI)
Annual wage (USD) ^{ab}				n ht	
Mean (SD)	44,921 (8,315)	63,546 (9,545)	77,843 (7,231)	92,4517,579)	104,760 (7,886)
Median (IQR)	47,060 (12,250)	67,520 (11,270)	79,240 (5,560)	92,150 (0,800)	103,480 (12,150)
Minimum (state, # scope of practice laws)	22,700 (AR, 1)	37,490 (MS, 1)	42,160 (MS, 2)	50,200 MS, 2)	70,190 (MS, 2)
Maximum (state, # scope of practice laws)	77,210 (DE, 3)	78,900 (AR, 4)	91,010 (CT, 2)	112,25 % (RI, 6)	120,200 (WA, 3)
		State Demographic	28		
			1.	.com	
Population density/square mile ^c	245 4 (470.0)	252 4 (4(0.5)	257.1(4(2.2))		2742(5(57))
Mean (SD) Median (IQR)	245.4 (470.9) 173.5 (195.8)	253.4 (469.5) 177.2 (195.8)	257.1 (462.2) 187.2 (189.8)	266.3 (§13.3) 200.1 (§85.3)	274.2 (565.7) 210.8 (177.3)
Minimum (state)	1/3.3 (193.8) 1.1 (AK)	1/7.2 (195.8) 1.1 (AK)	1.2 (AK)	1.3 (AK)	1.3 (AK)
Maximum (state)	9,307.2 (DC)	9,396.0 (DC)	9,416.5 (DC)	10,408 <u>6</u> (DC)	11,391.9 (DC)
				,7	····(-)
Number of scope of practice laws ^d				3.3 (2.4)	
Mean (SD)	2.2 (1.4)	2.6 (1.4)	2.8 (1.4)	3.3 (4.4)	3.7 (1.4)
Median (IQR)	2 (2)	2 (2)	3 (2)	3. E)	4 (2)
	0 (MS,NV,OH,PA,SC,VA,WI)	0 (OH,PA)	0 (OH)		1 (AL,IA,SC)
Maximum (state)	5 (ME, NC)	6 (RI)	6 (NM, RI)	6 (ND, M, RI)	6 (ND,NM,MA,MI,MN,I
PA ratio/100,000 population ^e				31.9 P 31.9 P 2.6)	
Mean (SD)	24.7 (7.6)	26.2 (11.4)	26.2 (10.8)	31.9 🛱 2.6)	38.5 (14.0)
Median (IQR)	23.4 (9.5)	25.5 (19.8)	23.5 (14.7)	32.9 😭 1.9)	33.2 (20.5)
Minimum (state)	8.8 (RI)	3.2 (MS)	4.6 (AR)	4.4 (HIS)	8.4 (MS)
Maximum (state)	47.9 (DE)	52.6 (SC)	80.1 (DC)	75.3 (AK)	72.0 (DC)
				cobyright.	
		7		igh	

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Page 9 of 24	BMJ Open	
1 2 3 4 5 6 7 8 9 10	BMJ Open SD: Standard Deviation; IQR: Interquartile Range; USD: United States Dollar To the states name, we used two-letter states abbreviations: ⁹ Vegipted by states 'PA population Deviations' of Datases and Deviation' (Cate population in year/state area in square mile) ¹⁰ PA sopport the face state ments of a Modern PA Practice Act ¹⁰ (employed PA in year/state population in that year) * 100,000, weighted by states' PA population	
11 12		222
13		
14		5
15		-
16 17		2
18	from	
19		F
20		
21		
22 23		
23 24		; 5
25	e de la companya de l	!
26		ł
27		2
28		>
29 30		<u> -</u> _
31		1
32		Ś
33	1 by	ŗ
34		ł
35 36	est.	ì
30 37		5
38		5
39		2
40	by	[
41		5
42 43	guest. Protected by copyright	1.
43 44		F
45	For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml	
46		
47		

Table 2 shows the adoption of SOP laws in the US for selected years of 1997, 2002, 2007, 2012, and 2017. The number of states with adoption of each of the six AAPA key elements is indicated with licensure accepted quickly by all states and PA to physician collaboration ratio determined at the practice level least adopted much more slowly. SOP elements roughly follow a similar pattern of increased adoption over time, including: licensure (100% in 2017 versus 49% in 1997); SOP at practice level (71% in 2017 versus 49% in 1997); full prescriptive authority (65% in 2017 versus 25% in 1997); co-signature requirements (61% in 2017 versus 39% in 1997); adaptable collaboration requirements (55% in 2017 versus 35% in 1997); and number of PAs a physician may collaborate with (24% in 2017 versus 18% in 1997).

There is also significant heterogeneity in each SOP element adoption by state. For example, Alabama, Iowa, and South Carolina had adopted only one, while six states (North Dakota, New Mexico, Massachusetts, Michigan, Minnesota, and Rhode Island) had adopted all six key elements as of 2017 (**Table 1**).

In general, SOP elements did not appear to be significantly associated with PA wage within the selected years. While some significant associations were found (i.e., adaptable collaboration and co-signature in 2002; licensure in 2007; adaptable collaboration in 2017) there is no overall pattern within any SOP element over time. The same pattern was observed in the cross-sectional adjusted full models, controlling for all 6 policies. Except, in the year 2017, in the full model, the adaptable collaboration was not any more significant, and instead full prescriptive authority became significant in that year. Likewise, the adjusted R² in regression models for individual SOP elements in the selected years were all small (Range: 0.0-0.29), with no appreciable pattern across time for any SOP element (**Table 2**).

Page 11 of 24

BMJ Open

		BMJ Open		36/br	
				136/bmjopen-202	
				en-2(
Fable 2 Cross-sectional Associations between P	resence of Individual Scope	e of Practice Laws and Phy	sician Assistants Annual	Wage (US\$) in 1997, 20	002, 2007, 2012, and 20
Scope of practice laws	1997	2002	2007	2012 55 N	2017
		Phy	sician Assistants Annual	Wage 4	
Licensure				on 1	
β (# of states)	\$172 (25)	-\$4878 (42)	-\$7007 (45)	-\$4600 (48)°	N/A (51)
95% CI	(-4,229 , 4,573)	(-11,271,1,515)	(-11,978 , -2,036)**	(-10,054 , 85 4)	
Adjusted R ²	0.1471	0.0879	0.1412	(-10,054 , 854) 0.2755 Eg	
PA to physician collaboration ratio				202	
β (# of states)	-\$243 (9)	\$2572 (8)	-\$5212 (8)	-\$5828 (9)	-\$2413 (12)
95% CI	(-7,367,6,881)	(-7,866 ,13,010)	(-12,790, 2,365)	(-12,351 , 69 9)	(-8,196,3,370)
Adjusted R ²	0.1471	0.0472	0.0336	0.2805	0.0382
Full prescriptive authority				(-12,351,690) 0.2805	
β (# of states)	\$5940 (13)	\$3310 (20)	-\$2991 (26)	-\$1833 (31)	\$2699 (33)
95% CI	(-139 , 12,019)	(-2,486,9,107)	(-7,104 , 1,122)	(-5,730, 2,063)	(-1,737 , 7,135)
Adjusted R ²	0.2118	0.0683	0.0380	0.2455	0.0539
Adaptable collaboration				0.2455 http://bm.	
β (# of states)	\$3865 (18)	\$7290 (17)	\$1581 (18)	\$3081 (22) 6	\$4497 (28)
95% CI	(-626, 8,356)	(2,125, 12,455)**	(-2,842,6,004)	(-600, 6,763)	(36, 8,957)*
Adjusted R ²	0.1982	0.1824	0.0052	0.2748	0.1023
Co-signature					
β (# of states)	-\$3520 (20)	-\$8187 (21)	-\$133 (22)	-\$211 (24)	\$1438 (31)
95% CI	(-8,510, 1,471)	(-13,582 , -2,792)**	(-4,441 , 4,175)	(-4,008, 3,58)	(-3,175,6,051)
Adjusted R ²	0.1821	0.2007	-0.0057	0.2313 April	0.0319
SOP at practice level				117,	
β (# of states)	\$4141 (25)	-\$1152 (26)	\$1444 (26)	\$2850 (32)	\$3714 (36)
95% CI	(-155, 8,436)	(-6,541 , 4,238)	(-2,681,5,568)	(-1,019,6,72)	(-1,534, 8,963)
Adjusted R ²	0.2102	0.0459	0.0047	0.2654 by	0.0641
Full model (all 6 policies)				Quest. -\$4.060	
β Licensure	-\$705	-\$583	-\$8,320	φ.,000 -	N/A
95% CI	(-4,967, 3,556)	(-6,796, 5,630)	(-14,567, -2,073)*	(-9,853, 1,73)	N/A
β PA to physician collaboration ratio	-\$908 (-8,028, 6,211)	-\$558 (-10,503, 9,387)	-\$4,047 (-12,771, 4,677)	-\$5,688 ਰੱ (-12,897, 1,52)	-\$5,653 (-11,757, 451)
95% CI	(-8,028, 0,211) \$4,465	(-10,303, 9,387) \$3,447	(-12,771,4,077) -\$1,984	(-12,897, 1,32, 6) -\$1,867	(-11,737,431) \$5,802
β Full prescriptive authority	(-1,928, 10,858)	(-1,921, 8,815)	(-6,124, 2,156)	(-5,950, 2,216)	(913, 10,692)*
F Preserver a automy	\$3,228	\$6,846	-\$1,902	\$657 <u>8</u>	\$4,748
		10		øyright.	

