



Provision of evaluation and management visits by nurse practitioners and physician assistants in the USA from 2013 to 2019: cross-sectional time series study

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ABSTRACT

OBJECTIVE

To examine the proportion of healthcare visits are delivered by nurse practitioners and physician assistants versus physicians and how this has changed over time and by clinical setting, diagnosis, and patient demographics.

DESIGN

Cross-sectional time series study.

SETTING

National data from the traditional Medicare insurance program in the USA.

PARTICIPANTS

Of people using Medicare (ie, those older than 65 years, permanently disabled, and people with end stage renal disease), a 20% random sample was taken.

MAIN OUTCOME MEASURES

The proportion of physician, nurse practitioner, and physician assistant visits in the outpatient and skilled nursing facility settings delivered by physicians, nurse practitioners, and physician assistants, and how this proportion varies by type of visit and diagnosis.

RESULTS

From 1 January 2013 to 31 December 2019, 276 million visits were included in the sample. The proportion of all visits delivered by nurse practitioners and physician assistants in a year increased from 14.0% (95% confidence interval 14.0% to 14.0%) to

25.6% (25.6% to 25.6%). In 2019, the proportion of visits delivered by a nurse practitioner or physician assistant varied across conditions, ranging from 13.2% for eye disorders and 20.4% for hypertension to 36.7% for anxiety disorders and 41.5% for respiratory infections. Among all patients with at least one visit in 2019, 41.9% had one or more nurse practitioner or physician assistant visits. Compared with patients who had no visits from a nurse practitioner or physician assistant, the likelihood of receiving any care was greatest among patients who were lower income (2.9% greater), rural residents (19.7%), and disabled (5.6%).

CONCLUSION

The proportion of visits delivered by nurse practitioners and physician assistants in the USA is increasing rapidly and now accounts for a quarter of all healthcare visits.

Introduction

The number of nurse practitioners and physician assistants is increasing in the United States of America. From 2019 to 2031, the Bureau of Labour Statistics estimates that the number of nurse practitioners will increase from 200 000 to 359 000 (80 percent growth), whereas the number of physician assistants will increase from 120 000 to 178 000 (48 percent growth).¹ However, to date, quantifying the proportion of care and the type of care provided by nurse practitioners and physician assistants has been hampered by the use of indirect billing (also called incident-to or shared visit billing). With indirect billing, the nurse practitioner or physician assistant provides most of the care for a patient but the bill for the service is submitted under a supervising physician.² A novel method, published in 2022, described how to identify indirect billing visits and estimated that nationally between 2010 and 2018, 44% of all nurse practitioner and physician assistant visits in the US were billed indirectly.³ Therefore, prior research that only examines the visits directly billed by an nurse practitioner or physician assistant substantially underestimates their involvement in the US health care system and conversely overestimates the involvement of physicians.^{3 4}

To better characterise the involvement of nurse practitioners and physician assistants in the US health care system, we identified indirect billing in traditional Medicare claims to estimate the proportion of visits delivered by nurse practitioners and physician assistants and how this varied by clinical setting and diagnosis and by patient demographics.³ We also

WHAT IS ALREADY KNOWN ON THIS TOPIC?

An increasing number of nurse practitioners and physician assistants provide care in the US and many other countries, but little work has characterized the care that they provide

Quantifying the care provided by nurse practitioners and physician assistants has been hampered in the US by the use of indirect billing, where the bill is submitted under a supervising physician

Research that only examined visits directly billed by a nurse practitioners or physician assistants substantially underestimates their involvement in the US health care system and conversely overestimates the involvement of physicians

WHAT THIS STUDY ADDS?

From 2013 to 2019, the proportion of all traditional healthcare visits delivered by nurse practitioners and physician assistants increased from 14.0% to 25.6%

For some clinical conditions, such as respiratory infections, nurse practitioners and physician assistants provide a larger proportion of healthcare visits

Our results highlight the rapidly growing involvement of nurse practitioners and physician assistants in the US

characterize which patients are more likely to receive care from a nurse practitioner or physician assistant.

Methods

Healthcare staff and their role in visits with a nurse practitioner or physician assistant

Nurse practitioners and physician assistants are employed worldwide, albeit in lower rates compared with the US (appendix methods).⁵⁻⁶ In the US, nurse practitioners and physician assistants are required to earn a graduate degree, complete a specified schedule of clinical training, and acquire appropriate certifications and licenses.⁷ Each state has its own regulations dictating their practice.⁸⁻⁹ Unlike scope of practice laws for physician assistants, which are generally consistent across states and require physician assistants to work with a physician,⁹ scope of practice laws for nurse practitioners varies widely across states. The American Association of Nurse Practitioners has characterized the scope of practice laws for nurse practitioner for each state as either full, reduced, or restricted.⁸ In a full scope of practice state, a nurse practitioner can practice fully independently and may have their own clinic.

