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Generating Physician Assistant and Nurse Practitioner Demand-Effect Ratios for Physician Workforce Projections

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AAMC Workforce Studies

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Association of
American Medical Colleges

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INTRODUCTION

The annual AAMC physician workforce projections reports provide timely information for physician workforce planning discussions at the national level. The reports account for various factors affecting physician supply, including the contributions of other health care providers. Physician assistants (PAs) and advanced practice registered nurses (APRNs), including nurse practitioners (NPs), contribute significantly to the nation's health care delivery capacity, offsetting some of the demand for physicians. However, measuring the extent to which these rapidly growing professions may or may not alleviate physician shortages is complex.[1] This paper documents a new method for calculating the demand-effect ratio, a value used in estimating the effect of PAs and NPs on physician demand in ambulatory care. This analysis generates a new set of data-based ratios to inform and improve projections of physician demand.

METHODS

We analyzed data from the National Hospital Ambulatory Medical Care Survey (NHAMCS),[2] administrated by the Centers for Disease Control and Prevention, which collects visit-level information. We first used visit information from 2011 to 2016 to inform the 2020 projections report, The Complexities of Physician Supply and Demand: Projections from 2018 to 2033.[3] Data include patients' region of residence, age, medical conditions, diagnoses, and types of providers seen. Only emergency department (ED) data are available from 2011 to 2016, and no physician specialty information is available.

The NHAMCS prompts patients to indicate the types of health care providers seen for each visit, including PAs, NPs, and ED attending MDs and DOs (referred to as physicians in this paper). A patient may report seeing multiple types of providers per visit. Table 1 displays the percentage of visits to each type of provider for 2011-2016. Between 2011 and 2016, the percentage of visits in which only a physician saw a patient decreased from 77.6% to 67.4%. Conversely, the percentages of visits in which only a PA or NP saw a patient increased (PA alone increased from 5.6% to 7.2%, and NP alone increased from 2.3% to 5.0%). Combined provider-type visits in which both a physician and a PA or NP saw a patient increased from 9.8% to nearly 15.8% of visits. Physicians' involvement in any visit (alone or combined with a PA/NP) decreased from 87.4% to 83.2%. In contrast, PA and NP involvement in any visit (alone or in combination with an attending physician) increased dramatically, from 12.4% and 5.9% to 16.6% and 12.2%, respectively.

Table 1. Percentage of Visits by Scenario and Provider Type, 2011-2016

Scenario	Provider Type	Year					
		2011	2012	2013	2014	2015	2016
Alone	Physician	77.6%	75.7%	78.0%	74.9%	74.2%	67.4%
	NP	2.3%	2.7%	2.9%	2.6%	4.4%	5.0%
	PA	5.6%	4.7%	3.7%	6.1%	4.7%	7.2%
Combined	Physician and PA/NP	9.8%	12.4%	12.0%	10.5%	11.1%	15.8%
Alone or Combined	Physician alone or in combination with PA/NP	87.4%	88.1%	90.0%	85.4%	85.3%	83.2%
	NP alone or in combination with a physician	5.9%	6.3%	6.8%	5.6%	8.0%	12.2%
	PA alone or in combination with a physician	12.4%	13.7%	12.0%	14.0%	12.5%	16.6%

Source: National Hospital Ambulatory Medical Care Survey, 2011-2016. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/dataset_documentation/nhamcs/stata/; ED2012 to ED2016-strata.dta. N = *149,686.*
Note: Physician = emergency department attending physician; NP = nurse practitioner; PA = physician assistant; PA/NP = PA and/or NP.

We created a dichotomous variable called "PA/NP" that treats PAs and NPs interchangeably because the current projections model does not differentiate between PAs and NPs due to limitations in the other data used. This PA/NP variable indicates that a patient was seen by a PA, an NP, or both. We considered three outcomes for each patient visit: 1) seen by a physician, 2) seen by a PA/NP, or 3) seen by a PA/NP and a physician ("combined").