			BMJ Open		136/bmjop	Р
4 6 5 9 6 6 7 9 8 9 9 6	5% CI Adaptable collaboration 5% CI Co-signature 5% CI SOP at practice level 5% CI where d P2	(-1,356, 7,813) -\$3,362 (-8,329, 1,605) \$2,514 (-2,017, 7,046) 0.228	(1,409, 12,284)* -\$8,812 (-13,937, -3,687)** -\$1,521 (-6,367, 3,324) 0.3074	(-6,837, 3,033) -\$1,779 (-6,747, 3,189) \$1,374 (-3,125, 5,872) 0.1341	136/bmjopen-202 (-3,693, 5,007) -\$85 (-4,151, 3,98 \$2,942 (-1,383, 7,26 0,304 8 Augus	(-57, 9,553) -\$919 (-5,732, 3,893) \$3,718 (-1,845, 9,282) 0.1699
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Adjusted R ²	017 observed licensure. ent female PA. Weighted	by PA number.	N 07	August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright	
43 44 45 46 47	For	peer review only - http	11 b://bmjopen.bmj.com/si	ite/about/guidelines.	-	

Page 13 of 24

BMJ Open

Table 3 presents the results of our individual growth models showing the associations between the presence of individual SOP elements and PA wage over time. Model 3 shows that states with full prescriptive authority in 1997 had predicted annual wage of \$5,227 (95% CI \$2,784, \$7,670) higher than in states without this law. In the individual model of full prescriptive authority (model 3), each year since 1997 was associated with a mean wage growth of \$3,047, however, the wage growth over time among states with full prescriptive authority grew \$309 less (95% CI \$-513, \$-105) per year than in states without this SOP element. A similar pattern is observed in Model 6 where SOP at the practice level in 1997 had wages \$3,134 (95% CI \$431, \$5,837) higher compared to states without this SOP element. In the adjusted full model 7, \$3,134 decreased to \$3.023 (95% CI \$278, \$5.769). In the individual model of SOP at practice level (model 6), each year since 1997 was associated with a mean wage growth of \$3,096, but wage growth was \$251 less (95% CI \$-449, \$-56) among these states compared to those without SOP at the practice level. Interestingly, states with the adaptable collaboration law had no significant difference in wage in 1997 (P = 0.6483), but again saw a decrease of \$285 (95% CI \$-484, \$-86) in wage growth per year compared to states without this law. In the adjusted full model 7, prescriptive authority and SOP at practice level in 1997 predicted annual wage of \$4,506 (95% CI \$1,946, \$7,066), and \$3,023 (95% CI \$278, \$5,769) higher than in states without this law, respectively. States with the co-signature law had no significant difference in wage in 1997 (P =0.6645), but saw a decrease of \$268 (95% CI \$-477, \$-60) in wage growth per year compared to states without this law. These changes in model 7, which contained all six elements, relative to models 1-6, which each contained a single element, may reflect either confounding of the associations between individual SOP elements and wage by other SOP elements, or variance inflation due to multicollinearity.

Models	Parameter Estimate	Standard Error	Lower 95% CI	Upper 5% CI	р
Model 1					
Intercept (year 1997)	45,356	1,502	42,338	48_374	< 0.000
Licensure	669	1,085	-1,461	2,998	0.538
Year	3,079	103	2,871	3287	< 0.000
СРІ	138	162	-180	\$ 2 57	0.3935
Mean age	524	150	229	8 19	0.0005
Percent female	14	15	-16	23	0.3609
Licensure*year	-134	93	-318	.49	0.1507
Model 2	14 -134 45,734 378 2,951 159			Dov	
Intercept (year 1997)	45,734	1,360	43,003	48465	< 0.000
PA to physician collaboration ratio	378	1,963	-3,474	49230	0.8472
Year	2,951	76	2,799	3903	< 0.000
CPI	159	161	-158	476	0.3263
Mean age	580	147	292		< 0.000
Percent female	9	15	-20	3 8	0.5343
Ratio*year	71	130	-185	- - - - - - - - - - - - - - - - - - -	0.5867
Model 3		150	100	20798 34087 7 9 34040 9 2002 4 2003 4 200 4 200 200	0.5007
Intercept (year 1997)	44,165	1,316	41,522	1 2807	< 0.000
Full prescriptive authority	5,227	1,245	2,784	7,570	<0.000
Year	3,047	87	2,873		<0.000
CPI	157	162	-161	3322	0.3318
Mean age	477	147	188	2/0	0.0012
Percent female	17	15	-13		0.2616
Prescription*year	-309	104	-513	905	0.2010
	-507	104	-515	35222 476 965 146 905 Aprii	0.005
Model 4					
Intercept (year 1997)	45,452	1,437	42,565	4\$339	< 0.000
Adaptable collaboration	719	1,575	-2,373	3810	0.6483
Year	3,090	87	2,916	37264	< 0.000
СРІ	151	159	-161	453	0.3435
Mean age	466	148	176	755	0.0017
Percent female	13	15	-16	1	0.3725
Collaboration*year	-285	101	-484	發 6	0.005
Model 5				3,810 3,0264 3,0255 9,002 8,6 Prot 8,095	
Intercept (year 1997)	45,222	1,431	42,348	4 & 095	< 0.000
Co-signature	1,563	1,429	-1,240	4 छ 67	0.2741
Year	3,138	87	2,963	30713	< 0.000
СРІ	99	159	-214	₹ 12	0.5363
				opy	
				48067 3000 Foopyright	
	13			Jht	

136/bmjopen-202

Page 15 of 24			BMJ Open		136/bm	
1 2 3	Mean age	445	150	150	136/bmjopen-202 F052849	0.0031
4	Percent female	11	15	-17	×10	0.4333
5	Co-signature*year	-356	99	-551	-962	0.0003
6 7 8	Model 6 Intercept (year 1997)	44,233		41,275	ප 47බ 91	< 0.0001
9	SOP at practice level	3,134	1,377	431	57837 36277	0.0231
10	Year CPI	3,096 167	90 161	2,914 -149	3022// 47884	<0.0001 0.2991
		533	161	-149 244	4404 892	0.2991
11	Mean age Percent female	12	148	-17		0.0003
12	SOP*year	-253	100	-17	· <u> </u>	0.0119
13 14 15	Model 7				4233 121 126 462042	
16	Intercept (year 1997) Licensure	42,509	1,759 1,089	38,976 -1,975	465504∠ ⊃⊂2401	<0.0001 0.8812
17	PA to physician collaboration ratio	836	1,089	-1,973	2 301 4 511	0.6639
	Full prescriptive authority	4,506	1,924	-2,939	70066	0.0006
18	Adaptable collaboration	4,500	1,504		3700	0.0000
19	Co-signature	637	1,373	-2,243	3516	0.6645
20	SOP at practice level	3,023	1,399		5.769	0.031
21	Year	3,315	129	3,056	3574	< 0.0001
22	CPI	120	160	-193	433	0.4529
23	Mean age	276	153	-24	\$77	0.0714
24	Percent female	26	15	-4	3 5	0.0856
25	Licensure*year	-86	98	-278	1 06	0.3807
	Ratio*year	123	131	-134	8 79	0.3491
26	Prescription*year	-180	119	-414	₹3	0.1306
27	Collaboration*year	-180	108	-392	9 3	0.0969
28	C0-signature*year	-268	106	-477	1 60	0.0118
29	SOP*year	-154	107	-363	70966 31109 31516 5269 31574 433 977 55 406 879 30 979 30 979 30 90 90 90 90 90 90 90 90 90 90 90 90 90	0.1487
30						

CI: Confidence Interval; CPI: Consumer price index percent change

^a Models were adjusted for PA mean-age, percent female PA, and CPI. Weighted by PA number.

^b Linear mixed models were used to generate least square means.

7, 2024 by guest. Protected by copyright. ^c See Supplementary Tables 3–9 for per state coefficients per SOP laws. All these models are weighted and adjusted by age and percent female.

DISCUSSION

Over the 20-year study period PA wages increased 2.2-fold with the change in wage primarily explained by time and not specific state scope of practice laws. It is clear that individual SOP laws are associated with increased wage, particularly early in our study period, but the impact of these SOP elements changed over time. For example, full prescriptive authority was associated with a \$5,227 higher wage in 1997, but with a negative wage growth of \$309 for each subsequent year of the study. This is also seen with SOP at practice level, which was associated with a \$3,134 higher wage in 1997, but a \$253 lower wage growth for each subsequent year of the study. Together, this indicates that in the early period of this study, some SOP elements were associated with increased average wage, however, the impact of this increase diminished over time in all such instances. This suggests that the importance of these SOP elements on increasing wage decreased over time.

The findings of this study support previous work by Perry (2009) showing an increase in PA scope of practice did not increase wage.¹² As PAs are able to provide a wider breadth of care there is arguably a benefit to society through an increase in access to care. Yet, previous research indicates that expanded SOP for nurse practitioners (NPs) does also increase wage but specifically related to independence.^{12, 28} As the majority of states have permissive SOP laws and with this realisation, it is not surprising that the constituents of AAPA have pressed forward to expand practice autonomy further through Optimal Team Practice (OTP).^{21, 29} The principles 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.³⁰ The tenets of OTP will move the PA profession closer to independent practice, similar to nurse practitioners. Future research should then investigate if this expansion of scope of practice impacts PA wage mirroring our nurse practitioner colleagues.

Our study only found a negative linear correlation between annual wage and percent female PAs in 2012, but this was non-significant in our multivariable growth models. This may indicate that the increase in the percentage of female workforce is not negatively impacting annual wage growth. These findings juxtapose the other research that notes an \$11,000 reported difference in wage by female PAs and an \$12,859 difference by female NPs.^{13, 31} Future research is needed to further explore the influence of the feminization of the PA profession on salary growth.

Page 17 of 24

BMJ Open

As the PA profession has been anointed the "Best Job in America" by the US News and World Report for 2021, the Bureau of Labor and Statistics projects a 31% growth in employment over the next 10 years.^{32, 33} This growth projection is due to the expected increase in demand for health care services and the ability to train PAs faster than physicians. With a projected shortage of 21,400 to 55,200 primary care physicians by 2033, PAs are often cited as one solution to meet this demand.³⁴ Research indicates that the supply of PAs is impacted by SOP laws with an increase the number of PAs per state population in states with permissive regulations.²¹ At the same time, the supply of PAs willing to work in primary care is likely restricted by the decreased earnings.⁹ Our study did not delineate specialty which directly impacts PA wage. So, as our country continues to grapple with solutions to increase access to primary care, future research needs to better understand the levers that influence physician assistants' earnings, including specialty care.

This study has a number of important limitations. First, we analysed aggregate data at the state level; such ecological analyses are inherently limited and preclude drawing causal conclusions. Second, our analysis does not include other possible confounding variables that may impact PA wage, including specialty area of clinical employment, physician or nurse practitioner employment numbers, or state and federal healthcare legislative policies. Third, we were unable to account for lag time in terms of when the SOP laws were passed and the impact on wage. Fourth, the AAPA data on PA demographics is from a survey and the response rate ranged from 10-35% annually which may lead to a sampling bias towards or away from the null. These limitations are counterbalanced by a number of important strengths, including the robust SOP data provided by AAPA that was cross referenced and verified for each state and each year combined with annual wage data from the Bureau of Labor and Statistics.

