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TITLE PAGE

COLLABORATIVE PRACTICE TRENDS IN U.S. PHYSICIAN OFFICES: AN ANALYSIS OF THE NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS), 2007–2016

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ABSTRACT

Objective: Traditional physician practices have changed with the utilization of physician assistants (PAs) and nurse practitioners (NPs). We characterized evolving collaborative practices and identified medical care trends.

Design: Temporal ecological study

Setting: Nonfederal physician offices

Participants: Patient visits to a physician, PA or NP, spanning years 2007–2016

Methods: A stratified random sample of visits to office-based physicians within 2007–2011 and 2012-2016 were pooled through a public use linkage file. Among 317,674 visits to physicians, PAs or NPs, we described solo and collaborative practices and compared trends over two 5-year timespans. Patient visits were weighted in bivariate analyses to achieve nationally representative estimates. Survey statistics provided patient demographic characteristics, reason for visit, and visit specialty by provider type.

Results: There were an estimated 4.4 billion, and 4.1 billion visits to physician offices within years 2007–2011, and 2012–2016, respectively. Over defined timespans, among visits attended by a PA or NP, the proportion of physician office visits (POVs) with a PA or NP decreased by 42.5 and 49.0 percent, respectively. Likewise, the proportion of POVs attended by a Physician-PA or Physician-NP increased by 2.6 and 72.4 percent, respectively. When stratifying by provider type, we observed a trend away from preventive care visits among all providers.

Conclusions: It appears that PA and NP collaboration has become an integral part of office-based health care delivery. Not only is the presence of PAs and NPs more visible in physician office settings but their share of visits is growing. PA and NP patterns of care, solo or with a physician differed as well. NPs practiced more independently in primary care while PAs were more independent for care in a non-primary care medical specialty.

KEYWORDS
Healthcare, health Policy

Strengths and limitations of this study:

- NAMCS is the leading source of nationally representative data on care delivered mainly by the office-based physicians.
- Improvements in the NAMCS method of data collection has enriched the reliability of the utilization of PAs and NPs.
- Restricting data to nonfederal visits by PAs or NPs are subject to underestimation until the 'incident to' clause for Medicare and Medicaid reimbursement is removed.
- The study was strengthened by using survey statistics.

INTRODUCTION

Patient needs in healthcare are changing as a result of shifts in demographics and disease characteristics.[1-3] For instance, the proportion of the U.S. population over 65 years is increasing, such that by 2050, seniors are projected to make up at least 35% of the total population.[4] Likewise, by the second decade of this century, the occurrence of obesity and diabetes had reached epidemic proportions.[5,6] Aside from the interaction of demographic shifts and the increased burden of disease, the Patient Protection and Affordable Care Act (ACA) expansion of health insurance benefits to an estimated 20 million, mainly low-income Americans, have created more demand for medical services without a concomitant growth in physician services.

The Association of American Medical Colleges predicts a national shortage of 46,000–90,400 physicians by 2025. If this prediction is realized, then the physician workforce pipeline will be inadequate to meet the growing demand.[7] Expanding roles of physician assistants (PAs), nurse practitioners (NPs), and certified nurse midwives (CNMs), as a solution to physician shortages has been discussed.[8,9] This innovative use of health professionals has not gone unnoticed and their utilization has grown nationwide. As of 2018, the Bureau of Labor Statistics (BLS) estimates the number of clinically active physicians and surgeons at 713,800, NPs at 155,500, and PAs at 106,200, with growth projections from 2016 to 2026 at 13%, 36%, and 37%, respectively.[10,11] During this same period the U.S. population is expected to grow from 320 to 346 million, further increasing the need to expand the roles of medical provider workforce.[12]

Although the slope of upward trend of PA/NPs exceeds the upward trend of physicians, how this has affected the distribution of collaborative practice in the healthcare delivery setting remains unknown. Medical care delivered by these professions take place in many locations, including (but not limited to) physician offices, clinics, hospitals, community health centers, and rehabilitation facilities. In this study, using the largest and longest running survey of ambulatory care in the U.S., the National Ambulatory Medical Care Survey (NAMCS), we described trends in solo or dyad use of PA or NP with a physician among sampled visits made to nonfederal physician private solo or group practice, comparing two 5-year time-spans of 2007–

2011 and 2012–2016. Specifically, we explored patient office visits (POVs) by specialty and type of provider and described appreciable changes in collaborative practice arrangements over time. While federal medical insurance policy has changed in the U.S. since the beginning of the century, but timing, and implementation logistics have not been uniform. Our objective was to investigate whether significant changes in collaborative practice are observable in the latter (2012-2016) versus former (2007-2011) 5-year time-spans of the NAMCS. To accomplish this, we have capitalize on improvements in the NAMCS method of data collection which have enriched the reliability of data on PAs and NPs.[9,13-15]

METHODS

Study Design, Data Source, and Setting

We conducted a temporal ecological study, compared averages of two 5-year time-spans of 2007–2011 and 2012-2016 characteristics of visits made to physician offices across provider type, using NAMCS datasets, drawing annually on independent samples of physician practices. NAMCS is undertaken by the National Center for Health Statistics (NCHS), a component of the Centers for Disease Control and Prevention (CDC), under the Department of Health and Human Services (DHHS). The NAMCS data collection methods have been described in detail.[16] Briefly, the NAMCS is a voluntary probability sample survey of patient encounters at nonfederal, office-based physician offices (including both allopathic and osteopathic physicians and surgeons). Although NAMCS has been reported to underestimate office-based non-physician clinicians' visits, efforts have improved the documenting of PAs and NPs.[9]

NAMCS Data Availability

Data are available in a public, open access repository. NCHS has a public use linkage to access NAMCS, 1973–1992 and NAMCS, 1993–2016.[17] The majority of NAMCS variables are publicly available. Accessing restricted NAMCS variables, through CDC Research Data Center (RDC), is possible.[18] We used publicly available data.

Data Abstraction and Participants

According to the NCHS, survey years with the same survey instrument can be combined.[19] We used NAMCS public use linkage to create two pooled 5-year time-spans data of 2007–2011 and 2012–2016. **Supplemental Figure 1** summarizes the data filtering process. In this investigation, the 2007–2016 years data were concatenated. NAMCS samples visits to physicians, PAs and NPs, as well as other providers (e.g., mental health provider, registered nurse/licensed practical nurse, or other visits without a provider).[9] Our eligibility requirement across survey years were visits attended by a solo physician, PA, or an NP, or a dyad. Thus, we excluded a small portion (1.6%) of visits attended by any other provider. Also with the assumption that type of visits and patients' socioeconomic status may vary at nonfederal or federally supported settings, or at hospital outpatient departments, this analysis is centered on visits to the main sampled setting, i.e., POVs, both solo and group practices (86.2%). To describe the temporal difference in utilization of PAs and NPs, and to assess their collaborative practice, the data were separated into two 5-year time-span comparative groups of 2007–2011, and 2012–2016. As we used the NAMCS publicly available data, not containing identifying variables, this study was determined exempt from review by the authors' Institutional Review Board (IRB 00124136).

Measures of Interest

Provider-types were MD/DOs, PAs, NPs, and CNMs. CNMs and NPs were collapsed to NPs consistent with NCHS protocol, as the number and percentages of CNMs in POVs are considered too small to be calculated separately.[9] We categorized provider-type to physician, PA, or NP, or a dyad (two providers per visit), defined as collaborative practice to mean two different professions involved in the provision of care during a patient visit, one of them a physician.