The relative role of the nurse practitioner, physician assistant, and physician will vary in individual visits. In many visits involving a nurse practitioner or physician assistant, the physician does not see the patient and is not involved in the diagnosis and management of the patient.¹⁰⁻¹¹ In other visits, the supervising physician may provide advice to the nurse practitioner or physician assistant at the time of the visit but does not physically see the patient. Physicians may also physically see the patient and have a more substantive role, particularly for visits in nursing facilities. Substantial ambiguity and controversy surrounds the billing guidelines and what is required when a visit is billed indirectly by a physician.¹²

Consistent with new guidelines by the US federal government for a form of indirect billing,¹³ when a visit is labelled as a nurse practitioner or physician assistant visit, we assume the visit is assigned to the clinician who spent the most time in history taking, physical exam, decision making, and management.

Data source

We used a 20% random sample of traditional Medicare claims data from 1 January 2013 to 31 December 2019 (see appendix for detail on data source). Medicare is the health insurer for people older than 65 years, permanently disabled, and people with end stage renal disease. Medicare accounts for roughly 20% of the US population and 23% of health care spending.¹⁴ Depending on the year in our cohort, traditional Medicare includes 61% to 71% of all people enrolled in Medicare (details in appendix). We excluded data from 2020 forward because we were concerned that care delivery changes related to the pandemic could distract from our key goal, which was to investigate the involvement of nurse practitioners and physician assistants in care delivery.

We identified all visits, both telemedicine and in-person, in the settings of outpatients (eg, office, hospital outpatient, retail clinics, and urgent care) or nursing facilities (eg, skilled nursing facility, hospice, and assisted living facility); we excluded visits in the inpatient and emergency department. Details on the codes used to identify and categorize visits and the full list of clinical settings are in the appendix.

Patient, visit, and county characteristics

We characterized patients by age, sex, race and ethnicity, low income (as captured by also being enrolled Medicaid, a public health insurance program that covers many Americans on low incomes), urban or rural residence, and region of the county.

Visits were categorized by diagnosis using the Clinical Classification Software Refined¹⁵ system and the primary diagnosis for the visit.¹⁶⁻¹⁷ For physician visits, we identified the specialty using the listed specialty (appendix).¹⁸ Primary care providers were defined as physicians with a specialty of general internal medicine, family medicine, general practice, or geriatric medicine. We also divided visits into those in the outpatient versus nursing facility settings.

We characterized counties by their 2019 state-level nurse practitioner scope of practice⁸ and by rurality (defined in appendix).¹⁹⁻²⁰ We hypothesized that states with restricted scope of practice laws for nurse practitioners would have fewer nurse practitioner visits because these nurses are less able to deliver care independently compared with those working in states with full scope of practice laws.²¹⁻²² Physicians are in relatively short supply in rural communities,²³ therefore, we hypothesized that nurse practitioners and physician assistants would account for a larger proportion of visits in rural areas.

Identifying visits misclassified as physician visits due to indirect billing

Details on how we used prescriptions to identify indirectly billed visits and the validity of this approach are available in a prior publication,³ as well as in the appendix. Briefly, we first identified all visits billed by nurse practitioners, physician assistants, or physicians. Secondly, we found visits with an associated prescription. An associated prescription was one written by a nurse practitioner, physician assistant, or physician one day before, on, or one day after the visit. We selected a one day window because this timeline provides more confidence that the prescription was made during the associated visit. If the nurse practitioner, physician assistant, or physician on the prescription and visit were the same, we categorized the visit as billed directly. However, if the clinicians on the visit and the prescription were different, with the prescription written by a nurse practitioner or physician assistant and visit billed by a physician, we considered these situations as potentially indirectly billed. From this group of potentially indirectly billed visits, we eliminated visits where whether the nurse practitioner or physician

Table 1 | Characteristics of patients with at least one nurse practitioner or physician assistant visit in 2019. Data percentage, unless otherwise specified