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

CONCLUSIONS

Physician Assistant median wage has risen 220% in the past two decades. At the same time, there has been a significant expansion of state scope of practice laws such that the majority of PAs today work in states with permissive regulations. This rise in physician assistant wage is mainly explained by time and the age of providers with minimal explanation by state scope of practice laws. As the PA profession moves towards Optimal Team Practice, future research

2		
3 4	1	should examine if this move towards greater autonomy impacts wage, as occurred in nurse
5	2	practitioners.
6 7	3	
8 9	4	Contributorship Statement
10 11	5	VLV, SN, and TJH were involved in the data analysis, interpretation, drafting the manuscript,
12	6	and reviewed/edited the manuscript.
13 14	7	
15 16	8	Funding
17	9	Funding was provided by the Don Pedersen Research Grant from Physician Assistant Education
18 19	10	Association.
20 21	11	Grant number: N/A
22 23	12	
24	13	Competing interests
25 26	14	None declared.
27 28	15	
29	16	Patient and public involvement
30 31	17	Patients or the public were not involved in the design, or conduct, or reporting, or dissemination
32 33	18	plans of this research.
34 35	19	
36	20	Patient consent for publication
37 38	21	Not required.
39 40	22	
41	23	Ethics approval
42 43	24	As we used publicly available BLS data, and the requested AAPA data does not contain
44 45	25	identifying variables, this study was determined exempt from review by the University of Utah
46 47	26	Institutional Review Board (IRB 00115478).
48	27	
49 50	28	Data availability statement
51 52	29	BLS and the United States Census Bureau have public use linkage to access Labor Statistics and
53 54	30	population data, respectively. The data from AAPA on PA census and legislative history was
55	31	requested through AAPA research department.
56 57		
58 59		17
60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

1 2		
3 4	1	
5 6	2	Figure 1 caption: Physician Assistant Annual Wage and Number of States with Each Practice
$\begin{array}{c} 5 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 11 \\ 12 \\ 13 \\ 14 \\ 15 \\ 16 \\ 17 \\ 18 \\ 19 \\ 20 \\ 21 \\ 22 \\ 23 \\ 24 \\ 25 \\ 26 \\ 27 \\ 28 \\ 29 \\ 30 \\ 31 \\ 32 \\ 33 \\ 34 \\ 35 \\ 36 \\ 37 \\ 38 \\ 39 \\ 40 \\ 41 \\ 42 \\ 43 \\ 44 \\ 5 \\ 46 \\ 47 \\ 48 \\ 9 \\ 50 \\ 51 \\ 52 \\ 53 \\ 54 \\ 55 \end{array}$	23	Figure 1 caption: Physician Assistant Annual Wage and Number of States with Each Practice Law from 1997 to 2017
56 57		
58 59		18
59 60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

REFERENCES

1. Morgan P, Leach B, Himmerick K, Everett C. Job openings for PAs by specialty. *Jaapa*. Jan 2018;31(1):45-47. doi:10.1097/01.Jaa.0000527701.08322.18

2. Quella A, Brock DM, Hooker RS. Physician assistant wages and employment, 2000-2025. *Jaapa*. Jun 2015;28(6):56-8, 60-3. doi:10.1097/01.JAA.0000465222.98395.0c

3. Clawson DK, Osterweis M. The Roles of Physician Assistants and Nurse Practitioners in Primary Care Washington, DC: Association of Academic Health Centers1993.

4. National Commission on Certification of Physician Assistants (NCCPA). 2019 Statistical Profile of Certified Physician Assistants Fact Sheet. 11/25/2020, 2020. Accessed 11/25/2020, 2020.

https://www.nccpa.net/news/2019-statistical-profile-of-certified

5. National Commission on Certification of Physician Assistants (NCCPA). 2019 Statistical Profile of Certified Physician Assistants. 3/7/2021, 2021. Accessed 3/7/2021, 2021.

https://prodcmsstoragesa.blob.core.windows.net/uploads/files/2019StatisticalProfileofCertifiedPhysicia nAssistants.pdf

6. Moote M, Krsek C, Kleinpell R, Todd B. Physician assistant and nurse practitioner utilization in academic medical centers. *Am J Med Qual.* Nov-Dec 2011;26(6):452-60. doi:10.1177/1062860611402984

7. McDaniel MJ, Ruback TJ. Physician Assistant Applicant Pool: The First 50 Years. *J Physician Assist Educ*. Oct 2017;28 Suppl 1:S18-s23. doi:10.1097/jpa.00000000000145

8. Streilein A, Leach B, Everett C, Morgan P. Knowing Your Worth: Salary Expectations and Gender of Matriculating Physician Assistant Students. *J Physician Assist Educ*. Mar 2018;29(1):1-6. doi:10.1097/jpa.00000000000180

9. Morgan P, Everett CM, Humeniuk KM, Valentin VL. Physician assistant specialty choice: Distribution, salaries, and comparison with physicians. *Jaapa*. Jul 2016;29(7):46-52. doi:10.1097/01.Jaa.0000484301.35696.16

10. Dower C, Moore J, Langelier M. It is time to restructure health professions scope-of-practice regulations to remove barriers to care. *Health Aff (Millwood)*. Nov 2013;32(11):1971-6. doi:10.1377/hlthaff.2013.0537

11. Davis A, Radix SM, Cawley J, Hooker R, Walker CS. Access and innovation in a time of rapid change: physician assistant scope of practice. 2015:

12. PERRY JJ. THE RISE AND IMPACT OF NURSE PRACTITIONERS AND PHYSICIAN ASSISTANTS ON THEIR OWN AND CROSS-OCCUPATION INCOMES. *Contemporary Economic Policy*. 2009;27(4):491-511. doi:<u>https://doi.org/10.1111/j.1465-7287.2009.00162.x</u>

13. American Academy of Physician Assistants. The six key elements of a modern PA practice act. 8/7/2010, 2020. Accessed 8/7/2020, 2020.

https://www.aapa.org/wpcontent/uploads/2016/12/Issue_Brief_Six_Key_Elements.pdf

14. Valentin VL, Najmabadi S, Everett C. Cross-sectional analysis of US scope of practice laws and employed physician assistants. *BMJ Open*. May 11 2021;11(5):e043972. doi:10.1136/bmjopen-2020-043972

15. American Academy of Physician Assistants. 2017 AAPA Salary Report. 11/25/2020, 2020. Accessed 7/30/2018, 2018. <u>https://www.aapa.org/download/22453</u>

16. Hing E, Hsiao CJ. In which states are physician assistants or nurse practitioners more likely to work in primary care? *Jaapa*. Sep 2015;28(9):46-53. doi:10.1097/01.Jaa.0000470436.69199.45

17. Glicken AD, Miller AA. Physician assistants: from pipeline to practice. *Acad Med*. Dec 2013;88(12):1883-9. doi:10.1097/acm.0000000000000009

18. Sutton JP, Ramos C, Lucado J. US Physician Assistant Supply by State and County in 2009. *JAAPA*. 2010;23(9):E3-E8.

BMJ Open

2	
3	19. Willis JB. Barriers to PA Practice in Primary Care and Rural Medically Underserved Areas. JAAPA.
4	1993;6(6):418-422.
5	20. McMichael BJ. Beyond Physicians: The Effect of Licensing and Liability Laws on the Supply of
6	Nurse Practitioners and Physician Assistants. <i>Journal of Empirical Legal Studies</i> . 2018;15(4):732-771.
7	doi:https://doi.org/10.1111/jels.12198
8	21. Valentin VL, Najmabadi S, Everett CM. Cross-sectional Analysis of United States Scope of
9	
10 11	Practice Laws and Employed Physician Assistants. <i>BMJ Open, in press</i> . 2021;
12	22. United States Census Bureau. State and County Intercensal Tables: 1990-2000. 11/25/2020,
13	2020. Accessed 11/25/2020, 2020. https://www.census.gov/data/tables/time-
14	series/demo/popest/intercensal-1990-2000-state-and-county-totals.html
15	23. United States Census Bureau. Intercensal Estimates of the Resident Population for the United
16	States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2010 (ST-EST00INT-01). 2011;
17	24. United States Census Bureau. Annual Estimates of the Resident Population for the United States,
18	Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2019 (NST-EST2019-01). 2019;
19	25. State Symbols USA. Size of States: National (U.S.) States: Size in Square Miles. 11/25/2020, 2020.
20	Accessed 11/25/2020, 2020. https://statesymbolsusa.org/symbol-official-item/national-
21	us/uncategorized/states-size
22	26. Bureau of Labor and Statistics. Frequently Asked Questions (FAQs): How are "wages" defined by
23	the Occupational Employment Statistics (OES) survey? 10/2/2020, 2020. Accessed 10/2/2020, 2020.
24 25	https://www.bls.gov/bls/faqs.htm
25	27. US Inflation Calculator. Consumer Price Index Data from 1913 to 2021. 6/18/2021, 2021.
27	Accessed 6/18/2021, 2021. https://www.usinflationcalculator.com/inflation/consumer-price-index-and-
28	annual-percent-changes-from-1913-to-2008/
29	28. Kleiner MM, Marier A, Park KW, Wing C. Relaxing Occupational Licensing Requirements:
30	Analyzing Wages and Prices for a Medical Service. <i>The Journal of Law and Economics</i> .
31	2016;59(2)doi: <u>https://doi.org/10.1086/688093</u>
32	29. Sobel J. Seven things you should know about optimal team practice. <i>Jaapa</i> . May 2019;32(5):12-
33	13. doi:10.1097/01.Jaa.0000554747.39429.94
34	30. American Academy of Physician Assistants. What is optimal team practice? 4/1/2021, 2021.
35	
36	Accessed 4/1/2021, 2021. https://www.aapa.org/advocacy-central/optimal-team-practice/
37	31. Greene J, El-Banna MM, Briggs LA, Park J. Gender differences in nurse practitioner salaries. <i>J Am</i>
38 39	Assoc Nurse Pract. Nov 2017;29(11):667-672. doi:10.1002/2327-6924.12512
40	32. US Bureau of Labor Statistics. Occupational Outlook Handbook. Physician Assistants. 4/1/2021,
40	2021. Accessed 4/1/2021, 2021. https://www.bls.gov/ooh/healthcare/physician-assistants.htm#tab-6
42	33. US News and World Report. US News Best Job Rankings. 4/1/2021, 2021. Accessed 4/1/2021,
43	2021. https://money.usnews.com/careers/best-jobs/rankings
44	34. Association of American Medical Colleges. The complexities of physician supply and demand:
45	projections from 2018 to 2033. 4/1/2021, 2021. Accessed 4/1/2021, 2021.
46	https://www.aamc.org/system/files/2020-06/stratcomm-aamc-physician-workforce-projections-june-
47	<u>2020.pdf</u>
48	
49	
50	
51	
52 53	
53 54	
54 55	
56	
57	
58	20
59	
60	For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright.