We framed the analysis as a set of ordinary least square (OLS) regressions:

$$P = \alpha_0 + \alpha_1 Age + \alpha_2 Region + \alpha_3 Year + \varepsilon$$

where P is the probability of a patient being seen by a certain type of provider, Age is the patient's age group (under 15 years of age; 15-24, 25-44, 45-64, and 65-74, years of age; and 75 years of age and above), $Region$ is the patient's region of residence (East, Midwest, South, and West), and $Year$ is a continuous variable (2011-2016). We treated the age variable as categorical because we believe the relationship between a patient's age and their probability of being seen by a provider is nonlinear.

We conducted the regression four times (Models I-IV), each time with a different dependent variable (in all cases a dichotomous variable): 1) P is the probability of a patient being seen by a physician but not a PA/NP (physician alone); 2) P is the probability of a patient being seen by a PA/NP but not a physician (PA/NP alone); 3) P is the probability of a patient being seen by a physician alone or a physician and a PA/NP (physician alone or in combination with a PA/NP); and 4) P is the probability of a patient being seen by a PA/NP alone or by both a PA/NP and a physician (PA/NP alone or in combination with a physician).

RESULTS

Appendix A displays the regression results for each model. The regression results of Model I inform us that compared with the reference age group (0-14 years), the probability of being seen exclusively by a physician first decreased with age (for 15-24, 25-44 years) and then increased with age (for 65-75 years, 75 years and above). In other words, the youngest and oldest age groups had a higher probability of being seen by a physician alone.

Model I results also suggest that compared with the reference region (East), there was a higher probability of being seen exclusively by a physician in the Midwest, South, and West, with the highest probability in the West. Overall, the probability of being seen exclusively by a physician decreased each calendar year between 2011 and 2016 by 1.7%.

Model II shows that compared with the youngest age group, patients between 15 and 24 years of age were slightly more likely to be exclusively seen by a PA/NP. The probability of seeing only a PA/NP declined for patients in older age groups. Compared with patients in the East, the probability of being seen exclusively by a PA/NP was larger in the Midwest and smaller in the South or West.

Because the outcome variable of Model III (physician alone or in combination with a PA/NP) is the inverse of that of Model II (PA/NP alone) and the outcome variable of Model IV (PA/NP alone or in combination with a physician) is the inverse of that of Model I (physician alone), the results of Models III and IV are the inverse (numbers with the opposite sign) of those for Models II and I, respectively.

Next, using the regression formula and the coefficients, we calculated the estimated probability of being seen by a physician only, by a PA/NP only, by a physician including in combination with PA/NP, and by a PA/NP including in combination with a physician, by region, age group, and year of visit. These probabilities are shown in Appendix B. For example, at an ED visit in 2014, a patient 15-24 years old in the Midwest region had a 0.72 probability of being seen by a physician alone. We calculated this using the age group, region, year coefficients, and the constant from Model I: -0.024 + 0.017 + (-0.017 × 4) + 0.793 = 0.718. The probability of this patient being seen by a PA/NP alone in 2014 was 0.14.

These analyses indicate that the probability of being seen by a physician decreased each calendar year, and this probability generally increased from East to Midwest to South to West. Patients in the youngest and oldest age groups were generally more likely to be seen by a physician than patients in other age groups.

Finally, we used these probabilities to generate sets of ratios of probabilities of being seen by two types of providers as inputs for the AAMC physician workforce projections model based on three different scenarios, displayed in Table 2. The first scenario (“Exclusive”) compares the probabilities of being seen exclusively by a PA/NP to the probabilities of being seen exclusively by a physician. The second scenario (“Mixed”) compares the probabilities of being seen by a PA/NP (alone or in combination) to a physician (alone or in combination). The third scenario (“Hybrid”) treats the combination visits and PA/NP exclusive visits identically, because combination visits are often assigned to a PA or NP first, with a physician brought in later (e.g., for a consult). Thus, the hybrid ratios are likely an overestimate of PA/NP usage. Table 3 displays the ratios for each scenario.