Characteristics	Patients with at least one visit (n=6 806 540)	Patients with no visit (n=9 443 340)	Estimated likelihood of at least one visit, percentage point difference (95% CI)*
Overall	41.9	58.1	—
Race/ethnicity:			
White	43.1	56.9	Reference
Black	40.5	59.5	-4.9 (-5.1 to -4.7)
Other	34.7	65.3	-5.8 (-6.2 to -5.5)
Asian	20.3	79.7	-19.0 (-19.3 to -18.7)
Hispanic	38.5	61.5	-5.3 (-5.5 to -5.1)
American Indian	57.7	42.3	5.3 (4.6 to 6.1)
Sex:			
Female	44.1	55.9	Reference
Male	38.7	61.3	-6.2 (-6.03 to -6.0)
Reason for Medicare enrollment:			
Older age	38.9	61.1	Reference
Disabled	50.9	49.1	5.6 (5.5 to 5.8)
Dual Medicaid enrollment†:			
No	40.3	59.7	Reference
Yes	47.2	52.8	2.9 (2.8 to 3.1)
Age (years):			
18-29	55.6	44.4	12.8 (12.0 to 13.5)
30-39	56.3	43.7	12.9 (12.5 to 13.4)
40-49	56.5	43.5	12.6 (9.6 to 10.2)
50-59	53.7	46.4	9.9 (9.6 to 10.2)
60-64	50.9	49.1	7.4 (7.0 to 7.7)
65-79	40.9	59.1	3.8 (3.7 to 3.9)
80 and older	36.9	63.1	Reference
Rural:			
Metro (population of >1 million)	34.0	66.0	Reference
Metro (population of 250 000-1 million)	45.9	54.1	10.6 (10.5 to 10.7)
Non-metro, non-rural	51.4	48.6	15.1 (14.9 to 15.2)
Rural	55.9	44.1	19.7 (19.4 to 20.1)
State scope of practice laws for nurse practitioners:			
Restricted	42.0	58.0	Reference
Reduced	40.8	59.2	-0.4 (-0.6 to -0.2)
Full	42.7	57.3	1.1 (1.0 to 1.3)

Only patients with at least one visit in 2019 were included in analysis. To characterize which patients were more likely to receive care from a nurse practitioner or physician assistant, we used a multivariable patient level logistic regression of the likelihood of receiving any care from a nurse practitioner or physician assistant (defined as yes or no) among those who received at least one visit in 2019. We presented average marginal effects, which is the average of predicted changes in fitted values for a one unit change for a given covariate. CI=confidence interval.

*Average estimated marginal effect are adjusted percent differences.

†Medicaid is a public health insurance program that covers many Americans on low incomes.

assistant provided care was unclear and therefore our estimate on the proportion of visits provided by nurse practitioner or physician assistant may be conservative. For example, we excluded visits if more than one prescription was given from different nurse practitioners or physician assistants during the time window because the related visit and prescription were not clear. The full list of exclusions in the appendix.

Extrapolating patterns observed among visits with a prescription to all visits

Our method of identifying visits indirectly billed can only be used for visits with an associated prescription. The second step in the method was to extrapolate patterns observed in visits with a prescription to those without a prescription. To do so, we used an inverse probability weighting procedure.²⁴ For each visit, we estimated the probability (along with the 95% confidence interval) that the visit would have an associated prescription based on

clinical setting, condition, patient characteristics, and geography. For visits with an associated prescription, we applied the inverse of that predicted probability as the weight for that visit in our analyses. This method assumed that the rate of indirect billing observed in a given visit with a prescription is the same as the rate of indirect billing observed in a similar visit in terms of setting, condition, patient characteristics, and geography, without a prescription (further explanation of why the weighting is needed and details on the variables used are provided in the appendix).

As a sensitivity analysis, we used a different method of generalizing from visits with an associated prescription to all visits. For each visit with a prescription, we used a regression model where the outcome was whether the visit was indirectly billed, and the predictor variables were the same visit characteristics used that were previously described. For each visit without a prescription, we estimated