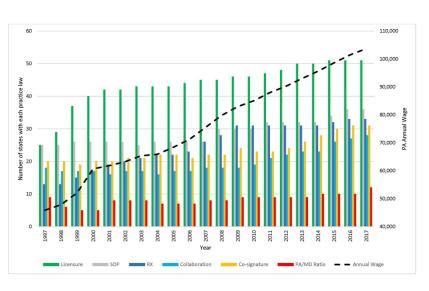


Figure 1 caption: Physician Assistant Annual Wage and Number of States with Each Practice Law from 1997 to 2017

Figure 1: Physician Assistant Annual Wage and Number of States with Each Practice Law from 1997 to 2017

279x215mm (300 x 300 DPI)

1 2 3 4 5 6 7 8	Supplementary 1997, 2002, 2007,
9 10	Age
11 12 13 14	Pearson's corre P
15 16 17	Percent femal
18 19 20	Pearson's corre P
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 35 56	^a Weighted by st
57 58	
59 60	

Supplementary Table 1 Correlation between PA Annual Wage and Mean PA Age and Percent Female PA in 1997, 2002, 2007, 2012, and 2017

		Year			
	1997	2002	2007	2012	2017
relation coefficient ^a	-0.08	0.31	0.22	0.52	0.29
	0.600	0.028	0.129	< 0.001	0.042
le PA					
relation coefficient ^a	0.41	-0.21	-0.03	-0.41	-0.15
	0.003	0.134	0.822	0.003	0.296
states' PA population					

1

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

	Item No	Recommendation	Pag No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or	2
		the abstract	
		(b) Provide in the abstract an informative and balanced summary of what	2
		was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation	4
		being reported	
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of	4-5
8		recruitment, exposure, follow-up, and data collection	
Participants	6	(<i>a</i>) <i>Cohort study</i> —Give the eligibility criteria, and the sources and	4-5
i unicipanto	Ū	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	
		(b) Cohort study—For matched studies, give matching criteria and	N/A
		number of exposed and unexposed	
		Case-control study—For matched studies, give matching criteria and the	
		number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders,	5
		and effect modifiers. Give diagnostic criteria, if applicable	
Data sources/	8*	For each variable of interest, give sources of data and details of methods	4-5
measurement		of assessment (measurement). Describe comparability of assessment	
		methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	5-6,
			14
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If	5-6
		applicable, describe which groupings were chosen and why	
Statistical methods	12	(a) Describe all statistical methods, including those used to control for	5-6
		confounding	
		(b) Describe any methods used to examine subgroups and interactions	5-6
		(c) Explain how missing data were addressed	5-6
		(d) Cohort study—If applicable, explain how loss to follow-up was	4-5
		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	
		(<u>e</u>) Describe any sensitivity analyses	Nor
		(e) Deserve any sensitivity analyses	

2
3
4
5
6
/
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
55 54
55
56
57
58
58 59
59 60
00

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially	4-5
		eligible, examined for eligibility, confirmed eligible, included in the study,	
		completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and	6-7
data		information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	5-6
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	9-1
Outcome data	15*	Cohort study-Report numbers of outcome events or summary measures over time	9-1
		Case-control study—Report numbers in each exposure category, or summary	
		measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	6-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and	6-1
		their precision (eg, 95% confidence interval). Make clear which confounders were	
		adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	N/2
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a	N//
		meaningful time period	
Other analyses	17	Report other analyses done-eg analyses of subgroups and interactions, and	N/2
		sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-
			14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or	14
		imprecision. Discuss both direction and magnitude of any potential bias	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations,	13-
		multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information	on		
Funding	22	Give the source of funding and the role of the funders for the present study and, if	15
-		applicable, for the original study on which the present article is based	

*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 available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997–2017: A Longitudinal Analysis

	1
Journal:	BMJ Open
Manuscript ID	bmjopen-2021-052849.R2
Article Type:	Original research
Date Submitted by the Author:	24-Jul-2021
Complete List of Authors:	Valentin, Virginia; University of Utah, Department of Family and Preventive Medicine Najmabadi, Shahpar; University of Utah, Department of Family and Preventive Medicine Honda, Trenton; Northeastern University, School of Clinical and Rehabilitation Sciences
Primary Subject Heading :	Health policy
Secondary Subject Heading:	Health economics
Keywords:	HEALTH ECONOMICS, HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, MEDICAL LAW





I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our <u>licence</u>.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which <u>Creative Commons</u> licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

R. O.

2		
3	1	Title Page
4	2	
5	3	Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997–
6	4	2017: A Longitudinal Analysis
7	5	8 .
8	6	Corresponding Author
9	7	Shahpar Najmabadi, PhD, MPH
10	8	Post-Doc Research Associate
11	9	University of Utah
12	10	Department of Family and Preventive Medicine
13	11	Division of Physician Assistant Studies
14 15	12	375 Chipeta Way Suite 200
15	13	Salt Lake City, UT 84108, USA
17	13	801-708-1684
18	14	s.najmabadi@utah.edu
19	15	<u>s.najmabadi@ditai.edu</u>
20	10	Authors
21		
22	18	Virginia L. Valentin, DrPH, PA-C
23	19	Associate Professor
24	20	University of Utah
25	21	Department of Family and Preventive Medicine
26	22	Division of Physician Assistant Studies
27	23	375 Chipeta Way Suite 200
28	24	Salt Lake City, UT 84108, USA
29	25	801-585-0038
30	26	<u>vvalentin@utah.edu</u>
31	27	
32	28	Salt Lake City, UT 84108, USA 801-585-0038 vvalentin@utah.edu Shahpar Najmabadi, PhD, MPH Post-Doc Research Associate University of Utah Department of Family and Preventive Medicine Division of Physician Assistant Studies 375 Chipeta Way Suite 200
33	29	Post-Doc Research Associate
34	30	University of Utah
35	31	Department of Family and Preventive Medicine
36	32	Division of Physician Assistant Studies
37	33	sto empeta traj suite 200
38	34	Salt Lake City, UT 84108, USA
39	35	801-708-1684
40	36	801-708-1684 s.najmabadi@utah.edu Trenton Honda PhD MMS PA-C
41	37	
42	38	Trenton Honda, PhD, MMS, PA-C
43	39	Clinical Professor
44	40	Northeastern University
45	41	202 Robinson Hall
46 47	42	360 Huntington Avenue
47 48	43	Boston, MA 02115, USA
40 49	44	617-373-3195
49 50	45	t.honda@northeastern.edu
50	46	
52	47	
53	48	Word Count
54	49	2,916
55	50	
56		
57		
58		1
59		
60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

1 2		
2 3	1	Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997–
4 5	2	2017: A Longitudinal Analysis
6	3	ABSTRACT
7 8	4	Objective
9	5	The purpose of this study is to determine whether, and to what degree, variation in Physician Assistant
10 11	6	(PA) state scope of practice (SOP) laws across states are associated with 1) PA median wage over time,
12	7	and 2) if a specific SOP key element has a greater impact on PA median wage than others. We
13 14	8	hypothesize that expanded SOP laws will be associated with higher PA wage.
15	9	Design
16 17	10	Longitudinal analysis from 1997 to 2017.
18	11	Setting
19 20	12	Fifty states and the District of Columbia (US Capital region).
21	13	Participants
22 23	14	Employed PAs from 1997 to 2017.
24 25	15	Methods
26	16	Four national data sets were combined to allow for longitudinal analysis of state level annual PA wage
27 28	17	with state SOP laws. We used linear regression models to explore the associations of SOP elements on
29	18	PA wage in 5-year intervals and individual growth models to assess the change in PA annual wage over
30 31	19	the study period.
32	20	Results
33 34	21	There was a 220% increase in weighted PA annual wage over two-decades. There was a positive linear
35 36	22	correlation between annual wage and age in 2012 and 2017 (r=0.52, P < 0.01; r=0.29, P=0.04,
37	23	respectively). The adjusted R ² for individual SOP elements in the selected years were all small (Range:
38 39	24	0.0-0.29), with no appreciable pattern across time for any SOP element. In 1997, several SOP laws show
40	25	association with median wage but this impact disappears over time.
41 42	26	Conclusions
43 44	27	PA median wage has risen over two-fold in the past two decades, with the rise in PA wage mainly
44 45	28	explained by time and provider age. In 1997 some SOP elements were associated with increased average
46 47	29	wage, however, the impact of this increase diminished over time in all such instances. As the PA
48 49	30	profession moves towards Optimal Team Practice, future research should examine if this move
50	31	towards greater autonomy impacts wage.
51 52	32	Key Words
53	33	Physician assistant, annual wage, scope of practice laws, health policy, organization of health services
54 55		
56 57		
58		2
59 60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Page 4 of 25

BMJ Open

Strengths and Limitations

- Data from the Bureau of Labor and Statistics (BLS) provided employed Physician Assistants (PAs) census data for all employed PAs from 1997 to 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 wage data from the BLS.
- This is the first study analysing two decades of national PA wage data for all 50 states and the District of Columbia longitudinally to describe the effect of state SOP laws on wage.
- The analysis did not include other possible confounding variables that may impact PA wage including PA specialty, physician or nurse practitioner employment numbers, or state and federal healthcare legislative policies.

BMJ Open

Associations between State Scope of Practice Laws and US Physician Assistant Wages from 1997-**2017: A Longitudinal Analysis INTRODUCTION** Despite the increase in supply of Physician Assistants (PAs) over the last twenty years, PA salaries have continued to rise.^{1,2} The number of employed PAs has risen from 13,500 in 1992 to 140,000 in 2019.^{3,4} Meanwhile, the median salary has continued to rise to a reported \$105,000 in 2019.⁵ Nonetheless, demand remains strong with an estimated five job postings per PA graduate.¹ Due to this demand, a survey of 26 academic medical centers reported a range of 3.5 to 63 weeks to fill an open PA position.⁶

This high employer demand continues to draw large numbers of students to the PA profession, with a reported 2.95 applicants per 1 PA program seat.⁷ An analysis of American Academy of Physician Assistants (AAPA) student surveys indicated that upon entering PA school, a majority of students expect to amass student loan debt of between \$75,000 and \$124,999 and earn salaries between \$80,000 and \$89,999.⁸ Prior research on PA wages indicates that wage is impacted by gender, specialty, geographic region of practice, years of practice, cost of living, the local economy, and population density.² An analysis by Morgan et al. demonstrated that a higher ratio of PAs to MDs was also correlated with higher PA salaries, suggesting that restrictions around practice ratios may impact wages.⁹ Higher PA salaries have also been correlated with larger number of PAs employed in high-paid specialties.^{1,2} Together, these prior studies suggest that scope of practice (SOP) may be associated with PA wages, however this relationship remains largely unexplored.^{1, 10-12}

In the United States (US), physician assistant scope of practice is determined at the state level and includes six key elements. The AAPA Modern PA Practice Act includes the following SOP elements: Licensure as a regulatory term; full prescriptive authority; scope of practice determined at the practice level; adaptable collaboration requirements; co-signature requirements determined at the practice level; and number of PAs a physician may collaborate with determined at the practice level.¹³ Prior research has shown that as of 2017, the majority of PAs work in states with permissive SOP regulations, defined as 5-6 of these six key elements.¹⁴ With this success, the AAPA is now working to expand practice autonomy further through Optimal Team Practice (OTP). The principles 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.¹⁵

Prior research has demonstrated that there is an inverse relationship between the supply of PAs and NPs and the restrictiveness of scope of practice laws. An analysis of 2018 AAPA Salary Report data found a statistically significant difference in PA salary in states that passed the following three scope of practice (SOP) key elements: Scope determined at practice site; adaptable supervision requirements; and

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

1 no chart co-signature requirement.^{14, 16-21} Whereas, past analysis of the impact of SOP laws from 1994-

2 2005 showed no impact on PA wage.¹² Over the past two decades there has been significant legislative

- 3 work at the state level, but there remains wide variation in PA SOP laws in the US, ranging from
- 4 restrictive to permissive.²² The purpose of this study is to determine whether, and to what degree,
- 5 variation in PA state SOP laws across states are associated with 1) PA median wage over time, and 2) if a
- 6 specific SOP key element has a greater impact on PA median wage than others. We hypothesize that
- 7 expanded PA scope of practice will be associated with higher PA wage.