In stratified models, we explored whether collaborative practice differed by patient demographic characteristics, reason for visit, and visit specialty. Patient characteristics included age (categorized as <15, 15–24, 25–44, 45–64, 65–74, and 75+ years), gender, race, and ethnicity (categorized as white, black, and other; and Hispanic/Latino and non-Hispanic/Latino, respectively). Reason for visit were four groups: acute, chronic (i.e. routine or

flare-up), pre-/post- surgery, and preventive care. Type of visit specialty were primary care, medical specialty, and surgical specialty. NAMCS excludes physicians in the specialties of anesthesiology, pathology, and radiology, and their designated sub-specialties.[9]

Statistical Analysis

We applied patient visit weights to all analyses to achieve nationally representative estimates and confidence intervals. Patient demographic characteristics, reason for visit, and visit specialty by provider-type were stratified for sub-group analyses. Chi-square test was used to compare parameter estimates over time, as well as in sub-group analyses by patient characteristics and visit characteristics by provider-type. The *a priori* alpha value was set at 0.05. Findings are generalizable to physician offices across the U.S. All statistical analyses were performed using SAS software 9.4 (SAS, Hickory, North Carolina).

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research

RESULTS

There were an estimated 8.5 billion patient visits to physician offices between 2007–2016; 4.4 billion (51.3%) within 5-year time-span of 2007–2011 (Time 1), and 4.1 billion (48.7%) within 5-year time-span of 2012–2016 (Time 2) **(Supplemental Figure 1)**. Physicians consistently had the highest proportion of visits at both 5-year time-spans, followed by Physician-PA, Physician-NP, solo-PA, solo-NP, and other collaborations. However, despite this ranking similarity between Times 1 and 2, the proportion of visits per provider differed significantly between these two time-spans (P <.01) **(Supplemental Table 1)**. **Figure 1** shows a mosaic plot of the proportion of POV provided by each provider type (solo or dyad, excluding solo-Physician) across the two 5-year intervals 2007–2011 and 2012–2016. The 2007–2011 and 2012–2016 intervals represent 46.5% and 53.5% of POV across the study timeframe, respectively. Of note, the proportion of

POV attended by a solo-PA or solo-NP decreased, on average, by 42.5 (P <.01) and 49.0 (P <.01) percent, respectively, across the study timeframe. Likewise, the proportion of POV attended by a Physician-PA or Physician-NP increased by 2.6 (P=.46) and 72.4 (P <.01) percent, respectively. Overall, this suggests that collaborative practice, in particular Physician-NP, was increased in recent years (2012–2016) (p <.01), while visits handled by a solo-PA or solo-NP seem to have decreased (P <.01) **(Figure 1)**. Overall, the highest annual percentage of POV with PA or NP solo or collaborative work was seen in 2015 [10.5%, 95% confidence interval (CI) 6.2, 14.7] **(Figure 2)**.A slight decrease in solo practice of physicians was also seen in recent years (P=.17) **(Supplemental Table 1)**.

Patient Characteristics

Table 1A and 1B shows the demographics for overall patients by provider type within time-spans 2007–2011 and 2012–2016, respectively.

Sex: Overall, comparing Time 1 and Time 2, irrespective of provider, there was no significant difference in sex distribution of patients (P=.86); women had almost 1.4 times more visits than men within both 5-year time-spans (58.3% female patient visits versus 41.7% male patient visits in both Time1 and Time 2). When stratified by provider type, despite significant sex distribution within years 2007–2011 (P=.01), patients' sex did not differ by provider within 2012–2016 (P=.36).

Race and ethnicity: No significant differences were observed between time-spans of 2007–2011 and 2012–2016 by patient race (P=.40). When stratified by provider type, compared to the years 2007–2011, solo-NP patient race was significantly different in the years 2012–2016, with the most increase seen in visits of patients of other races (non-white, non-black) and decrease in visits of black and white patients (P=.01). Also, for the Physician-PA visits, there was a significant change in the race pattern between the years of 2007–2011, and 2012–2016, with the most dramatic increase seen in visits of patients of other races (non-white, non-black) and decrease in visits of white and black patients. Overall, nominal (not significant) changes were seen across the two time periods by ethnicity (P=.10). However, when stratifying by defined time-spans and provider type, for the Physician-PA visits there was a significant

increase in proportion of Hispanic patients seen between the years of 2007–2011 and 2012–2016 (from 12.1% to 23.8%, P <.01).

Age: The mean age of patients significantly differed between Time 1 and Time 2 (P <.01). Overall, the number of visits by older patients (≥45) increased (from 56.4% in Time 1 to 59.6% in Time 2). Within years 2007–2011, compared to physicians, PAs and NPs visited more patients <45 years old; PAs (56.3%), NPs (60.2%), physicians (43.5%) (P <.01). Within years 2012–2016, compared to physicians, NPs had more patients <45 years (55.3% versus 40.4%, P=.02), while within same time-span, PA visits of patients <45 years did not differ with physicians (40.3% versus 40.4%, P=.99).

Major Reason for Visit

Overall, irrespective of provider type, reason for visit differed between years 2007–2011 and 2012–2016 (P <.01); i.e. proportion of acute and chronic visits increased (33.9% versus 36.9%), and (39.0% vs. 45.9%), respectively; and proportion of visits for pre/post-surgery and preventive care decreased (7.0% versus 4.3%), and (20% versus 13.0%), respectively. These changes varied by provider type. For example, in the stratified data by provider type, within years 2012–2016, compared to years 2007–2011, solo-PA visits for preventive care and acute problem decreased (21.3% versus 12.5%), and (40.3% versus 34.0%), respectively; while solo-PA share of chronic problem increased drastically (31.0% vs. 47.3%, P <.01). A similar trend in proportion of acute and chronic problem, as well as preventive care visits among Physician-PA practice between Time 1 and Time 2 was seen (P=.04). Solo-NP and Physician-NP major reason for visits over time showed less variability. In comparing the 5-year time-spans, a trend away from preventive care visits were observed among all providers (**Figure 3**).

Visit Specialty

Overall, irrespective of provider type, the specialty of visits differed between years 2007–2011 and 2012–2016 (P <.01); i.e.; within recent years (2012–2016), there were less primary care visits (52.7% versus 56.7%), and more visits with medical specialty (27.0% versus 22.7%). Surgical visits were almost the same between these two time-spans. Of note, Solo-PA had an

outstanding change in specialty pattern over years, indicating decreased visits with primary care specialty (37.6% versus 56.3%), and increased medical care and surgical care specialties (36.6% versus 25.0%), and (25.8% versus 18.7%), respectively. Risk ratios for the association between specialty visit (primary, medical, and surgical) and provider practice type (dyad versus solo as reference) within these two time spans is illustrated in **Figure 4**. With 2011–2016, PAs had higher probability of having primary care visits in a dyad practice versus solo (RR 1.49, 95% CI 1.08, 2.06), and less probability to do a medical specialty visit in a dyad practice versus solo (RR 0.53, 95% CI 0.32, 0.87). However, within 2011–2016, NPs primary care visits were more probable as a solo-NP (RR 0.68, 95% CI 0.49, 0.93), while for medical specialty care, NPs had higher probability of working with a physician at a visit (RR 3.72, 95% CI 1.72, 8.06).