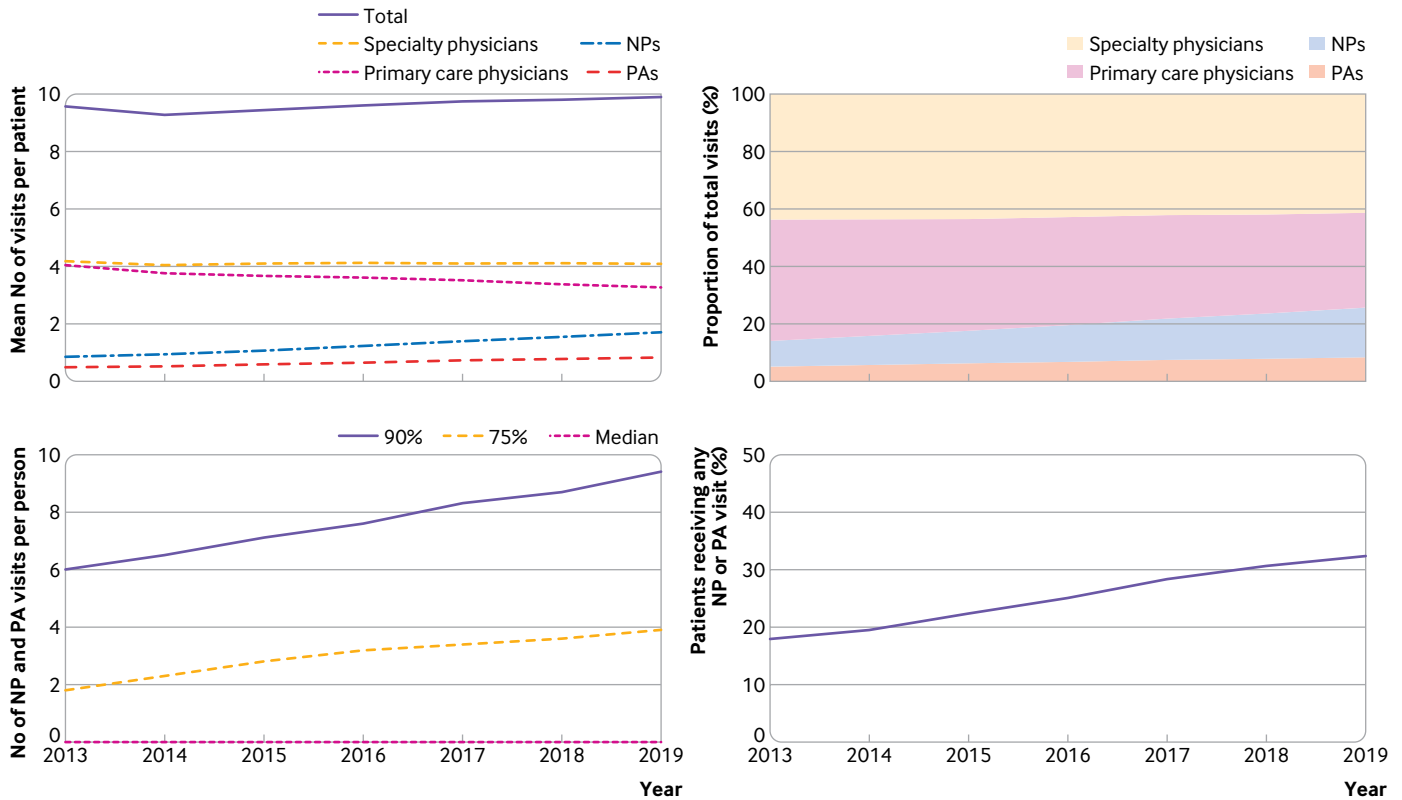


Fig 1 | Trends in the number of nurse practitioner (NP) and physician assistant (PA) visits per patient, the percentage receiving any NP or PA visit, and fraction of total visits delivered by NPs and PAs, 2013-19. We applied an inverse probability weighting method to the number of visits per patient (appendix). 95% confidence intervals can be found in appendix table S6; estimates for the mean, standard deviation, median, and interquartile range are presented in appendix table S9. We separately measured visits per patient for NPs, PAs, specialty physicians, and primary care physicians. We separately measured the proportion of total visits delivered by NPs and PAs. The denominator was the number of visits in our sample provided by NPs and PAs (both indirectly and directly billed) and physicians (specialty and primary care physicians). The numerator was the number of these visits billed by NPs and PAs (both indirectly and directly billed). We measured the median, 75th, and 90th percentiles of visits per patient for NPs and PAs (appendix table S9). We also measured the percentage of patients receiving any NP or PA visit

the likelihood that the billing was indirect using the regression coefficients from this model and the visit characteristics. This sensitivity analysis resulted in similar findings (details on method and comparison of results in the appendix). In both methods, standard errors were adjusted for patient level clustering.

Statistical analyses

For each year, we measured the mean number nurse practitioner, physician assistant, and physician visits (with and without prescription) per patient in the cohort (including those without visits) as well as the proportion of all visits provided by a nurse practitioner or physician assistant. We also examined how the proportion varies by type of visit and by condition categories. We focused on the 27 most common condition categories, with each condition accounting for more than 1% of total visits and collectively 76% of all visits in 2019. Standard errors were adjusted for patient level clustering.

Some researchers have hypothesized that more visits are by nurse practitioners and physician assistants in communities with fewer physicians.²⁵ To understand whether there were more nurse practitioner and physician assistant visits per patient in communities

with fewer physician visits per patient, we divided zip codes into deciles of the number of physician visits per patient. We used observed physician visits per capita versus physicians working in the community per capita because we believe these values better capture the true supply of physicians. Data for physicians working includes physicians who do not provide care to Medicare patients (eg, military physicians) and do not distinguish between part-time and full-time physicians. To ensure stable estimates, we excluded zip codes with fewer than five people enrolled in our data. We selected the five because this number represented the bottom decile of zip codes in our sample.