Table 2. Three Scenarios for Calculating Ratios

Ratio I: Exclusive	(PA or NP alone)/physician alone
Ratio II: Mixed	(PA or NP alone or in combination)/(physician alone or in combination)
Ratio III: Hybrid	(PA or NP alone or in combination)/physician alone

Table 3. Calculated Demand-Effect Ratio by Scenario, Region, Age Group, and Year

Age Group, Year	Scenario I: Exclusive				Scenario II: Mixed				Scenario III: Hybrid			
	East	Mid-west	South	West	East	Mid-west	South	West	East	Mid-west	South	West
0-14 years												
2011	0.12	0.14	0.09	0.09	0.25	0.23	0.17	0.14	0.29	0.26	0.19	0.15
2012	0.14	0.16	0.11	0.10	0.27	0.25	0.19	0.16	0.32	0.29	0.21	0.17
2013	0.15	0.17	0.12	0.11	0.29	0.28	0.21	0.18	0.35	0.32	0.24	0.20
2014	0.17	0.19	0.13	0.12	0.31	0.30	0.23	0.20	0.38	0.35	0.26	0.22
2015	0.18	0.21	0.15	0.14	0.33	0.32	0.25	0.22	0.41	0.38	0.29	0.25
2016	0.20	0.22	0.16	0.15	0.36	0.35	0.27	0.24	0.45	0.41	0.32	0.27
15-24 years												
2011	0.13	0.15	0.10	0.09	0.27	0.26	0.20	0.17	0.33	0.30	0.22	0.18
2012	0.14	0.17	0.11	0.10	0.30	0.28	0.22	0.19	0.36	0.33	0.25	0.21
2013	0.16	0.18	0.12	0.12	0.32	0.31	0.24	0.21	0.39	0.36	0.27	0.23
2014	0.18	0.20	0.14	0.13	0.34	0.33	0.26	0.23	0.43	0.39	0.30	0.26
2015	0.19	0.22	0.15	0.14	0.36	0.35	0.28	0.25	0.46	0.43	0.33	0.28
2016	0.21	0.23	0.17	0.16	0.39	0.38	0.30	0.27	0.50	0.46	0.36	0.31
25-44 years												
2011	0.12	0.14	0.09	0.08	0.27	0.26	0.19	0.16	0.33	0.30	0.22	0.18
2012	0.13	0.15	0.10	0.09	0.29	0.28	0.21	0.18	0.36	0.33	0.24	0.20
2013	0.15	0.17	0.11	0.10	0.31	0.30	0.23	0.20	0.39	0.36	0.27	0.23
2014	0.16	0.18	0.13	0.12	0.34	0.32	0.25	0.22	0.42	0.39	0.30	0.25
2015	0.18	0.20	0.14	0.13	0.36	0.35	0.28	0.25	0.46	0.42	0.33	0.28
2016	0.20	0.22	0.16	0.15	0.38	0.37	0.30	0.27	0.49	0.46	0.36	0.31
45-64 years												
2011	0.08	0.10	0.05	0.05	0.23	0.22	0.16	0.13	0.28	0.25	0.18	0.14
2012	0.09	0.11	0.06	0.06	0.25	0.24	0.18	0.15	0.31	0.28	0.20	0.16
2013	0.10	0.13	0.08	0.07	0.27	0.26	0.20	0.17	0.33	0.30	0.22	0.19
2014	0.12	0.14	0.09	0.08	0.29	0.28	0.22	0.19	0.37	0.33	0.25	0.21
2015	0.13	0.16	0.10	0.09	0.31	0.30	0.24	0.21	0.40	0.36	0.28	0.24
2016	0.15	0.17	0.11	0.11	0.34	0.32	0.26	0.23	0.43	0.40	0.31	0.26
65-74 years												
2011	0.05	0.07	0.03	0.02	0.20	0.18	0.12	0.10	0.23	0.20	0.14	0.10