Table 1A: Patients' demographic characteristics, stratified by provider type, NAMCS 2007–2011

n*1000
% (95% Confidence Interval)

Characteristic	Total	Solo-Phys.	Solo-PA	Solo-NP	Phys.-PA	Phys.-NP	Other collaboration	P
Sex								
Female	2,547,042	2,387,457	21,125	17,604	96,690	23,610	554	.01
	58.4 (57.6, 59.1)	58.4 (57.6, 59.1)	57.8 (54.2, 61.3)	67.5 (62.5, 72.5)	57.5 (54.8, 60.3)	57.2 (53.9, 60.4)	54.5 (31.9, 77.1)	
Male	1,817,122	1,703,712	15,452	8,474	71,323	17,698	462	
	41.6 (40.9, 42.4)	41.6 (40.9, 42.4)	42.2 (38.7, 45.8)	32.5 (27.5, 37.5)	42.5 (39.7, 45.2)	42.8 (39.6, 46.1)	45.5 (22.9, 68.1)	
Race								
White	3,668,660	3,443,589	31,305	22,994	135,002	35,133	634	-
	84.1 (82.3, 85.8)	84.2 (82.4, 86.0)	85.6 (81.9, 89.2)	88.2 (82.0, 94.3)	80.4 (76.5, 84.2)	85.1 (80.3, 89.8)	62.4 (47.3, 77.4)	
Black	477,217	438,902	3,744	2,707	26,378	5,100	382	
	10.9 (9.3, 12.5)	10.7 (9.1, 12.3)	10.2 (6.8, 13.7)	10.4 (4.4, 16.3)	15.7 (11.2, 20.2)	12.3 (7.7, 17.0)	37.6 (22.6, 52.7)	
Other	218,287	208,677	1,528	376	6,631	1,073		
	5.0 (4.1, 6.0)	5.1 (4.1, 6.1)	4.2 (2.3, 6.1)	1.4 (0.2, 2.7)	3.9 (2.0, 5.9)	2.6 (1.1, 4.1)	-	
Ethnicity								
Hispanic/Latino	493,353	456,838	7,484	3,584	20,360	5,052	33	.18
	11.3 (9.3, 13.4)	11.2 (9.1, 13.2)	20.5 (13.2, 27.8)	13.7 (1.4, 26.1)	12.1 (7.5, 16.7)	12.2 (5.1, 19.4)	3.3 (0.0, 11.0)	
Non-Hispanic/Latino	3,870,812	3,634,331	29,093	22,494	147,652	36,256	983	
	88.7 (86.7, 90.7)	88.8 (86.8, 90.9)	79.5 (72.2, 86.9)	86.3 (73.9, 98.6)	87.9 (83.3, 92.5)	87.8 (80.6, 95.0)	96.7 (89.0, 100)	
Age								
<15	716,249	667,405	8,692	6,869	22,255	10,847	177	<.01
	16.4 (15.5, 17.4)	16.3 (15.3, 17.3)	23.8 (13.2, 34.3)	26.3 (13.9, 38.8)	13.2 (8.2,18.3)	26.3 (13.8, 38.7)	17.5 (8.8, 26.2)	
15–24	326,815	305,553	3,680	3,293	11,911	2,364	11	
	7.5 (7.2, 7.8)	7.5 (7.2, 7.8)	10.1 (7.2, 12.9)	12.6 (9.1, 16.2)	7.1 (5.7, 8.5)	5.7 (4.1, 7.4)	1.1 (0.4, 1.9)	
25–44	858,223	807,176	8,191	5,545	29,840	7,251	216	
	19.7 (19.0, 20.4)	19.7 (19.0, 20.4)	22.4 (17.3, 27.5)	21.3 (15.4, 27.1)	17.8 (14.6, 21.0)	17.6 (13.4, 21.7)	21.3 (13.2, 29.4)	
45–64	1,287,176	1,208,896	9,082	5,560	53,018	10,253	365	
	29.5 (28.8, 30.1)	29.5 (28.9, 30.2)	24.8 (19.6, 30.0)	21.3 (16.2, 26.5)	31.6 (28.9, 34.2)	24.8 (19.2, 30.4)	35.9 (16.9, 55.0)	
65–74	584,405	544,484	4,213	2,491	27,595	5,441	177	
	13.4 (13.0, 13.8)	13.3 (12.9, 13.7)	11.5 (8.2, 14.9)	9.6 (6.0, 13.1)	16.4 (14.1, 18.7)	13.2 (9.1, 17.3)	17.5 (10.4, 24.5)	
≥75	5,912,954	557,652	2,716	2,317	23,391	5,149	68	
	13.5 (12.9, 14.2)	13.6 (13.0, 14.3)	7.4 (5.0, 9.8)	8.9 (5.1, 12.7)	13.9 (11.3, 16.5)	12.5 (7.8, 17.2)	6.7 (0.0, 13.4)	

Table 1B: Patients' demographic characteristics, stratified by provider type, NAMCS 2012–2016

	n*1000 % (95% Confidence Interval)							
Characteristic	**Total**	**Solo-Phys.**	**Solo-PA**	**Solo-NP**	**Phys.-PA**	**Phys.-NP**	**Other collaboration**	**P**
Sex								
Female	2,410,872	2,222,316	9,787	8,107	121,084	48,499	1,076	.36
	58.3 (57.6, 59.0)	58.1 (57.4, 58.9)	54.6 (48.4, 60.8)	54.9 (45.5, 64.4)	60.9 (56.6, 65.3)	59.1 (55.9, 62.2)	61.4 (48.7, 74.1)	
Male	1,726,453	1,599,754	8,133	6,657	77,613	33,618	676	
	41.7 (41.0, 42.4)	41.9 (41.2, 42.6)	45.4 (39.2, 51.6)	45.1 (35.6, 54.6)	39.1 (34.7, 43.4)	40.9 (37.8, 44.1)	38.6 (25.9, 51.3)	
Race								
White	3,457,833	3,207,866	15,800	12,958	149,073	70,607	1,526	<.01
	83.6 (82.4, 84.7)	83.9 (82.8, 85.1)	88.2 (83.7, 92.7)	87.8 (81.9, 93.6)	75.0 (68.6, 81.4)	86.0 (82.8, 89.1)	87.0 (75.4, 98.7)	
Black	434,501	393,206	1,640	1,083	30,356	8,006	207	
	10.5 (9.9, 11.2)	10.3 (9.7, 10.9)	9.2 (5.0, 13.4)	7.3 (4.1, 10. 6)	15.3 (10.6, 20.0)	9.8 (7.5, 12.0)	11.9 (0.5, 23.3)	
Other	244,991	220,998	479	723	19,267	3,502	191	
	5.9 (4.9, 6.9)	5.8 (4.7, 6.8)	2.7 (1.0, 4.3)	4.9 (1.0, 8.9)	9.7 (6.3, 13.1)	4.3 (2.5, 6.1)	1.1 (0.0, 2.8)	
Ethnicity								
Hispanic/Latino	551,903	491,346	3,036	1,903	47,233	8,259	124	<.01
	13.3 (12.3, 14.4)	12.9 (11.8, 14.0)	16.9 (8.6, 25.3)	12.9 (4.4, 21.4)	23.8 (19.4, 28.2)	10.1 (7.6, 12.6)	7.1 (3.0, 11.2)	
Non-Hispan./Latino	3,585,422	3,330,724	14,884	12,862	151,464	73,857	1,629	
	86.7 (85.6, 87.7)	87.1 (86.0, 88.3)	83.1 (74.7, 91.5)	87.1 (78.6, 95.6)	76.2 (71.8, 80.7)	89.9 (87.5, 92.4)	92.9 (88.8, 97.0)	
Age								
<15	593,134	540,191	2,496	3,354	31,860	15,001	229	.02
	14.3 (13.3, 15.4)	14.1 (13.1, 15.2)	13.9 (5.4, 22.4)	22.7 (11.7, 33.7)	16.0 (9.0, 23.1)	18.3 (8.9, 27.7)	13.1 (0.0, 30.0)	
15–24	298,158	278,863	1,349	998	11,239	5,566	142	
	7.2 (6.8, 7.6)	7.3 (6.9, 7.7)	7.5 (4.3, 10.8)	6.8 (4.5, 9.1)	5.7 (4.0, 7.3)	6.8 (4.7, 8.8)	8.1 (1.9, 14.3)	
25–44	778,408	725,937	3,392	3,802	32,094	12,940	241	
	18.8 (18.1, 19.5)	19.0 (18.3, 19.7)	18.9 (14.2, 23.7)	25.8 (16.5, 35.0)	16.2 (12.0, 20.3)	15.8 (12.1, 19.5)	13.8 (3.3, 24.2)	
45–64	1,250,891	1,144,988	5,624	3,683	73,499	22,497	597	
	30.2 (29.5, 30.9)	30.0 (29.3, 30.6)	31.4 (25.7, 37.1)	25.0 (17.7, 32.2)	37.0 (31.7, 42.3)	27.4 (23.4, 31.4)	34.1 (24.2, 44.0)	
65–74	644,858	596,011	2,615	1,732	30,836	13,394	267	
	15.6 (15.1,16.1)	15.6 (15.1, 16.1)	14.6 (10.7, 18.5)	11.7 (6.8, 16.6)	15.5 (12.4, 18.6)	16.3 (11.0, 21.7)	15.3 (8.2, 22.4)	
≥75	571,874	536,079	2,441	1,192	19,168	12,717	275	
	13.8 (13.2, 14.4)	14.0 (13.4, 14.6)	13.6 (9.2, 18.1)	8.1 (3.4, 12.8)	9.7 (7.7, 11.6)	15.5 (11.8, 19.2)	15.7 (6.6, 24.8)	