9 METHODS

10 Data

Data were obtained from the Bureau of Labor and Statistics (BLS), AAPA census, and the AAPA database on PA legislative history. Census data were obtained from the U.S. Census Bureau to estimate PA/population ratio by state.²³⁻²⁶ These four datasets were linked to allow for evaluation of annual PA demographics, SOP laws by state, and wage data from all 50 U.S. states and the District of Columbia (DC) during the 21-year period from 1997 to 2017. The combined state/year dataset included number of employed PAs and median wage in each state annually from the BLS, PA demographics from the AAPA census, state SOP laws from AAPA legislative history, and PA/population ratio by state from the U.S. Census Bureau. Independent Variables (IV), Dependent Variable (DV), and Covariates Scope of Practice (IV): The AAPA established the ideal PA practice act which includes the 6 Key Elements of a Modern PA Practice: 1) licensure as a regulatory term, 2) full prescriptive authority, 3) scope of practice determined at the practice level, 4) adaptable collaboration requirements, 5) co-signature requirements determined at the practice level, and 6) number of PAs a physician may collaborate with determined at the practice level.¹³ Data compiled by the AAPA legislative staff were obtained from AAPA and included which of these six key elements were approved in each state by year. From this, the total number of key elements in a given state in a given year was calculated. There were no missing data for the number of key elements. Annual Wage Estimates (DV): In the BLS occupational employment statistics (OES) survey, annual wage estimates are defined as straight-time, gross pay, exclusive of premium pay. Included in the collection of OES wage data are base rate, cost-of-living allowances, guaranteed pay, hazardous-duty pay, incentive pay including commissions and production bonuses, on-call pay, and tips. Excluded from the wage data

 $\frac{2}{3}$ 32 are back pay, jury duty pay, overtime pay, severance pay, shift differentials, nonproduction bonuses, and

33 tuition reimbursements.²⁷

Page 7 of 25

BMJ Open

Covariates: The AAPA census provided mean age and percent female gender for each state by year. To adjust for the inflation over years 1997–2017, US consumer price index (CPI) percent change was used.²⁸ There was no missing data for these covariates. **Statistical Analysis** We used descriptive statistics to summarize PA and state demographics. We conducted multiple linear regression models to explore the associations of SOP elements in PA wage change in the selected years of 1997, 2002, 2007, 2012, and 2017. Multiple linear regression models were adjusted for age and percent female PA, and weighted for the PA population size in each state. To assess the change in PA annual wage over years 1997 to 2017, individual growth analyses were applied at the level of the state to examine the impact of presence or absence of a key element on wage growth over time. All growth models were adjusted for year, and the time-varying covariates of mean PA age, percent female PAs within the state, and the US CPI. As in our linear regression models, our individual growth models were additionally weighted for the PA population size in each state. Missing Data: State-level missing values on the time-varying variables of PA annual wage (n=9, 0.8%), number of employed PAs (n=28, 2.6%), and PA age and percent female PAs (n=204, 19% per variable) were imputed with the average of the state's last known and next known observations. In case of 2 missing values in a row (i.e. PA age and percent female PAs in years 2011 and 2012 for all states and DC), the last observation carried forward (LOCF) and the next observation carried backward (NOCB) techniques were used, respectively. In two cases of 3 missing values in a row for employed PAs (Hawaii and Arkansas), after replacing the LOCF and NOCB for the 1st and 3rd missing values, respectively, the average of these replaced values was used for the middle (2nd) missing value. All analyses were conducted using SAS version 9.4. RESULTS We analyzed 1,071 PA annual wage records from 50 states and the District of Columbia over 21 years. Table 1 summarizes cross-sectional demographics of US employed PAs, and state demographics for the selected years of 1997, 2002, 2007, 2012, and 2017 (5-year intervals). Overall, weighted PA annual wage increased steadily, with the minimum wage earned seen in Mississippi for all years measured except 1997. The median age of sampled PAs was stable across time at between 40 and 41 years. The median percent of female PAs showed a constant increase over the study time frame, growing from 49% in 1997 to 69% in 2017. There was a positive linear correlation between annual wage and age in 2012 and 2017 (r = 0.52, P < 0.01; r = 0.29, P = 0.04, respectively). The negative linear correlation between annual wage

and percent female PAs was only statistically significant in 2012 (r = -0.41, P < 0.01) (Supplementary (Supplementary))

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

1 Table 1). The weighted PA median ratio per 100,000 population increased almost monotonically from

2 23.4 PA in 1997 to 33.2 PA per 100,000 population in 2017. Likewise, the median number of PA SOP

- 3 laws also increased monotonically over the study period, from 2 in 1997 to 4 in 2017. Figure 1
- 4 demonstrates the 220% increase in weighted PA annual wage over the observation period, from a median

to beet terien only

5 of \$47,060 in 1997 to \$103,480 in 2017.

Page 9 of 25

BMJ Open

				136/bmjopen-2021-(528492	
Table 1 Physician Assistant and State Demogra	phics and Median Wage in 1997. 2	002, 2007, 2012, and 20	17	2021-	
			Year	0528	
	1997	2002	2007	2022	2017
	Physicia	n Assistants Demograp	ohics	n 18	
Age ^a				40.8 5 2.1)	
Mean (SD)	40.9 (1.8)	41.2 (1.8)	39.7 (2.1)	40.8 (2.1)	39.7 (2.1)
Median (IQR)	41 (3)	41 (2)	41 (3)	41,33)	40 (2)
Minimum (state)	36 (NJ)	37 (NJ)	37 (NJ)	34 (P C)	33 (AR)
Maximum (state)	46 (AR)	48 (NM)	47 (AK, NM)	47 (₩Y)	47 (WY)
Percent female ^a				Dowr	
Mean (SD)	48.2 (8.6)	58.4 (7.0)	63.9 (6.0)	67.0 2 6.0)	69.2 (5.8)
Median (IQR)	49 (11)	60 (11)	64 (7)	68 66)	69 (6)
Minimum (state)	20 (MS)	18 (MS)	38 (UT)	40 (W Y)	44 (HI)
Maximum (state)	75 (ND)	75 (ND)	79 (ND)	77 (AD)	78 (IL, PA, WI)
Annual wage (USD) ^{ab}				л Э	
Mean (SD)	44,921 (8,315)	63,546 (9,545)	77,843 (7,231)	92,451 (7,579)	104,760 (7,886)
Median (IQR)	47,060 (12,250)	67,520 (11,270)	79,240 (5,560)	92,150 (0,800)	103,480 (12,150)
Minimum (state, # scope of practice laws)	22,700 (AR, 1)	37,490 (MS, 1)	42,160 (MS, 2)	50,200 MS, 2)	70,190 (MS, 2)
Maximum (state, # scope of practice laws) Maximum (state, # scope of practice laws)	77,210 (DE, 3)	78,900 (AR, 4)	91,010 (CT, 2)	112,25 ((RI, 6)	120,200 (WA, 3)
	(,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			n.	120,200 (111, 3)
		State Demographic	cs	<u></u>	
Population density/square mile ^c				.co m	
Mean (SD)	245.4 (470.9)	253.4 (469.5)	257.1 (462.2)	266.3 🙀 13.3)	274.2 (565.7)
Median (IQR)	173.5 (195.8)	177.2 (195.8)	187.2 (189.8)	200.1 (185.3)	210.8 (177.3)
Minimum (state)	1.1 (AK)	1.1 (AK)	1.2 (AK)	1.3 🗛 K)	1.3 (AK)
Maximum (state)	9,307.2 (DC)	9,396.0 (DC)	9,416.5 (DC)	10,408 G (DC)	11,391.9 (DC)
Number of scope of practice laws ^d				3.3 (2.4)	
Mean (SD)	2.2 (1.4)	2.6 (1.4)	2.8 (1.4)	3.3 (2.4)	3.7 (1.4)
Median (IQR)	2 (2)	2 (2)	3 (2)	3.22)	4 (2)
Minimum (state)	0 (MS,NV,OH,PA,SC,VA,WI)	0 (OH,PA)	0 (OH)	0 (Q H)	1 (AL,IA,SC)
Maximum (state)	5 (ME, NC)	6 (RI)	6 (NM, RI)	6 (ND, kg M, RI)	6 (ND,NM,MA,MI,MN,I
PA ratio/100,000 population ^e				יי ד	
Mean (SD)	24.7 (7.6)	26.2 (11.4)	26.2 (10.8)	31.9 P 31.9 P 2.6)	38.5 (14.0)
Median (IQR)	23.4 (9.5)	25.5 (19.8)	23.5 (14.7)	32.9 (21.0)	33.2 (20.5)
Minimum (state)	8.8 (RI)	3.2 (MS)	4.6 (AR)	4.4 (M S)	8.4 (MS)
Maximum (state)	47.9 (DE)	52.6 (SC)	80.1 (DC)	75.3 € AK)	72.0 (DC)
				copyright	

136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

<text> SD: Standard Deviation; IQR: Interquartile Range; USD: United States Dollar For the states name, we used two-letter states abbreviations. ^a Weighted by states' PA population ^b See supplementary Table 1 for -linear correlation of PA annual wage with age and percent female PA in the respective year ^c Densities of 50 States + DC per square mile, weighted by the population of states and DC (state population in year/state area in square mile)²³ ^d PA scope of practice laws are the 6 Key Elements of a Modern PA Practice Act ¹³ ^e (employed PA in year/state population in that year) * 100,000, weighted by states' PA population For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Table 2 shows the adoption of SOP laws in the US for selected years of 1997, 2002, 2007, 2012, and 2017. SOP elements are progressively adopted by states over time, although some are consistently adopted more than others [i.e. licensure (100% in 2017 versus 49% in 1997); SOP at practice level (71% in 2017 versus 49% in 1997); full prescriptive authority (65% in 2017 versus 25% in 1997); co-signature requirements (61% in 2017 versus 39% in 1997); adaptable collaboration requirements (55% in 2017 versus 35% in 1997); and number of PAs a physician may collaborate with (24% in 2017 versus 18% in 1997)].