2012	0.06	0.04	0.03	0.06	0.21	0.20	0.14	0.11	0.26	0.23	0.16	0.12
2013	0.08	0.05	0.07	0.08	0.23	0.22	0.16	0.13	0.28	0.26	0.18	0.15
2014	0.09	0.09	0.09	0.18	0.26	0.24	0.18	0.15	0.31	0.28	0.21	0.17
2015	0.10	0.11	0.20	0.09	0.28	0.26	0.20	0.17	0.34	0.31	0.23	0.19
2016	0.12	0.23	0.11	0.10	0.30	0.28	0.22	0.19	0.37	0.34	0.26	0.22
75 years and over												
2011	0.03	0.05	0.01	0.01	0.17	0.15	0.10	0.07	0.20	0.17	0.11	0.08
2012	0.04	0.06	0.02	0.02	0.19	0.17	0.12	0.09	0.22	0.20	0.13	0.10
2013	0.05	0.08	0.03	0.03	0.21	0.19	0.14	0.11	0.25	0.22	0.15	0.12
2014	0.07	0.09	0.04	0.04	0.23	0.21	0.15	0.13	0.27	0.25	0.17	0.14
2015	0.08	0.10	0.05	0.05	0.25	0.23	0.17	0.14	0.30	0.27	0.20	0.16
2016	0.09	0.12	0.07	0.06	0.27	0.25	0.19	0.16	0.33	0.30	0.22	0.18

Source: National Hospital Ambulatory Medical Care Survey, 2011-2016. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/dataset_documentation/nhamcs/stata/; ED2012 to ED2016-strata.dta.
N = *149,686.*

Note: Ratio I (Exclusive) = (PA or NP alone)/physician alone; Ratio II (Mixed) = (PA or NP alone or in combination)/(physician alone or in combination); Ratio III (Hybrid) = (PA or NP alone or in combination)/physician alone.

CONCLUSION

This analysis has a few limitations. First, the NHAMCS data we used included only ED visits, and extrapolating these usage patterns to other settings may not be realistic. Second, the OLS regression oversimplifies the complex nature of the relationship between the probability of being seen by types of providers. We only consider three factors (age group, region, and year), and the explanatory power is minimal (with an R2 0.012-0.016). Furthermore, the analyses only use data for NPs, but NPs make up only part of the general population of APRNs.

APRNs and PAs significantly contribute to the nation's health care delivery capacity, and both professions are growing rapidly. The extent to which these groups offset physician demand has significant implications for physician workforce needs and projections. These analyses provide an empirical examination of one method of estimating demand-effect ratios and highlight the effects of patient age, region, and year on the probability of being seen by physicians or NPs/PAs.

APPENDIXES

Appendix A. Estimated Probability of Being Seen by Different Types of Providers, Controlling for Age Group, Region, and Year

Age Group, Region, Year	Exclusive				Mixed			
	Model I: Physician alone		Model II: PA/NP alone		Model III: Physician alone or in combination		Model IV: PA/NP alone or in combination	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Age Group								
0-14 years (reference)	--	--	--	--	--	--	--	--
15-24 years	-0.024***	0.006	0.002	0.005	-0.002	0.005	0.024***	0.006
25-44 years	-0.023***	0.005	-0.008	0.004	0.008	0.004	0.023***	0.005
45-64 years	0.007	0.005	-0.035***	0.004	0.035***	0.004	-0.007***	0.005
65-74 years	0.036***	0.007	-0.054***	0.005	0.054***	0.005	-0.036***	0.007
75 years and above	0.059***	0.006	-0.069***	0.004	0.069***	0.004	-0.059***	0.006
Region								
East (reference)	--	--	--	--	--	--	--	--
Midwest	0.017**	0.005	0.019***	0.004	-0.019***	0.004	-0.017**	0.005
South	0.067***	0.004	-0.017***	0.003	0.017***	0.003	-0.067***	0.004
West	0.094***	0.005	-0.020***	0.003	0.020***	0.003	-0.094***	0.005
Year	-0.017***	0.001	0.009***	0.001	-0.009***	0.001	0.017***	0.001
Constant	0.793***	0.006	0.086***	0.004	0.914***	0.004	0.207***	0.006
R^2	0.016		0.013		0.012		0.016	
N	149,686		149,686		149,686		149,686	

Source: National Hospital Ambulatory Medical Care Survey, 2011-2016. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/dataset_documentation/nhamcs/stata/; ED2012 to ED2016-strata.dta.
N = *149,686.*
Note: ***p<0.001; **p<0.005. SE = standard error. Because Models I and IV are the inverse situations, and Models II and III are the inverse situations, the coefficients of Models I and IV and of Models II and III are the inverse of each other.