To characterize which patients were more likely to receive care from a nurse practitioner or physician assistant, we used a multivariable patient-level logistic regression of the likelihood of receiving any care from a nurse practitioner or physician assistant (defined as yes or no) among people who received at least one visit in 2019 (table 1). This analysis used the unweighted sample. Our predictors included patient characteristics (defined previously), and nurse practitioner scope of practice laws (defined as either restricted, reduced, or full). We presented average marginal effects, which is the average of predicted changes in fitted values for a

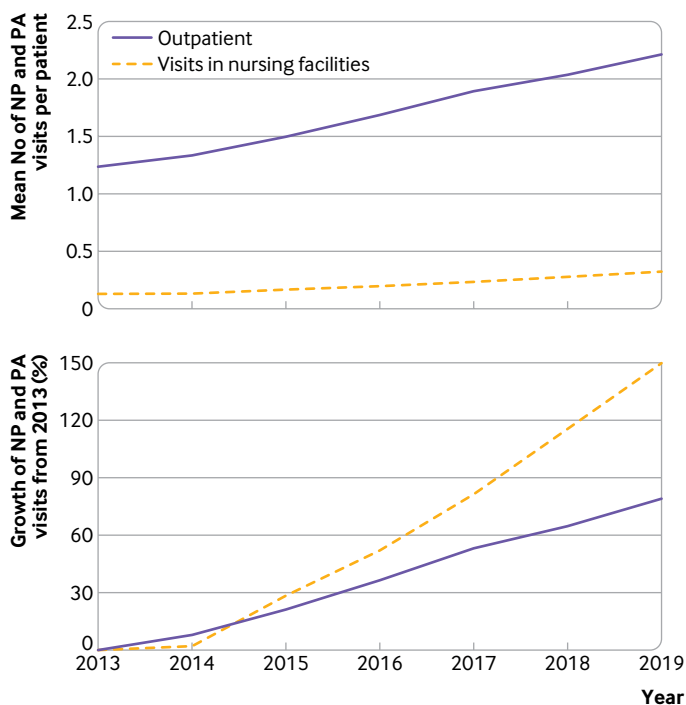


Fig 2 | Trends in the mean number of nurse practitioner (NP) and physician assistant (PA) visits by setting from 2013 to 2019 and relative growth in NP and PA visits from 2013 by setting. We focused on evaluation and management visits as defined using the Restructured Berenson-Egger Type of Service codes. We only included visits in outpatient and nursing facility settings. We applied an inverse probability weighting method to the number of visits per patient (appendix). 95% confidence intervals can be found in appendix table S7; estimates for the mean, standard deviation, median, and interquartile range are presented in appendix table S9

one unit change for a given covariate.²⁶ As a sensitivity analysis, we limited our analysis to patients with at least three total visits (physician, nurse practitioner, or physician assistant visits) to ensure stable estimates. We selected three because this number was the median value in the distribution of total visits (appendix).

For each physician specialty, we estimated the proportion of all billed visits that were indirectly billed and therefore actually provided by a nurse practitioner or physician assistant. We focused on the 20 most common specialties because they accounted for 86% of all specialty visits.

We multiplied all visit and patient counts by five to account for our 20% sample. Statistical analyses were performed in SAS, version 9.4.

Patient and public involvement

No patients were involved in setting the research question, developing the outcome measures, design, or implementation of the study, interpretation, or writing of the manuscript. Our study used already collected de-identified restricted claims data purchased from the US federal government. Harvard Medical School's institutional review board do not require that patients or members of the public planning are involved when the study was planned or submitted to ethical committees and funding agencies. These data were stored in a secure environment and required authorization to access.

Results

Care delivered by nurse practitioners and physician assistants

From 2013 to 2019, 275 915 797 visits were recorded in our sample. The mean number of nurse practitioner visits per patient per year increased from 0.9 (standard deviation 3.8) to 1.7 (5.5), an 89% increase, and the mean number of physician assistant visits per patient increased from 0.5 (2.6) to 0.8 (3.3), a 60% increase (fig 1). The number of visits per patient was skewed and the median number of visits to a nurse practitioner or physician assistant was 0 throughout the study period; the 75th percentile number of nurse practitioner or physician assistant visits per patient per year increased from 1.8 to 3.9 (117% increase) and the 90th percentile increased from 6.0 to 9.4 (57% increase; supplementary table S9). From 2013 to 2019, the total number of patients with any nurse practitioner or physician assistant visit increased from 17.9% to 32.3% (fig 1; table 1).