DISCUSSION

The results of this analysis are consistent with a wide range of findings that collaborative practice has increased at physician offices in the U.S. over the recent years.[20] The PA and NP utilization observed in 8.5 billion visits to physician private solo or group practice grew to an average of 10.5% in 2015. Simultaneously, there was a significant shift in the reason for visits handled by a PA or NP or in a collaborative practice.

These changes may be due to a number of reasons. For example, the ACA may have influenced the employment of PAs and NPs by physicians at a time when staffing expansion was needed. However, the market (demand) for PAs and NPs began decades before and has been slowly increasing as healthcare service delivery has consolidated and the traditional 'solo physician' model is increasingly becoming an anachronism. The interchangeability of PAs and NPs may be at work as well, since salaries are similar and role differences are often minimal.[21,22] Enabling PA and NP legislation by states also expanded during the study timeframe, which may have facilitated greater utilization.[23,24]

Changes in healthcare service delivery trends may partially explain these findings. On the medical side, new arrangements include consolidation of physician offices into medical centers, enlargement of hospitals and beds, the emergence of retail clinics, outpatient surgery, and team-based care.[25] At the same time, the ubiquity of chronic disease is increasing as an aging population places larger demands on medical systems.[26] The timing of our study, overlapping with the implementation and national roll-out of the ACA, also affords the possibility that this largescale change in federal medical insurance policy may have impacted the growth of collaborative care practices. As a federal policy enactment, it was supportive of PAs and APRNs (advanced practice registered nurses) and may have served as an accelerant for PA and NP program growth.[27]

We find that collaborative care, where the physician-PA/NP is linked in a patient encounter, is growing in proportion as well.[26] One possible explanation is due to the growth in employment among PAs and NPs. As of 2018 the BLS puts employed PAs at 106,200 and NPs at 155,500.[10,11] Their growth is projected from 2016 to 2026 at 36%, and 37%, respectively with

physician growth somewhat lower at 13%.[10,11] This forecast is predicated on increasing demand for healthcare services and decreasing annual physician productivity.[28,29] The growing number of studies on the ability of PAs and NPs to manage complex patients with the same outcome as physicians is not only reassuring but informs a wide variety of health systems that their inclusion in team based medicine may be in the patient's best interest as much as the system's best interest.[30-33]

A number of theories might explain the rise in the observed collaborative medical care services. The economic explanation is that a visit with a PA or NP and conjoined with a physician is reimbursed by Medicare or Medicaid at 100% of the prevailing community rate. The PA or NP that sees the patient as a sole provider is reimbursed for that visit at 85% of the prevailing rate.[34] The policy stipulates that services must be rendered under the direct supervision of a physician, meaning the physician must be present in the office suite and immediately available.[35] The social explanation is that consumers of medical services are more accepting of diverse types of providers as primary care undergoes changes in style and organization.[29] This opens more opportunities for physician practices as well as medical centers, clinics, and other settings to employ PAs and APRNs.[36] After a half century of PAs and NPs providing high-quality healthcare in the U.S., they appear to be well integrated into collaborative relationships in physician office medicine.[37]

Our study has some limitations. Although the NAMCS is a rich and widely used database, in existence since 1973 and freqently drawn upon for various and sundry questions about health services, the survey probability sample may not be equally valid for all provider types. For example, the NAMCS samples physicians (as opposed to the NHAMCS which samples clinics).[9] As such, it is likely that PAs and NPs who work autonomously with their own schedule of patients are underrepresented in the probability sample.[14,38] Also, PA/NPs working under some relationship within a physician's office may be functioning as the physician's agent and the physician thus receives the Medicare or Medicaid reimbursement credit instead of the PA/NP under the "incident to clause" of reimbursement.[14] The *incident to* clause is defined as services or supplies furnished as an integral, although incidental, part of the physician's personal professional services in the course of diagnosis or treatment of an injury or illness.

This policy is a potential confounder in private medical practices but not found in integrated prepaid health systems, Community Health Centers, the Veterans Health Administration, Department of Defense, or other federal systems. In those systems the PA or NP is at a higher representation of the medical staff and provides care proportional so.[39] These limitations are counterbalanced by a number of important strengths. First, we used a national dataset with a robust sampling technique that has been validated in a large number of studies. Second, the longitudinal nature of the data and the large number of nationwide samples allow for exploration of trends over time. Last, our examination of proportions rather than absolute numbers permits us to identify changes in POVs and collaborative care robust to temporal changes in population.

CONCLUSIONS

Collaborative medical care that involves a PA or an NP and a physician is growing in American medicine. The finding from this analysis of two 5-year time-spans of patient visits in 2007–2011 and 2012–2016 is that in the recent years collaborative practice has become an integral part of healthcare delivery at physician practices in the U.S. Not only is the presence of PAs and NPs more visible in physician office settings, but their share of visits appears to be growing.

CONTRIBUTORSHIP

SN, TH, and RH were involved in the data analysis, interpretation and drafting the manuscript. All authors reviewed/edited the manuscript and approved the final version.

COMPETING INTERESTS

None declared.