There is also significant heterogeneity in each SOP element adoption by state. For example, as of 2017 Alabama, Iowa, and South Carolina had adopted only one SOP element, while six states (North Dakota, New Mexico, Massachusetts, Michigan, Minnesota, and Rhode Island) had adopted all six key elements as of this date (**Table 1**).

In general, SOP elements did not appear to be significantly associated with PA wage within the selected years. While some significant associations were found (i.e., adaptable collaboration and co-signature in 2002; licensure in 2007; adaptable collaboration in 2017) there is no overall pattern within any SOP element over time. The same general pattern was observed in our cross-sectional models controlling for all 6 policies. Likewise, the adjusted R² in regression models for individual SOP elements in the selected years were all small (Range: 0.0-0.29), with no appreciable pattern across time for any SOP element (**Table 2**).

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

 136/bmjopen-202

Scope of practice laws	1997	2002	2007	2012 5	2017
		Phy	vsician Assistants Annua	l Wage 4	
Licensure				on 1	
β (# of states) 95% CI Adjusted R ²	\$172 (25) (-4,229 , 4,573) 0.1471	-\$4878 (42) (-11,271 , 1,515) 0.0879	-\$7007 (45) (-11,978 , -2,036)** 0.1412	-\$4600 (48) (-10,054 , 85 4) 0.2755 נַקַ	N/A (51)
PA to physician collaboration ratio				202	
β (# of states) 95% CI Adjusted R ²	-\$243 (9) (-7,367 , 6,881) 0.1471	\$2572 (8) (-7,866 ,13,010) 0.0472	-\$5212 (8) (-12,790 , 2,365) 0.0336	-\$5828 (9). (-12,351 , 69 6) 0.2805	-\$2413 (12) (-8,196 , 3,370) 0.0382
Full prescriptive authority				ided	
β (# of states) 95% CI Adjusted R ²	\$5940 (13) (-139 , 12,019) 0.2118	\$3310 (20) (-2,486 , 9,107) 0.0683	-\$2991 (26) (-7,104 , 1,122) 0.0380	-\$1833 (31) (-5,730 , 2,069) 0.2455	\$2699 (33) (-1,737 , 7,135) 0.0539
Adaptable collaboration				://bn	
β (# of states) 95% CI Adjusted R ²	\$3865 (18) (-626 , 8,356) 0.1982	\$7290 (17) (2,125 , 12,455)** 0.1824	\$1581 (18) (-2,842, 6,004) 0.0052	\$3081 (22) (-600 , 6,763) 0.2748	\$4497 (28) (36 , 8,957)* 0.1023
Co-signature				j.cor	
β (# of states) 95% CI Adjusted R ²	-\$3520 (20) (-8,510 , 1,471) 0.1821	-\$8187 (21) (-13,582 , -2,792)** 0.2007	-\$133 (22) (-4,441 , 4,175) -0.0057	-\$211 (24) (-4,008 , 3,58 0.2313 Prii	\$1438 (31) (-3,175 , 6,051) 0.0319
SOP at practice level				17,	
β (# of states) 95% CI Adjusted R ²	\$4141 (25) (-155 , 8,436) 0.2102	-\$1152 (26) (-6,541 , 4,238) 0.0459	\$1444 (26) (-2,681 , 5,568) 0.0047	\$2850 (32)8 (-1,019 , 6,729) 0.2654 b	\$3714 (36) (-1,534 , 8,963) 0.0641
Full model (all 6 policies)				guest .	
β Licensure 95% CI	-\$705 (-4,967, 3,556) -\$908	-\$583 (-6,796, 5,630) -\$558	-\$8,320 (-14,567, -2,073)* -\$4,047	-\$4,060 + (-9,853, 1,73 3) -\$5,688 @	N/A N/A -\$5,653
β PA to physician collaboration ratio 95% CI	(-8,028, 6,211) \$4,465	(-10,503, 9,387) \$3,447	(-12,771, 4,677) -\$1,984	(-12,897, 1,527) -\$1,867	(-11,757, 451) \$5,802
β Full prescriptive authority	(-1,928, 10,858) \$3,228	(-1,921, 8,815) \$6,846	(-6,124, 2,156) -\$1,902	(-5,950, 2,21 6) \$657 <u>8</u>	(913, 10,692)* \$4,748
		11	· · · · ·	pyright.	·

Page 13 of 25			BMJ Open		136/bmjopen-202	
1 2 3 4 5 6 7 8 9 10	95% CI β Adaptable collaboration 95% CI β Co-signature 95% CI β SOP at practice level 95% CI Adjusted R ²	(-1,356, 7,813) -\$3,362 (-8,329, 1,605) \$2,514 (-2,017, 7,046) 0.228	(1,409, 12,284)* -\$8,812 (-13,937, -3,687)** -\$1,521 (-6,367, 3,324) 0.3074	(-6,837, 3,033) -\$1,779 (-6,747, 3,189) \$1,374 (-3,125, 5,872) 0.1341	(-3,693, 5,007) -\$85 (-4,151, 3,989) \$2,942 (-1,383, 7,26 3) 0.304 Rugus	(-57, 9,553) -\$919 (-5,732, 3,893) \$3,718 (-1,845, 9,282) 0.1699
11 12 13 14 15 16 17 18	CI: Confidence Interval N/A: Not applicable, as all states and DC in year 20 ^a Models were adjusted for PA mean-age and perce * 0.01 ** p <0.01)17 observed licensure. nt female PA. Weighted	by PA number.		2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by	
19 20 21 22 23 24 25					m http://bmjopen.bmj.	
26 27 28 29 30 31 32					oom/ on April 17, 2024	
33 34 35 36 37 38 39					by guest. Protected by copyright	
40 41 42 43 44 45 46 47	For	peer review only - http	12 p://bmjopen.bmj.com/si	ite/about/guidelines.	•	

Table 3 presents the results of our individual growth models showing the associations between the presence of individual SOP elements and PA wage over time. Model 3 shows that states with full prescriptive authority in 1997 had predicted annual wage of \$5,227 (95% CI \$2,784, \$7,670) higher than in states without this law. In the individual model of full prescriptive authority (model 3), each year since 1997 was associated with a mean wage growth of \$3,047, however, the wage growth over time among states with full prescriptive authority grew \$309 less (95% CI \$-513, \$-105) per year than in states without this SOP element. A similar pattern is observed in Model 6 where SOP at the practice level in 1997 had wages \$3,134 (95% CI \$431, \$5,837) higher compared to states without this SOP element. In the adjusted full model 7, \$3,134 decreased to \$3.023 (95% CI \$278, \$5.769). In the individual model of SOP at practice level (model 6), each year since 1997 was associated with a mean wage growth of \$3,096, but wage growth was \$251 less (95% CI \$-449, \$-56) among these states compared to those without SOP at the practice level. Interestingly, states with the adaptable collaboration law had no significant difference in wage in 1997 (P = 0.6483), but again saw a decrease of \$285 (95% CI \$-484, \$-86) in wage growth per year compared to states without this law. When modelling all SOP elements simultaneously (model 7), prescriptive authority and SOP at practice level in 1997 predicted annual wage of \$4,506 (95% CI \$1,946, \$7,066), and \$3,023 (95% CI \$278, \$5,769) higher than in states without this law, respectively. States with the co-signature law had no significant difference in wage in 1997 (P = 0.6645), but saw a decrease of \$268 (95% CI \$-477, \$-60) in wage growth per year compared to states without this law. These changes in model 7, which contained all six elements, relative to models 1-6, which each contained a single element, may reflect either confounding of the associations between individual SOP elements and wage by other SOP elements, or variance inflation due to multicollinearity.

Page 15 of 25

BMJ Open

	BMJ O			136/bmjopen-202	
Table 3 Adjusted associations between Mean US PA Models	A Annual Wage (US\$) Growth and Pres Parameter Estimate	sence of Scope of Pract Standard Error	ice Laws Over Time (Lower 95% CI	(1997–20) ^{a, b} Upper 5% CI	р
Model 1				490	
Intercept (year 1997)	45,356	1,502	42,338	48_374	< 0.00
Licensure	669	1,085	-1,461	200998	0.53
Year	3,079	103	2,871	3287	< 0.00
CPI	138	162	-180	957	0.39
Mean age	524	150	229	Se o	0.00
Percent female	14	15	-16	N2	0.36
Licensure*year	-134	93	-318	.4 9	0.15
Model 2				Dow	
Intercept (year 1997)	45,734	1,360	43,003	42465	< 0.00
PA to physician collaboration ratio	378	1,963	-3,474	49230	0.84
Year	2,951	76	2,799	3903	< 0.00
CPI	159	161	-158	476	0.32
Mean age	580	147	292		< 0.00
Percent female	9	15	-20		0.53
Ratio*year	71	130	-185		0.55
		150	100	29798 34287 3429 7 8819 2032 9 Down 465 4027 40058 3476 38476 38476 38476 38476 38476 38476 38476 38476 38477	0.20
Model 3	44.165	1.216	41.500		<0.0(
Intercept (year 1997)	44,165	1,316	41,522	40807	<0.0
Full prescriptive authority	5,227	1,245	2,784	7 5 670	< 0.0
Year	3,047	87	2,873	3.22	< 0.0
CPI	157	162	-161	476	0.33
Mean age	477	147	188	46 5	0.00
Percent female	17	15	-13	4 6	0.26
Prescription*year	-309	104	-513	教育6 第55 11-6 05 April	0.00
Model 4					
Intercept (year 1997)	45,452	1,437	42,565	4\$\$39	< 0.00
Adaptable collaboration	719	1,575	-2,373	3810	0.64
Year	3,090	87	2,916	3264	< 0.0
CPI	151	159	-161	46 3	0.34
Mean age	466	148	176	755	0.00
Percent female	13	15	-16	gg2	0.37
Collaboration*year	-285	101	-484	\$ \$6	0.00
				3,8010 3,20264 4,453 9,555 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,0000 9,000000 9,00000000	
Model 5			1	ot	<u> </u>
Intercept (year 1997)	45,222	1,431	42,348	485095	< 0.00
Co-signature	1,563	1,429	-1,240	4 <u>छ</u>67	0.27
Year	3,138	87	2,963	3 gj 13	<0.0
CPI	99	159	-214	4 12	0.53
				4@267 300113 4012 2009yright.	
				rig	
	14			h	