By contrast, during this period, the mean number of visits by a primary care physician per patient per year decreased from 4.0 (standard deviation 5.5) to 3.3 (5.1) (18% decrease), whereas mean specialty physician visits per patient per year only slightly decreased from 4.2 (8.3) to 4.1 (7.9) visits (2% decrease). Compared with nurse practitioners and physician assistants, primary care physicians are more likely to provide new patient visits and less likely to provide annual exams (supplementary table S5).

From 2013 to 2019, the proportion of total visits delivered by nurse practitioners in a year increased from 8.9% (95% confidence interval 8.9% to 8.9%) to 17.3% (17.3% to 17.3%), additionally, the proportion delivered by physician assistants increased from 5.1% (5.1% to 5.1%) to 8.4% (8.4% to 8.4%). Together, the proportion of total visits delivered by either a nurse practitioner or a physician assistant increased from 14.0% (14.0% to 14.0%) to 25.6% (25.6% to 25.6%). The proportion of total weighted visits delivered by primary care physicians decreased from 42.4% (42.4% to 42.4%) to 33.0% (33.0% to 33.1%) and the percentage delivered by specialty physicians decreased slightly from 43.7% (43.7% to 43.7%) to 41.3% (41.3% to 41.3%).

From 2013 to 2019, the mean number of annual visits per patient delivered by nurse practitioners and physician assistants increased from 1.2 (standard deviation 4.0) to 2.2 (4.7) (83% growth from 2013 to 2019) in the outpatient setting, and from 0.1 (2.1) to 0.3 (4.3) (200% growth) in nursing facilities (fig 2). Again, the number of nurse practitioner and physician assistant visits per patient at these care sites was skewed and the median number of visits to a nurse practitioner and physician assistant was 0 throughout the study period (supplementary table S9).

Characteristics of patients who receive care

Among the 16 249 880 patients with at least one visit in 2019, 6806 540 patients (42%) had at least one nurse practitioner or physician assistant visit and 1 688 930

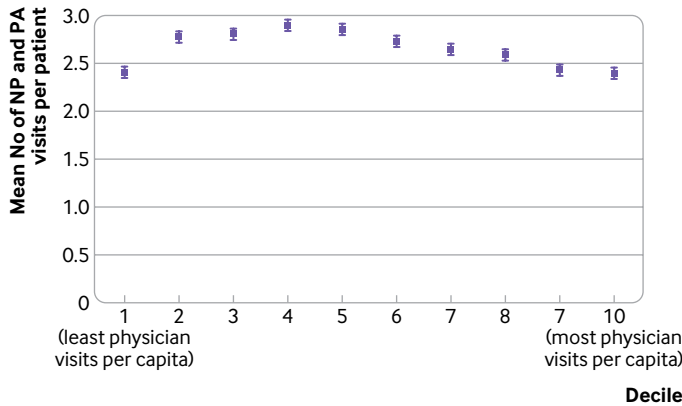


Fig 3 | Association of the mean number of nurse practitioner (NP)/physician assistant (PA) visits and physician visits per patient in 2019 across geographical areas in the USA. To ensure stable estimates, we eliminated zip codes with fewer than five people enrolled in Medicare. We selected five because this number represented the bottom 10 percentile of zip codes for the number of people enrolled in traditional Medicare in the 20% Medicare sample. We apply an inverse probability weighting method to the number of visits per patient (see appendix for details). We present median and the interquartile range for the number of NP and PA visits per patient; estimates for the mean, standard deviation, median, and interquartile range are presented in appendix table S10. The unit of analysis is zip code. We divided all zip codes in the US into deciles of physician visit per capita, with each decile containing approximately 3295 zip codes. Physician visits per capita for each decile (range does not include the upper bound): 1 (0-3.8); 2 (3.8-4.7); 3 (4.7-5.4); 4 (5.4-5.9); 5 (5.9-6.5); 6 (6.5-7.0); 7 (7.0-7.6); 8 (7.6-8.4); 9 (8.4-9.6); 10 (9.6-62.9)

(10%) only had visits with a nurse practitioner or physician assistant (table 1). We observed a lower proportion of patients having at least one visit from nurse practitioners and physician assistants among patients who were black relative to white (-4.9% (95% confidence interval -5.1% to -4.7%)) and patients who were male relative to female (-6.2% (-6.3% to -6.0%)). Conversely, we observed higher use of nurse practitioners and physician assistants among patients who were disabled (5.6% (5.5% to 5.8%)), had a lower income (2.9% (2.8% to 3.1%)), and lived in a rural area (19.7% (19.4% to 20.1%)).