FUNDING

None

FIGURE LEGENDS

Figure 1: Distribution of non-physician providers weighted visits to physician offices by two 5-year time-spans (NAMCS)

Figure 2: Temporal trend of percent of PAs and/or NPs present at a physician office visit: NAMCS 2007–2016

Figure 3: Percent change in major reason for visit between years 2007–2011 and 2012–2016, NAMCS

Figure 4: Risk ratios for the association between specialty visit (primary, medical, surgical) and provider's practice type [(dyad vs solo (Ref.)] in time series 1 (2007–2011) and 2 (2012–2016)

SUPPLEMENTAL FILES

Supplemental Table 1: Physician office visits by provider type, controlling for two 5-year time-span, NAMCS

Supplemental Figure 1: Flow of NAMCS data for study

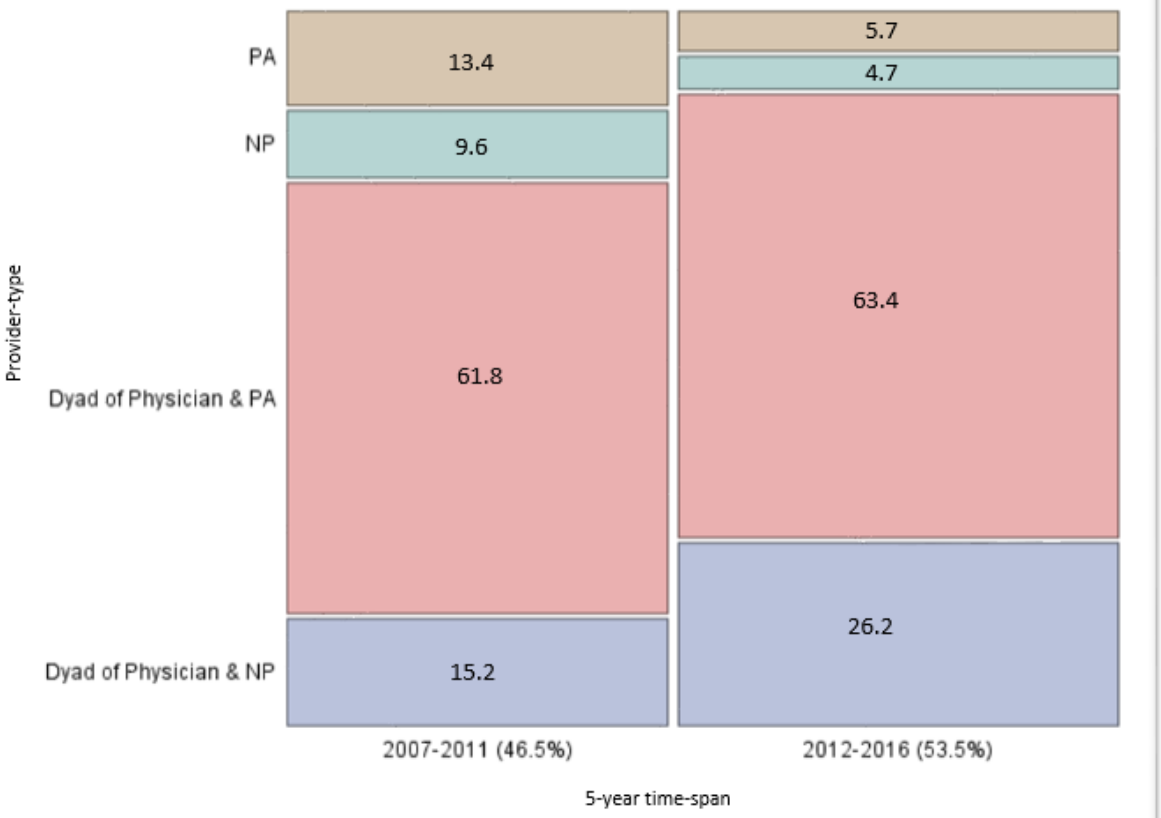
REFERENCES

1. Kimberly J, Cronk I. Making value a priority: how this paradigm shift is changing the landscape in health care. *Annals of the New York Academy of Sciences.* 2016;1381(1):162-167.
2. Dall TM, Gallo PD, Chakrabarti R, West T, Semilla AP, Storm MV. An aging population and growing disease burden will require a large and specialized health care workforce by 2025. *Health affairs (Project Hope).* 2013;32(11):2013-2020.
3. Bauer UE, Briss PA, Goodman RA, Bowman BA. Prevention of chronic disease in the 21st century: elimination of the leading preventable causes of premature death and disability in the USA. *Lancet (London, England).* 2014;384(9937):45-52.

4. Institute of Medicine Committee on the Long-Run Macroeconomic Effects of the Aging USP. The National Academies Collection: Reports funded by National Institutes of Health. In: *Aging and the Macroeconomy: Long-Term Implications of an Older Population.* Washington (DC): National Academies Press (US); 2012.
5. Vecchie A, Dallegri F, Carbone F, et al. Obesity phenotypes and their paradoxical association with cardiovascular diseases. *European journal of internal medicine.* 2018;48:6-17.
6. Kaplan RM, Milstein A. Contributions of Health Care to Longevity: A Review of 4 Estimation Methods. *Ann Fam Med.* 2019;17(3):267-272.
7. AAMC/IHS. *The complexities of physician supply and demand: Projections from 2017 to 2032.* 2019.
8. Morgan P, Everett CM, Humeniuk KM, Valentin VL. Physician assistant specialty choice: distribution, salaries, and comparison with physicians. *JAAPA : official journal of the American Academy of Physician Assistants.* 2016;29(7):46-52.
9. Lau DT, McCaig LF, Hing E. Toward a More Complete Picture of Outpatient, Office-Based Health Care in the U.S. *American journal of preventive medicine.* 2016;51(3):403-409.
10. BLS. Physician Assistants. https://www.bls.gov/ooh/healthcare/physician-assistants.htm. Published 2019. Accessed 5/8/2019.
11. BLS. Nurse Anesthetists, Nurse Midwives, and Nurse Practitioners. https://www.bls.gov/ooh/healthcare/nurse-anesthetists-nurse-midwives-and-nurse-practitioners.htm. Published 2019. Accessed 5/8/2019.
12. Colby SL, Ortman JM. *Projections of the Size and Composition of the U.S. Population: 2014 to 2060, Current Population Reports.* Washington DC: Census Bureau;2014.
13. Aparasu RR, Hegge M. Autonomous ambulatory care by nurse practitioners and physician assistants in office-based settings. *J Allied Health.* 2001;30(3):153-159.
14. Hing E, Hsiao CJ. In which states are physician assistants or nurse practitioners more likely to work in primary care? *JAAPA : official journal of the American Academy of Physician Assistants.* 2015;28(9):46-53.
15. Hing E, Hooker RS, Ashman JJ. Primary health care in community health centers and comparison with office-based practice. *J Community Health.* 2011;36(3):406-413.
16. CDC. Ambulatory health care data. https://www.cdc.gov/nchs/ahcd/. Published 2019. Accessed 15/10/2019, 2019.
17. NCHS. Questionnaires, Datasets, and Related Documentation. https://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm. Published 2017. Accessed.
18. NCHS. National Ambulatory Medical Care Survey (NAMCS) and National Hospital Ambulatory Medical Care Survey (NHAMCS) Restricted Variables. https://www.cdc.gov/rdc/b1datatype/dt1224a.htm. Published 2011. Accessed 31/10/2019, 2019.
19. NCHS. Ambulatory Health Care Data: Frequently Asked Questions. https://www.cdc.gov/nchs/ahcd/ahcd_faq.htm. Published 2019. Accessed 03/10/2019, 2019.
20. Dai M, Ingham RC, Peterson LE. Scope of Practice and Patient Panel Size of Family Physicians Who Work With Nurse Practitioners or Physician Assistants. *Family medicine.* 2019;51(4):311-318.
21. McMichael BJ. Occupational licensing and legal liability: the effect of regulation and litigation on nurse practitioners, physician assistants, and the healthcare system. In: Vanderbilt University Press; 2015.
22. Hooker RS, McMichael BJ. Are physician assistants and nurse practitioners interchangeable? *Journal of the American Academy of Physician Assistants.* 2019;32(8).