Appendix B. Calculated Probability of a Visit With Certain Types of Providers by Scenario Type, Region, Age Group, and Year

Age Group, Year	Exclusive Scenarios							
	Probability of seeing a physician only				Probability of seeing a PA/NP only			
	East	Mid-west	South	West	East	Mid-west	South	West
0-14 years								
2011	0.78	0.79	0.84	0.87	0.10	0.11	0.08	0.08
2012	0.76	0.78	0.83	0.85	0.10	0.12	0.09	0.08
2013	0.74	0.76	0.81	0.84	0.11	0.13	0.10	0.09
2014	0.73	0.74	0.79	0.82	0.12	0.14	0.10	0.10
2015	0.71	0.73	0.78	0.80	0.13	0.15	0.11	0.11
2016	0.69	0.71	0.76	0.79	0.14	0.16	0.12	0.12
15-24 years								
2011	0.75	0.77	0.82	0.85	0.10	0.12	0.08	0.08
2012	0.74	0.75	0.80	0.83	0.11	0.12	0.09	0.09
2013	0.72	0.74	0.79	0.81	0.11	0.13	0.10	0.09
2014	0.70	0.72	0.77	0.80	0.12	0.14	0.11	0.10
2015	0.68	0.70	0.75	0.78	0.13	0.15	0.12	0.11
2016	0.67	0.68	0.73	0.76	0.14	0.16	0.12	0.12
25-44 years								
2011	0.75	0.77	0.82	0.85	0.09	0.11	0.07	0.07
2012	0.74	0.75	0.80	0.83	0.10	0.11	0.08	0.08
2013	0.72	0.74	0.79	0.81	0.10	0.12	0.09	0.08
2014	0.70	0.72	0.77	0.80	0.11	0.13	0.10	0.09
2015	0.69	0.70	0.75	0.78	0.12	0.14	0.11	0.10
2016	0.67	0.69	0.74	0.76	0.13	0.15	0.11	0.11
45-64 years								
2011	0.78	0.80	0.85	0.88	0.06	0.08	0.04	0.04
2012	0.77	0.78	0.83	0.86	0.07	0.09	0.05	0.05
2013	0.75	0.77	0.82	0.84	0.08	0.10	0.06	0.06
2014	0.73	0.75	0.80	0.83	0.09	0.11	0.07	0.07
2015	0.72	0.73	0.78	0.81	0.10	0.11	0.08	0.08
2016	0.70	0.72	0.77	0.79	0.10	0.12	0.09	0.08

65-74 years								
2011	0.81	0.83	0.88	0.91	0.04	0.06	0.02	0.02
2012	0.80	0.81	0.86	0.89	0.05	0.03	0.03	0.05
2013	0.78	0.80	0.85	0.87	0.06	0.04	0.06	0.07
2014	0.76	0.78	0.83	0.86	0.07	0.07	0.08	0.15
2015	0.75	0.76	0.81	0.84	0.08	0.09	0.16	0.08
2016	0.73	0.75	0.80	0.82	0.09	0.17	0.09	0.09
75 years and above								
2011	0.84	0.85	0.90	0.93	0.03	0.04	0.01	0.01
2012	0.82	0.84	0.89	0.91	0.03	0.05	0.02	0.01
2013	0.80	0.82	0.87	0.90	0.04	0.06	0.03	0.02
2014	0.78	0.80	0.85	0.88	0.05	0.07	0.04	0.03
2015	0.77	0.78	0.83	0.86	0.06	0.08	0.04	0.04
2016	0.75	0.77	0.82	0.84	0.07	0.09	0.05	0.05