Visits per patient by nurse practitioners and physician assistants versus physicians

Across the zip code deciles of physician visits per patient in 2019, no consistent relation was clear between the number of nurse practitioner or physician assistant visits per patient and the number of physician visits per patient (fig 3). A possible positive association in the lower deciles and a negative relation in zip codes with more physician visits per patient was noted. This negative association in higher deciles was possibly more evident in states with full scope of practice laws (supplementary figure S3).

Variation in nurse practitioner and physician assistant visits by condition categories

Among the 27 most common condition categories, nurse practitioners and physician assistants provided the largest proportion of visits for respiratory infections (41.5%, 4.3 million visits) and anxiety disorders (36.7%; 0.89 million visits) (fig 4). Nurse practitioners and physician assistants provided the smallest fraction of visits for heart disease (18.2%; 2.5 million visits) and eye disorders (13.2%, 0.59 million visits).

Proportion of physician visits that are billed indirectly

Visits that are billed indirectly are those provided by nurse practitioners and physician assistants but billed under a physician. From 2013 to 2019, the proportion of billed physician visits where the primary clinician was a nurse practitioner or physician assistant increased from 4.8% to 6.9% (supplementary table S2). In 2019, specialties varied widely in the proportion of visited billed indirectly by physician specialty, ranging from 19.2% in general surgery, 15.5% in psychiatry, 13.3% in urology to 9.1% in gastroenterology, 7.7% in dermatology, 5.7% in ophthalmology, and 4.3% in pain management (supplementary table S3).

Discussion

Principal findings

From 2013 to 2019, the proportion of all visits delivered by nurse practitioners and physician assistants to people enrolled on the traditional Medicare program increased from 14.0% to 25.6%. In 2019, the proportion of total visits delivered by a nurse practitioner or physician assistant varied substantially, ranging from 13.2% for eye disorders to 41.5% for respiratory infections. Consistent with prior literature,^{27 28} concurrent with the growth in nurse practitioner and physician assistant visits, primary care physician visits per patient per year decreased by 18%. Among all patients who had at least one visit, 42% had at least one visit with a nurse practitioner or physician assistant and the likelihood of receiving any care from a nurse practitioner or physician assistant was greatest among patients with lower incomes, residing in rural areas, and who are disabled.

Comparison with other studies

Our estimate of 25.6% visits provided by a nurse practitioner or physician assistant is consistent with a

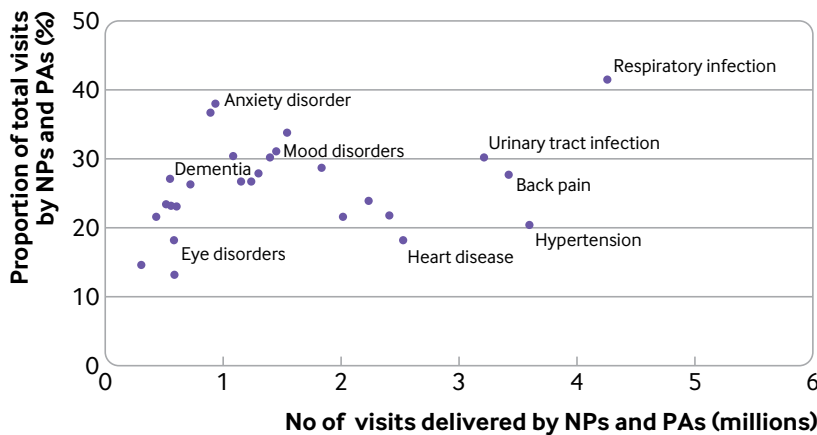


Fig 4 | Proportion of total visits delivered by nurse practitioners (NPs) and physician assistants (PAs) for each condition by percentage of total visits for each condition in 2019. We focused on the 27 most common conditions as each condition accounted for at least 1% of total visits and collectively about 76% of total visits in 2019. All 27 conditions and the proportion delivered by NP and PAs are in the appendix

prior study examining primary care visits in a single electronic health record system, which found 27.2% were provided via a nurse practitioner or physician assistant.⁴ Our study extends this work by looking at visits on a national scale, across all clinical specialties, and by clinical condition.

These results illustrate the rapidly growing involvement of nurse practitioners and physician assistants in the US health care system. The proportion of care provided by nurse practitioners and physician assistants will likely only increase over time because substantially more new nurse practitioners and physician assistants are entering the workforce compared with physicians.¹ Although Americans have historically seen a physician as their usual clinician, increasingly that usual clinician will now be a nurse practitioner or physician assistant.²⁹ One survey indicated that 54% of Americans had difficulty differentiating between the role of the nurse practitioner and the physician with varying opinions about differences in qualifications.²⁹ This confusion may increase in the future given the shift of some nurse practitioner education programs to doctor of nursing practice degrees,³⁰ which means that some nurse practitioners may also be called doctors.