23. Davis A, Radix S, Cawley JF, Hooker RS, Walker C. Access and innovation in a time of rapid change: physician assistant scope of practice. *Annals of Health Law.* 2015;24(1):286-336.
24. Buerhaus P. Nurse practitioners: a solution to America's primary care crisis. In: American Enterprise Institute; 2018.
25. Basu S, Phillips RS, Song Z, Bitton A, Landon BE. High levels of capitation payments needed to shift primary care toward proactive team and nonvisit care. *Health affairs (Project Hope).* 2017;36(9):1599-1605.
26. Ray KN, Martsolf GR, Mehrotra A, Barnett ML. Trends in visits to specialist physicians involving nurse practitioners and physician assistants, 2001 to 2013. *JAMA Intern Med.* 2017;177(8):1213-1216.
27. Henry L. Physician assistants, nurse practitioners, and community health centers under the Affordable Care Act. *Human Organization.* 2015;74(1):42.
28. Essary AC, Green EP, Gans DN. Compensation and production in family medicine by practice ownership. *Health Serv Res Manag Epidemiol.* 2016;3:2333392815624111.
29. Hedden L, Barer ML, Cardiff K, McGrail KM, Law MR, Bourgeault IL. The implications of the feminization of the primary care physician workforce on service supply: a systematic review. *Human resources for health.* 2014;12:32.
30. Virani SS, Akeroyd JM, Ramsey DJ, et al. Comparative effectiveness of outpatient cardiovascular disease and diabetes care delivery between advanced practice providers and physician providers in primary care: Implications for care under the Affordable Care Act. *Am Heart J.* 2016;181:74-82.
31. Kurtzman ET, Barnow BS. A Comparison of nurse practitioners, physician assistants, and primary care physicians' patterns of practice and quality of care in health centers. *Med Care.* 2017;55(6):615-622.
32. Morgan PA, Smith VA, Berkowitz TSZ, et al. Impact of physicians, nurse practitioners, and physician assistants on utilization and costs for complex patients. *Health affairs (Project Hope).* 2019;38(6):1028-1036.
33. Everett CM, Morgan P, Jackson GL. Primary care physician assistant and advance practice nurses roles: Patient healthcare utilization, unmet need, and satisfaction. *Healthc (Amst).* 2016;4(4):327-333.
34. Medpac. Improving Medicare's payment policies for advanced practice registered nurses and physician assistants. http://www.medpac.gov/-blog-/the-commission-recommends-aprns-and-pas-bill-medicare-directly-/2019/02/15/improving-medicare's-payment-policies-for-aprns-and-pas. Published 2019. Accessed 19/10/2019, 2019.
35. Leszinsky L, Candon M. Primary care appointments for Medicaid beneficiaries with advanced practitioners. *Ann Fam Med.* 2019;17(4):363-366.
36. Dill MJ, Pankow S, Erikson C, Shipman S. Survey shows consumers open to a greater role for physician assistants and nurse practitioners. *Health affairs (Project Hope).* 2013;32(6):1135-1142.
37. Kilo CM, Wasson JH. Practice redesign and the patient-centered medical home: history, promises, and challenges. *Health affairs (Project Hope).* 2010;29(5):773-778.
38. Morgan PA, Strand J, Ostbye T, Albanese MA. Missing in action: care by physician assistants and nurse practitioners in national health surveys. *Health Serv Res.* 2007;42(5):2022-2037.
39. Moran EA, Basa E, Gao J, Woodmansee D, Almenoff PL, Hooker RS. PA and NP productivity in the Veterans Health Administration. *JAAPA : official journal of the American Academy of Physician Assistants.* 2016;29(7):1-6.

Figure 1: Distribution of non-physician providers weighted visits to physician offices by two 5-year time-spans (NAMCS)



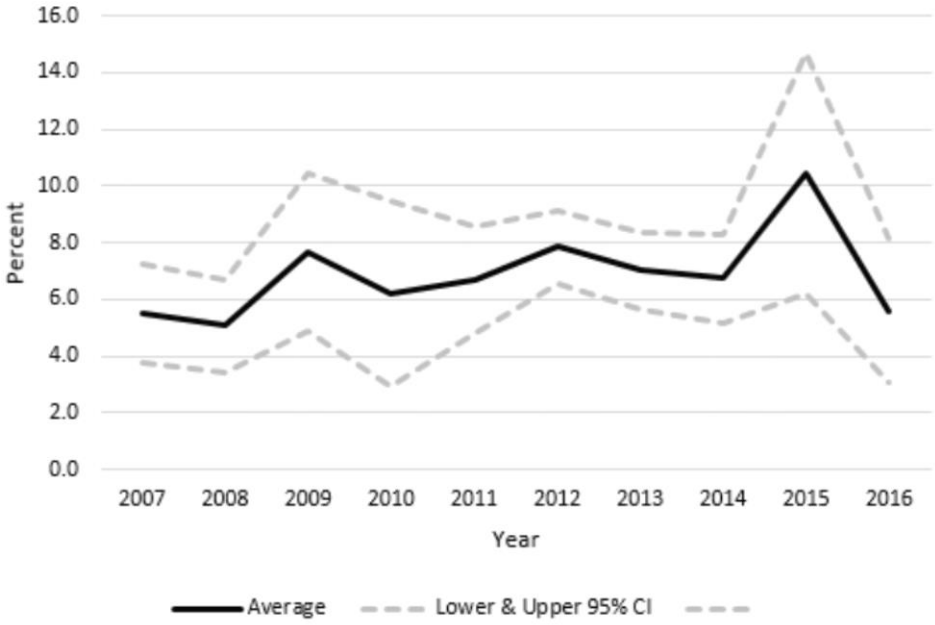


Figure 2: Temporal trend of percent of PAs and/or NPs present at a physician office visit: NAMCS 2007-2016