	BMJ O	pen		136/bmjop	
Mean age Percent female Co-signature*year	445 11 -356	150 15 99	150 -17 -551	136/bmjopen-202 දිගිපිදුදි49 on	0.0031 0.4333 0.0003
Model 6				<u>o</u>	
Intercept (year 1997)	44,233	1,473	41,275	477191	< 0.0001
SOP at practice level	3,134	1,377	431	52837	0.0231
Year	3,096	90	2,914	3දු77	< 0.0001
CPI	167	161	-149	43 84	0.2991
Mean age	533	148	244	823	0.0003
Percent female	12	15	-17	M <u></u> 1	0.4287
SOP*year	-253	100	-449	:5 6	0.0119
				52837 34277 484 823 11 156 000 460042 2601 44711	
Model 7	10 500		20.076	n la c	0.0001
Intercept (year 1997)	42,509	1,759	38,976	4 65 042	< 0.0001
Licensure	163	1,089	-1,975	201	0.8812
PA to physician collaboration ratio	836	1,924	-2,939		0.6639
Full prescriptive authority	4,506	1,304	1,946	79066	0.0006
Adaptable collaboration	17	1,575	-3,075	3,109	0.9915
Co-signature	637	1,467	-2,243 278	3316	0.6645 0.031
SOP at practice level Year	3,023	1,399 129		5 7 09	<0.001
CPI	3,315 120		3,056	$3\frac{3}{3}/4$	0.4529
		160 153	-193 -24	400	0.4329
Mean age	276	153	-24 -4	<u>s</u> ///	0.0714
Percent female Licensure*year	26 -86	98	-4 -278		0.0856
Ratio*year	-80	131	-278 -134	H 00	0.3491
Prescription*year	-180	131	-134 -414	0/7 -32	0.1306
Collaboration*year	-180 -180	119	-414	2 2	0.1306
Conadoration year Co-signature*year	-180 -268	108	-392 -477	30	0.0989
SOP*year	-208 -154	108	-477	אפע דעק	0.1487
SOI year	-154	107	-305	79066 31109 3105 3107 3107 3107 3107 3107 3107 3107 3107	0.1407
				<u> </u>	

CI: Confidence Interval; CPI: Consumer price index percent change

^a Models were adjusted for PA mean-age, percent female PA, and CPI. Weighted by PA number.

^b Linear mixed models were used to generate least square means.

 \dagger , 2024 by guest. Protected by copyright.

BMJ Open

DISCUSSION Over the 20-year study period, PA wages increased 2.2-fold with the change in wage primarily explained by time and not specific state scope of practice laws. It is clear that individual SOP laws are associated with increased wage, particularly early in our study period, but the impact of these SOP elements changed over time. For example, full prescriptive authority was associated with a \$5,227 higher wage in 1997, but with a negative wage growth of \$309 for each subsequent year of the study. This is also seen with SOP at practice level, which was associated with a \$3,134 higher wage in 1997, but a \$253 lower wage growth for each subsequent year of the study. Together, this indicates that in the early period of this study, some SOP elements were associated with increased average wage, however, the impact of this increase diminished over time in all such instances. This suggests that the impact of these SOP elements on wage decreased over time. The findings of this study support previous work by Perry (2009) showing an increase in PA scope of practice did not increase wage.¹² Yet, previous research indicates that expanded SOP for nurse practitioners (NPs) does indeed increase wage, but only when specifically related to independence.^{12, 29} As PAs are able to provide a wider breadth of care as their SOP increases, there is arguably a benefit to society through an increase in access to care, however this does not appear to translate into individual wage growth per se. As the majority of states have permissive SOP laws and with this realisation, it is not surprising that the constituents of AAPA have pressed forward to expand practice autonomy further through Optimal Team Practice.^{22, 30} The tenets of OTP will move the PA profession closer to independent practice, similar to nurse practitioners. Future research should then investigate if this expansion of scope of practice impacts PA wage as has been observed for nurse practitioners. Our study only found a negative linear correlation between annual wage and percent female PAs in 2012, but this was non-significant in our multivariable growth models. This may

indicate that the increase in the percentage of female workforce is not impacting annual wage
growth. These findings juxtapose the other research that notes an \$11,000 reported difference in
wage by female PAs and an \$12,859 difference by female NPs.^{13, 31} Future research is needed to
explore the influence of the feminization of the PA profession on salary growth.

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright

As the PA profession has been anointed the "Best Job in America" by the US News and World Report for 2021, the Bureau of Labor and Statistics projects a 31% growth in employment over the next 10 years.^{32, 33} This growth projection is due to the expected increase in demand for health care services and the ability to train PAs faster than physicians. With a projected shortage of 21,400 to 55,200 primary care physicians by 2033, PAs are often cited as one solution to meet this demand.³⁴ Research indicates that the supply of PAs is impacted by SOP laws, resulting in an increase in PAs per capita in states with permissive regulations.²² At the same time, the supply of PAs willing to work in primary care is likely restricted by the decreased earnings.⁹ Our study did not delineate specialty which directly impacts PA wage. So, as our country continues to grapple with solutions to increase access to primary care, future research needs to better understand the levers that influence physician assistants' earnings, including specialty care. This study has a number of important limitations. First, we analysed aggregate data at the

state level; such ecological analyses are inherently limited and preclude drawing causal conclusions. Second, our analysis does not include other possible confounding variables that may impact PA wage, including specialty area of clinical employment, physician or nurse practitioner employment numbers, or state and federal healthcare legislative policies. Third, we were unable to account for lag time in terms of when the SOP laws were passed and the impact on wage. Fourth, the AAPA data on PA demographics is from a survey and the response rate ranged from 10-35% annually which may lead to a sampling bias towards or away from the null. These limitations are counterbalanced by a number of important strengths, including the robust SOP data provided by AAPA that was cross referenced and verified for each state and each year combined with annual wage data from the Bureau of Labor and Statistics.

24 CONCLUSIONS

Physician Assistant median wage has risen 220% in the past two decades. At the same time, there has been a significant expansion of state scope of practice laws such that the majority of PAs today work in states with permissive regulations. This rise in physician assistant wage is mainly explained by time and the age of providers with minimal explanation by state scope of practice laws. As the PA profession moves towards Optimal Team Practice, future research should examine if this move towards greater autonomy impacts wage, as occurred in nurse practitioners.

1 ว		
2 3	1	
4 5	2	Contributorship Statement
6 7	3	VLV, SN, and TJH were involved in the data analysis, interpretation, drafting the manuscript,
8	4	and reviewed/edited the manuscript.
9 10	5	
11 12	6	Funding
13 14	7	Funding was provided by the Don Pedersen Research Grant from Physician Assistant Education
15 16	8	Association.
17	9	Grant number: N/A
18 19	10	
20 21	11	Competing interests
22 23	12	None declared.
24 25	13	
26	14	Patient and public involvement
27 28	15	Patients or the public were not involved in the design, or conduct, or reporting, or dissemination
29 30	16	plans of this research.
31	17	
32 33	18	Patient consent for publication
34 35	19	Not required.
36 37	20	
38	21	Ethics approval
39 40	22	As we used publicly available BLS data, and the requested AAPA data does not contain
41 42	23	identifying variables, this study was determined exempt from review by the University of Utah
43 44	24	Institutional Review Board (IRB 00115478).
45	25	
46 47	26	Data availability statement
48 49	27	BLS and the United States Census Bureau have public use linkage to access Labor Statistics and
50	28	population data, respectively. The data from AAPA on PA census and legislative history was
51 52	29	requested through AAPA research department.
53 54	30	
55 56		
57		10
58 59		18
60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Figure 1 caption: Physician Assistant Annual Wage and Number of States with Each Practice
 Law from 1997 to 2017

tor beer terien only

REFERENCES

1. Morgan P, Leach B, Himmerick K, Everett C. Job openings for PAs by specialty. *Jaapa*. Jan 2018;31(1):45-47. doi:10.1097/01.Jaa.0000527701.08322.18

2. Quella A, Brock DM, Hooker RS. Physician assistant wages and employment, 2000-2025. *Jaapa*. Jun 2015;28(6):56-8, 60-3. doi:10.1097/01.JAA.0000465222.98395.0c

3. Clawson DK, Osterweis M. The Roles of Physician Assistants and Nurse Practitioners in Primary Care Washington, DC: Association of Academic Health Centers1993.

4. National Commission on Certification of Physician Assistants (NCCPA). 2019 Statistical Profile of Certified Physician Assistants Fact Sheet. 11/25/2020, 2020. Accessed 11/25/2020, 2020.

https://www.nccpa.net/news/2019-statistical-profile-of-certified

5. National Commission on Certification of Physician Assistants (NCCPA). 2019 Statistical Profile of Certified Physician Assistants. 3/7/2021, 2021. Accessed 3/7/2021, 2021.

https://prodcmsstoragesa.blob.core.windows.net/uploads/files/2019StatisticalProfileofCertifiedPhysicia nAssistants.pdf

6. Moote M, Krsek C, Kleinpell R, Todd B. Physician assistant and nurse practitioner utilization in academic medical centers. *Am J Med Qual*. Nov-Dec 2011;26(6):452-60. doi:10.1177/1062860611402984

7. McDaniel MJ, Ruback TJ. Physician Assistant Applicant Pool: The First 50 Years. *J Physician Assist Educ*. Oct 2017;28 Suppl 1:S18-s23. doi:10.1097/jpa.00000000000145

8. Streilein A, Leach B, Everett C, Morgan P. Knowing Your Worth: Salary Expectations and Gender of Matriculating Physician Assistant Students. *J Physician Assist Educ*. Mar 2018;29(1):1-6. doi:10.1097/jpa.00000000000180

9. Morgan P, Everett CM, Humeniuk KM, Valentin VL. Physician assistant specialty choice: Distribution, salaries, and comparison with physicians. *Jaapa*. Jul 2016;29(7):46-52. doi:10.1097/01.Jaa.0000484301.35696.16

10. Dower C, Moore J, Langelier M. It is time to restructure health professions scope-of-practice regulations to remove barriers to care. *Health Aff (Millwood)*. Nov 2013;32(11):1971-6. doi:10.1377/hlthaff.2013.0537

11. Davis A, Radix SM, Cawley J, Hooker R, Walker CS. Access and innovation in a time of rapid change: physician assistant scope of practice. 2015:

12. PERRY JJ. THE RISE AND IMPACT OF NURSE PRACTITIONERS AND PHYSICIAN ASSISTANTS ON THEIR OWN AND CROSS-OCCUPATION INCOMES. *Contemporary Economic Policy*. 2009;27(4):491-511. doi:https://doi.org/10.1111/j.1465-7287.2009.00162.x

13. American Academy of Physician Assistants. The six key elements of a modern PA practice act. 8/7/2010, 2020. Accessed 8/7/2020, 2020.

https://www.aapa.org/wpcontent/uploads/2016/12/Issue_Brief_Six_Key_Elements.pdf

14. Valentin VL, Najmabadi S, Everett C. Cross-sectional analysis of US scope of practice laws and employed physician assistants. *BMJ Open*. May 11 2021;11(5):e043972. doi:10.1136/bmjopen-2020-043972

15. American Academy of Physician Assistants. What is optimal team practice? 4/1/2021, 2021. Accessed 4/1/2021, 2021. <u>https://www.aapa.org/advocacy-central/optimal-team-practice/</u>

16. American Academy of Physician Assistants. 2017 AAPA Salary Report. 11/25/2020, 2020. Accessed 7/30/2018, 2018. <u>https://www.aapa.org/download/22453</u>

Hing E, Hsiao CJ. In which states are physician assistants or nurse practitioners more likely to work in primary care? *Jaapa*. Sep 2015;28(9):46-53. doi:10.1097/01.Jaa.0000470436.69199.45
 Glicken AD, Miller AA. Physician assistants: from pipeline to practice. *Acad Med*. Dec

2013;88(12):1883-9. doi:10.1097/acm.0000000000000000

19. Sutton JP, Ramos C, Lucado J. US Physician Assistant Supply by State and County in 2009. *JAAPA*. 2010;23(9):E3-E8.

20. Willis JB. Barriers to PA Practice in Primary Care and Rural Medically Underserved Areas. *JAAPA*. 1993;6(6):418-422.

21. McMichael BJ. Beyond Physicians: The Effect of Licensing and Liability Laws on the Supply of Nurse Practitioners and Physician Assistants. *Journal of Empirical Legal Studies*. 2018;15(4):732-771. doi:<u>https://doi.org/10.1111/jels.12198</u>

22. Valentin VL, Najmabadi S, Everett CM. Cross-sectional Analysis of United States Scope of Practice Laws and Employed Physician Assistants. *BMJ Open, in press*. 2021;

23. United States Census Bureau. State and County Intercensal Tables: 1990-2000. 11/25/2020, 2020. Accessed 11/25/2020, 2020. <u>https://www.census.gov/data/tables/time-</u>series/demo/popest/intercensal-1990-2000-state-and-county-totals.html

24. United States Census Bureau. 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;

25. United States Census Bureau. 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;

26. State Symbols USA. Size of States: National (U.S.) States: Size in Square Miles. 11/25/2020, 2020. Accessed 11/25/2020, 2020. <u>https://statesymbolsusa.org/symbol-official-item/national-us/uncategorized/states-size</u>

27. Bureau of Labor and Statistics. Frequently Asked Questions (FAQs): How are "wages" defined by the Occupational Employment Statistics (OES) survey? 10/2/2020, 2020. Accessed 10/2/2020, 2020. https://www.bls.gov/bls/faqs.htm

28. US Inflation Calculator. Consumer Price Index Data from 1913 to 2021. 6/18/2021, 2021. Accessed 6/18/2021, 2021. <u>https://www.usinflationcalculator.com/inflation/consumer-price-index-and-annual-percent-changes-from-1913-to-2008/</u>

29. Kleiner MM, Marier A, Park KW, Wing C. Relaxing Occupational Licensing Requirements: Analyzing Wages and Prices for a Medical Service. *The Journal of Law and Economics*. 2016;59(2)doi:<u>https://doi.org/10.1086/688093</u>

30. Sobel J. Seven things you should know about optimal team practice. *Jaapa*. May 2019;32(5):12-13. doi:10.1097/01.Jaa.0000554747.39429.94

31. Greene J, El-Banna MM, Briggs LA, Park J. Gender differences in nurse practitioner salaries. *J Am Assoc Nurse Pract*. Nov 2017;29(11):667-672. doi:10.1002/2327-6924.12512

32. US Bureau of Labor Statistics. Occupational Outlook Handbook. Physician Assistants. 4/1/2021, 2021. Accessed 4/1/2021, 2021. <u>https://www.bls.gov/ooh/healthcare/physician-assistants.htm#tab-6</u>

33. US News and World Report. US News Best Job Rankings. 4/1/2021, 2021. Accessed 4/1/2021, 2021. https://money.usnews.com/careers/best-jobs/rankings

34. Association of American Medical Colleges. The complexities of physician supply and demand: projections from 2018 to 2033. 4/1/2021, 2021. Accessed 4/1/2021, 2021. https://www.aamc.org/system/files/2020-06/stratcomm-aamc-physician-workforce-projections-june-2020.pdf

<u>2020.pdf</u>

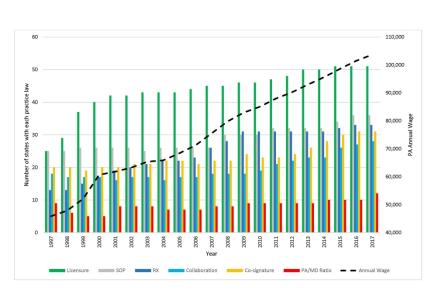


Figure 1 caption: Physician Assistant Annual Wage and Number of States with Each Practice Law from 1997 to 2017

Figure 1: Physician Assistant Annual Wage and Number of States with Each Practice Law from 1997 to 2017

BMJ Open: first published as 10.1136/bmjopen-2021-052849 on 18 August 2021. Downloaded from http://bmjopen.bmj.com/ on April 17, 2024 by guest. Protected by copyright.

279x215mm (300 x 300 DPI)

ΒM

	2
	g
	/J Open: first published as 10.113
	₽
	ŝ
	B
	ublished as 10
	ĥe
	õ.
	ຶ
	s 10.1136/bmjopen-2021-052849 on 18 Au
	1
	<u>8</u>
	br
	ğ
	ĕ
	Ň
	6/bmjopen-2021-052849 on 18 Augus
	3
	۶ß
	84
	00
	З
	8
	₽
(ā
	ş
	20
	2
	JSt 2021. Do
	õ
	<u>n</u>
	a
	æ
	Ж.
	ð fr
	ed from
	ed from ht
	d from ht
	ed from http://b
	ed from http://bmjo
	ed from http://bmjope
	ed from http://bmjopen
	ed from http://bmjopen.bm
•	ed from http://bmjopen.bmj.c
•	ed from http://bmjopen.bmj.com
	ed from http://bmjopen.bmj.com/ o
	ed from http://bmjopen.bmj.com/ on /
•	ed from http://bmjopen.bmj.com/ on Apr
	ed from http://bmjopen.bmj.com/ on April 1
	ed from http://bmjopen.bmj.com/ on April 17,
	p://bmjopen.bmj.com/ on April 1
	p://bmjopen.bmj.com/ on April 1
	p://bmjopen.bmj.com/ on April 1
-	p://bmjopen.bmj.com/ on April 1
	p://bmjopen.bmj.com/ on April 1
	p://bmjopen.bmj.com/ on April 17, 2024 by guest.
-	p://bmjopen.bmj.com/ on April 1
-	p://bmjopen.bmj.com/ on April 17, 2024 by guest.
	p://bmjopen.bmj.com/ on April 17, 2024 by guest.
	p://bmjopen.bmj.com/ on April 17, 2024 by guest.
	p://bmjopen.bmj.com/ on April 17, 2024 by guest.
-	p://bmjopen.bmj.com/ on April 17, 2024 by guest.
	p://bmjopen.bmj.com/ on April 17, 2024 by guest.
	p://bmjopen.bmj.com/ on April 17, 2024 by guest.
	p://bmjopen.bmj.com/ on April 17, 2024 by guest.

		Year			
	1997	2002	2007	2012	2017
Age					
Pearson's correlation coefficient ^a	-0.08	0.31	0.22	0.52	0.2
P	0.600	0.028	0.129	< 0.001	0.04
Percent female PA					
Pearson's correlation coefficient ^a	0.41	-0.21	-0.03	-0.41	-0.1
P	0.003	0.134	0.822	0.003	0.29
Weighted by states' PA population					
	1				

Supplementary Table 1 Correlation between PA Annual Wage and Mean PA Age and Percent Female PA in 1997, 2002, 2007, 2012, and 2017

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

	Item No	Recommendation	Pag No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or	2
		the abstract	
		(b) Provide in the abstract an informative and balanced summary of what	2
		was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation	4
		being reported	
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of	4-5
	U U	recruitment, exposure, follow-up, and data collection	
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and	4-5
i ui tioipuilits	Ũ	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	
			N/A
		(<i>b</i>) <i>Cohort study</i> —For matched studies, give matching criteria and	IN/P
		number of exposed and unexposed	
		<i>Case-control study</i> —For matched studies, give matching criteria and the	
		number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders,	5
		and effect modifiers. Give diagnostic criteria, if applicable	
Data sources/	8*	For each variable of interest, give sources of data and details of methods	4-5
measurement		of assessment (measurement). Describe comparability of assessment	
		methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	5-6,
			14
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If	5-6
		applicable, describe which groupings were chosen and why	
Statistical methods	12	(a) Describe all statistical methods, including those used to control for	5-6
		confounding	
		(b) Describe any methods used to examine subgroups and interactions	5-6
		(c) Explain how missing data were addressed	5-6
		(d) Cohort study—If applicable, explain how loss to follow-up was	4-5
		addressed	
		Case-control study—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	
		(e) Describe any sensitivity analyses	Nor
		() Desente any sensitivity analyses	1 101

3
4
5
6
0
/
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
42 43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59

1 2

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially	4-5
		eligible, examined for eligibility, confirmed eligible, included in the study,	
		completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and	6-7
data		information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	5-6
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	9-12
Outcome data	15*	Cohort study-Report numbers of outcome events or summary measures over time	9-12
		Case-control study—Report numbers in each exposure category, or summary	
		measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	6-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and	6-12
		their precision (eg, 95% confidence interval). Make clear which confounders were	
		adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a	N/A
		meaningful time period	
Other analyses	17	Report other analyses done-eg analyses of subgroups and interactions, and	N/A
		sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-
			14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or	14
		imprecision. Discuss both direction and magnitude of any potential bias	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations,	13-
		multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information	on		
Funding	22	Give the source of funding and the role of the funders for the present study and, if	15
		applicable, for the original study on which the present article is based	

*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 available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.