However, our results do not support the idea that nurse practitioners and physician assistants are simply replacing physicians in a one-to-one fashion. Rather, clinicians are complementing each other with nurse practitioners and physician assistants having a greater focus on some types of visits, possibly where their training and expertise is best suited. Across conditions, we observe substantial differences in the involvement of nurse practitioner and physician assistants with higher involvement in low acuity acute problems (eg, respiratory infections and urinary tract infections) and mental illness, and a lesser role for heart disease and eye disorders. Compared with nurse practitioners and physician assistants, primary care physicians are more likely to provide new patient visits and less likely to provide annual exams. Surprisingly, we found that in areas of the US with fewer physician visits per capita, fewer numbers of nurse practitioner and physician assistant visits were recorded. We hypothesize that this finding reflects a shift to team based care and that nurse practitioners and physician assistants often practice alongside physicians. Our findings echo prior work in which substantial variation has been reported in the role of nurse practitioners and physician assistants in multidisciplinary teams across patient counseling, educational services, and the provision of primary care.³¹⁻³⁴ A large body of research has directly compared nurse practitioners and physicians on the quality of care and spending. Although exceptions exist,³⁵ in general, many studies have found similar quality and spending.³⁶⁻⁴² One criticism of this published literature is that these studies make direct comparisons of clinicians with different training. We believe more research is needed to understand how nurse practitioners and physician assistants are integrated into practice, and if configurations are

optimal in terms of the mix of clinicians on the quality and efficiency of care delivered.³⁶⁻⁴²

Our results also show that younger patients who are more likely to be disabled or have lower income and those who live in rural areas are more likely to receive care from a nurse practitioner or physician assistant. Nurse practitioners and physician assistants are also increasingly involved in care for older patients in nursing facilities. Taken together, these results suggest that nurse practitioners and physician assistants provide more care to underserved communities in the US.

Among industrialized countries, the US is in an outlier in that it has fewer physicians per capita.^{6,7} Our results highlight that the US has addressed this relative shortage through a growing reliance on nurse practitioners and physician assistants. Nurse practitioners and physician assistants now work in many other countries (appendix),^{6,7} and the trends we observe in the US could inform other countries because they consider how to address their own clinician shortages.

Limitations

Our study has several important limitations. Firstly, we cannot directly link a prescription to a given visit. We assumed that a prescription that was filled within a one day window around a visit was associated with that visit. However, we acknowledge that some misclassification is possible where the nurse practitioner or physician assistant writes prescriptions on behalf of the physician who provided care and where physicians write prescriptions on behalf of the nurse practitioner or physician assistant who provided care. Secondly, we limited our analysis to people who were enrolled in the traditional Medicare program with Part D coverage (roughly 47% of all people enrolled in Medicare) and therefore, may not be generalizable to other populations in the US health care system including those enrolled in Medicaid, commercial insurance, and Medicare Advantage programs. The latter may be particularly important, because during the study period enrollment in Medicare Advantage increased significantly.⁴³ Third, we focused only on visits delivered by physicians, nurse practitioners, and physician assistants and did not include visits from many other clinicians, such as social workers and psychologists. Fourth, our method of identifying indirect billing visits necessarily focuses on visits with an associated prescription, and we then extrapolate the patterns observed in those visits to all visits through an inverse probability weighting procedure. Neither our method of linking prescriptions to visits nor our weighting procedure is perfect, and this may bias our findings. For example, if nurse practitioners and physician assistants prescribed at higher rates than physicians, our estimates for rates of nurse practitioner and physician assistant visits would be too high. Conversely, if physicians prescribed at higher rates than nurse practitioners and physician assistants, our estimates would be too low. We do not know the

direction or magnitude of such a bias. Fifth, a limitation of administrative claims is the nurse practitioner and physician assistant specialisation is not generally specified and therefore we cannot describe the relative importance of different types of nurse practitioner and physician assistant training (for example, those with expertise in mental health, primary care, or obstetric care). Sixth, we used the primary diagnosis on the visit to categorize visits, but this diagnosis may not always accurately reflect the reason for the visit.

Conclusions

Despite these limitations, we believe our results provide the best available estimate of the involvement of nurse practitioners and physician assistants in the US health care system. In summary, we found that from 2013 to 2019, the fraction of all traditional Medicare visits delivered by nurse practitioners and physician assistants increased from 14.0% to 25.6%. Our results highlight the rapidly growing involvement of nurse practitioners and physician assistants in the US. Future research is needed to understand the implications of this growth on the quality of care that Americans receive.

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Web appendix: Online appendix