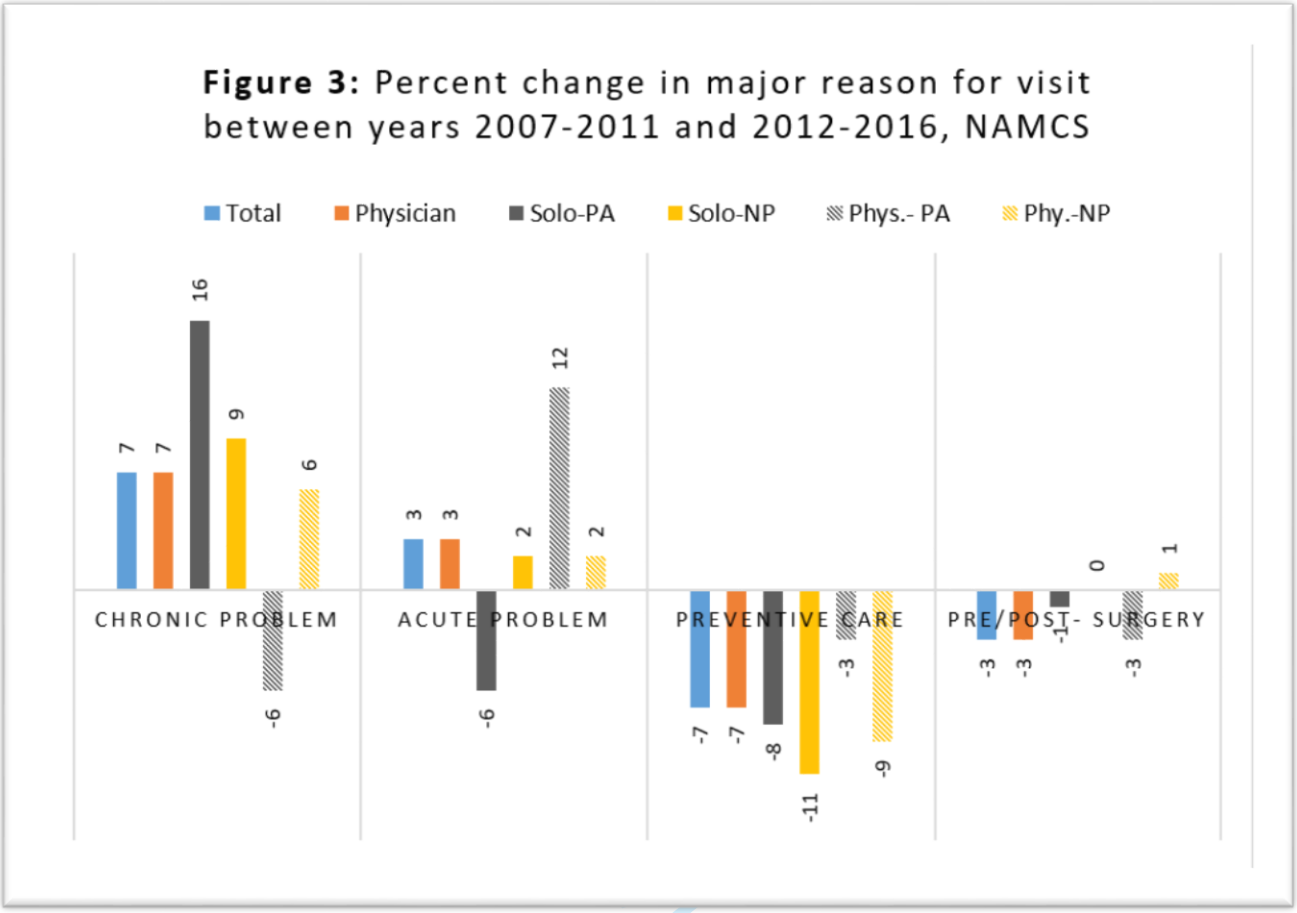
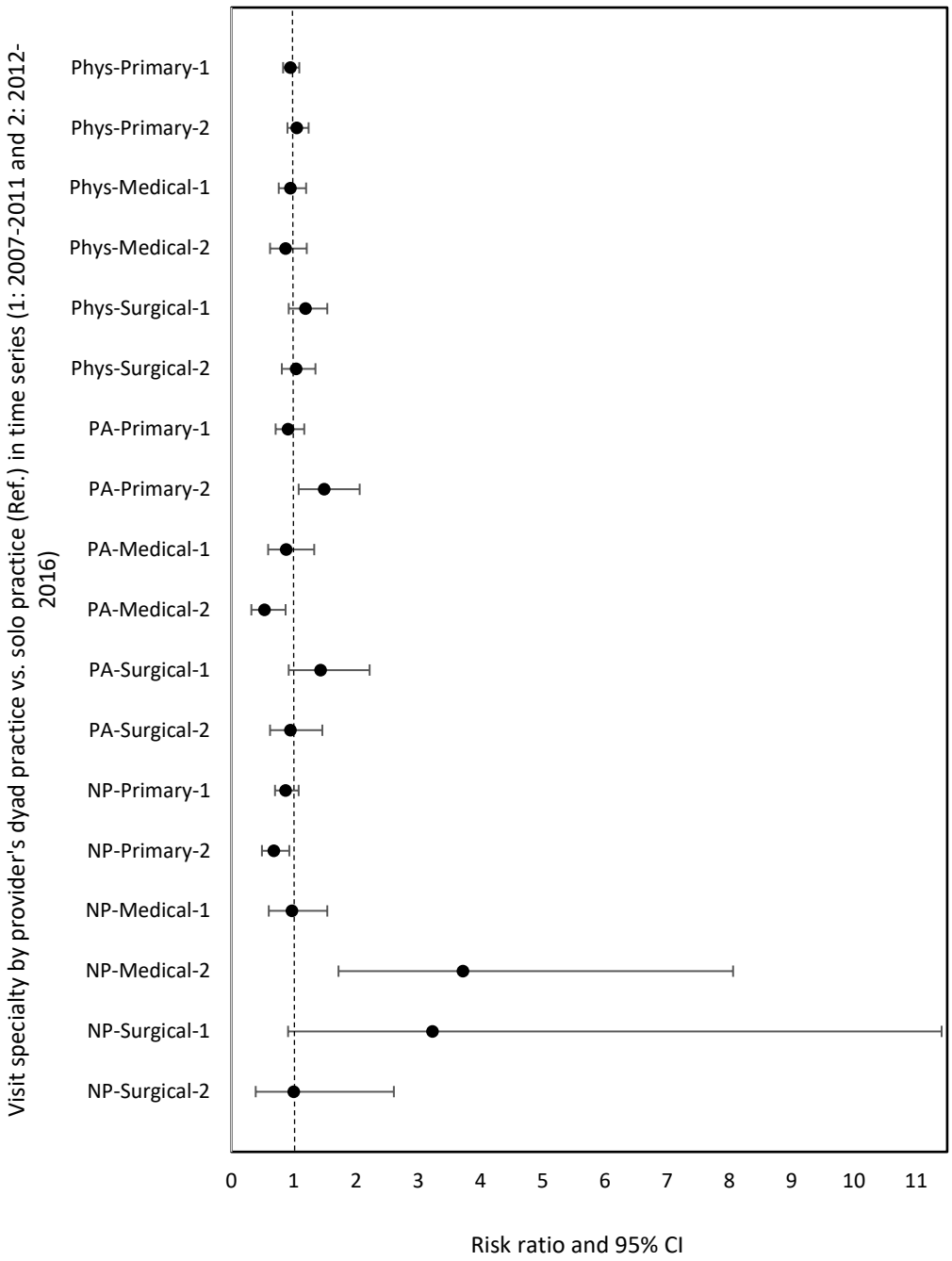
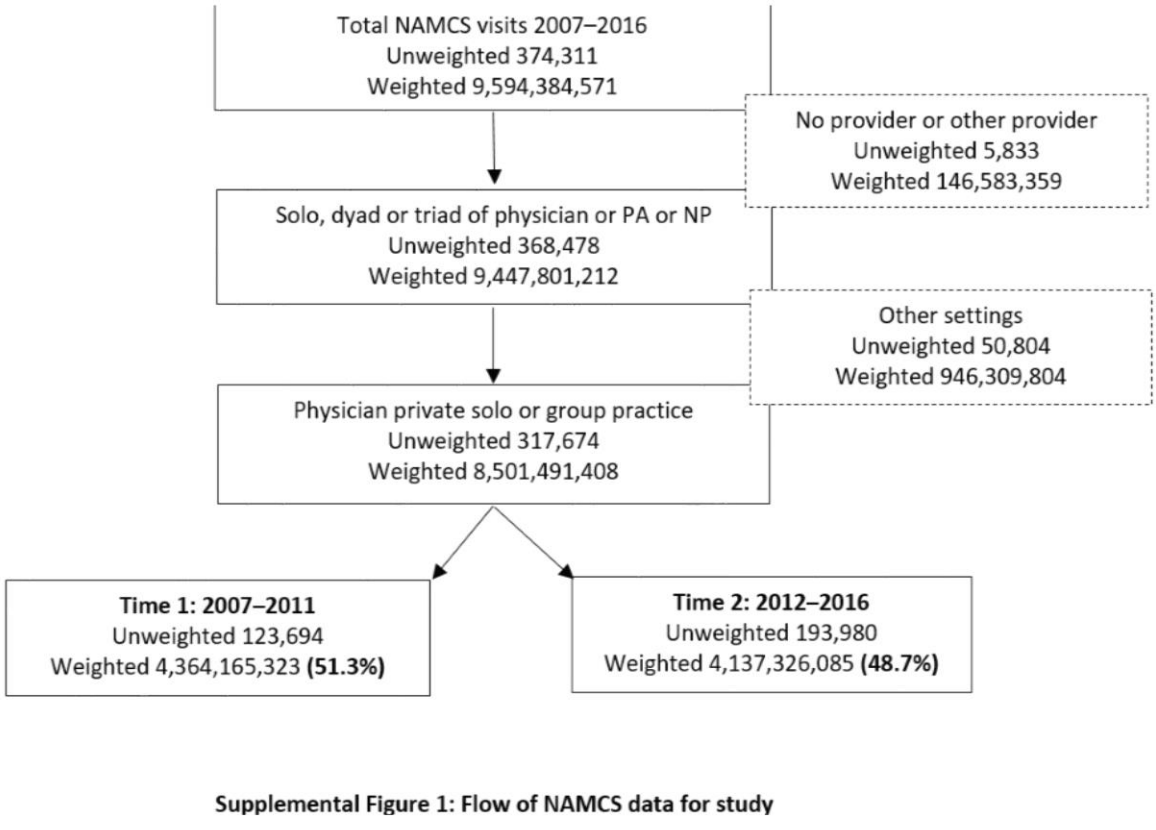