Age Group, Year	**Combined Scenarios**							
	Probability of seeing a physician alone or in combination				Probability of seeing a PA/NP alone or in combination			
0-15 years	East	Mid-west	South	West	East	Mid-west	South	West
2011	0.90	0.89	0.92	0.92	0.22	0.21	0.16	0.13
2012	0.90	0.88	0.91	0.92	0.24	0.22	0.17	0.15
2013	0.89	0.87	0.90	0.91	0.26	0.24	0.19	0.16
2014	0.88	0.86	0.90	0.90	0.27	0.26	0.21	0.18
2015	0.87	0.85	0.89	0.89	0.29	0.27	0.22	0.20
2016	0.86	0.84	0.88	0.88	0.31	0.29	0.24	0.21
15-24 years								
2011	0.90	0.88	0.92	0.92	0.25	0.23	0.18	0.15
2012	0.89	0.88	0.91	0.91	0.26	0.25	0.20	0.17
2013	0.89	0.87	0.90	0.91	0.28	0.26	0.21	0.19
2014	0.88	0.86	0.89	0.90	0.30	0.28	0.23	0.20
2015	0.87	0.85	0.88	0.89	0.32	0.30	0.25	0.22
2016	0.86	0.84	0.88	0.88	0.33	0.32	0.27	0.24
25-44 years								
2011	0.91	0.89	0.93	0.93	0.25	0.23	0.18	0.15

2012	0.90	0.89	0.92	0.92	0.26	0.25	0.20	0.17
2013	0.90	0.88	0.91	0.92	0.28	0.26	0.21	0.19
2014	0.89	0.87	0.90	0.91	0.30	0.28	0.23	0.20
2015	0.88	0.86	0.89	0.90	0.31	0.30	0.25	0.22
2016	0.87	0.85	0.89	0.89	0.33	0.31	0.26	0.24
45-64 years								
2011	0.94	0.92	0.96	0.96	0.22	0.20	0.15	0.12
2012	0.93	0.91	0.95	0.95	0.23	0.22	0.17	0.14
2013	0.92	0.90	0.94	0.94	0.25	0.23	0.18	0.16
2014	0.91	0.89	0.93	0.93	0.27	0.25	0.20	0.17
2015	0.90	0.89	0.92	0.92	0.28	0.27	0.22	0.19
2016	0.90	0.88	0.91	0.92	0.30	0.28	0.23	0.21
65-74 years								
2011	0.96	0.94	0.98	0.98	0.19	0.17	0.12	0.09
2012	0.95	0.93	0.97	0.97	0.20	0.19	0.14	0.11
2013	0.94	0.92	0.96	0.96	0.22	0.20	0.15	0.13
2014	0.93	0.91	0.95	0.95	0.24	0.22	0.17	0.14
2015	0.92	0.90	0.94	0.94	0.25	0.24	0.19	0.16
2016	0.91	0.90	0.93	0.93	0.27	0.25	0.20	0.18
75 years and above								
2011	0.97	0.96	0.99	0.99	0.16	0.15	0.10	0.07
2012	0.97	0.95	0.98	0.99	0.18	0.16	0.11	0.09
2013	0.96	0.94	0.97	0.98	0.20	0.18	0.13	0.10
2014	0.95	0.93	0.96	0.97	0.22	0.20	0.15	0.12
2015	0.94	0.92	0.96	0.96	0.23	0.22	0.17	0.14
2016	0.93	0.91	0.95	0.95	0.25	0.23	0.18	0.16

Source: National Hospital Ambulatory Medical Care Survey, 2011-2016. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/dataset_documentation/nhamcs/stata/; ED2012 to ED2016-strata.dta.
N = *149,686.*

NOTES

1. For a description of how these demand-effect ratios are incorporated into physician workforce projections, go to the main AAMC Workforce Studies web site and review the most recent projections report: HIS Markit Ltd. *The Complexities of Physician Supply and Demand: Projections From 2019 to 2034*. Washington, DC: AAMC; 2021.
2. National Hospital Ambulatory Medical Care Survey, 2011-2016. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/dataset_documentation/nhamcs/stata/; ED2012 to ED2016-strata.dta. Accessed March 2019.
3. AAMC Workforce Studies. *The Complexities of Physician Supply and Demand: Projections from 2018 to 2033.* Washington, DC: AAMC; 2020.