Figure 3: Percent change in major reason for visit between years 2007-2011 and 2012-2016, NAMCS
Total
Physician
Solo-PA
Solo-NP
Phys.- PA
Phy.-NP
CHRONIC PROBLEM
ACUTE PROBLEM
PREVENTIVE CARE
PRE/POST- SURGERY
7
7
16
9
-6
6
3
3
-6
2
12
2
-7
-7
-8
-11
-3
-9
-3
-3
-1
-3
0
1

Figure 4: Risk ratios for the association between specialty visit (primary, medical, surgical) and provider's practice type [dyad vs solo (Ref.)] in time series 1 (2007-2011) and 2 (2012-2016)





Supplemental Figure 1: Flow of NAMCS data for study

Supplemental Table 1: Physician office visits by provider type, controlling for two 5-year time-span, NAMCS

Provider type	Overall[a]		2007–2011[b]		2012–2016[c]		P
	n*1000	% 95% CI	n*1000	% 95% CI	n*1000	% 95% CI	
Solo Physician	7,913,241	93.1 92.1, 94.1	4,091,169	51.7 49.3, 54.1	3,822,071	48.3 45.9, 50.7	.17
Solo-PA	54,498	0.6 0.5, 0.8	36,577	67.1 61.9, 72.3	17,920	32.9 27.7, 38.1	<.01*
Solo-NP	40,844	0.5 0.3, 0.6	26,078	63.8 56.2, 71.5	14,765	36.2 28.5, 43.8	<.01*
Physician-PA	366,711	4.3 3.3, 5.3	168,013	45.8 34.7, 56.9	198,698	54.2 43.1, 65.3	.46
Physician-NP	123,425	1.5 1.1, 1.8	41,308	33.5 25.3, 41.7	82,117	66.5 58.3, 74.7	<.01*
Other Collaborations	2,770	0.03 0.01, 0.05	1,017	36.7 0.0, 84.7	1,753	63.3 15.3, 100.0	.46
Total	8,501,491	100	4,364,165	-	4,137,326	-	

CI: Confidence Interval

[a] Overall 10-year of 2007–2016; [b] Time 1: 5-year time-span of 2007–2011; [c] Time 2: 5-year time-span of 2012–2016

* Significant at alpha=.05

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 the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	2, 5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2, 5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—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 *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	2, 5-6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A 6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	None

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	Supplemental Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		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	7-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-10
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	None
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	None, page 16

*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

COLLABORATIVE PRACTICE TRENDS IN U.S. PHYSICIAN OFFICE VISITS: AN ANALYSIS OF THE NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS), 2007–2016

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Primary Subject Heading:	Health policy
Secondary Subject Heading:	Health policy, Health services research, General practice / Family practice
Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PRIMARY CARE, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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TITLE PAGE

COLLABORATIVE PRACTICE TRENDS IN U.S. PHYSICIAN OFFICE VISITS: AN ANALYSIS OF THE NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS), 2007–2016

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Word Count:
3,715

ABSTRACT

Objective: We characterize collaborative practice arrangements in physician offices by examining the share of visits that involved physician assistants (PAs) and nurse practitioners (NPs). The hypothesis was that team-based care was increasing.

Design: Temporal ecological study

Setting: Nonfederal physician offices

Participants: Patient visits to a physician, PA or NP, spanning years 2007–2016

Methods: A stratified random sample of visits to office-based physicians were pooled through the National Ambulatory Medical Care Survey (NAMCS) public use linkage file. Among 317,674 visits to physicians, PAs or NPs, we described solo and collaborative practices and compared trends over two timespans of 2007–2011, and 2012–2016. This was an assessment of a natural experiment that compared visits' characteristics before and after implementation of the Affordable Care Act of 2010. Weighted patient visits were aggregated in bivariate analyses to achieve nationally representative estimates. Survey statistics assessed patient demographic characteristics, reason for visit, and visit specialty by provider type.

Results: Within years 2007–2011, and 2012–2016 there were 4.4 billion, and 4.1 billion physician office visits (POVs), respectively. Comparing the two timespans, the rate of POVs with a solo PA (0.43% vs 0.21%, P <.01) or NP (0.31% vs 0.17%, P <.01) decreased. Likewise, the rate of POVs with a conjoined Physician-PA (1.98% vs 2.34%, P=0.46) or Physician-NP (0.49% vs. 0.97%, P <.01) increased (adjusted patient and number of chronic conditions OR: 1.35, 95% CI 1.01, 1.79). The temporal change in percent of POVs with a PA or NP with or without a physician was significant (P=0.0499). Preventive visits declined among all providers.

Conclusions: Collaborative care with a physician-PA or -NP appears to be a growing part of office-based healthcare delivery. Furthermore, in 2012–2016 NPs provided more independent primary care, and PAs provided more independent care in a non-primary care medical specialty.

KEYWORDS
Healthcare; Health Policy

Strengths and limitations of this study:

- NAMCS is the leading source of nationally representative data on care delivered in physician offices.
- The data were confined to nonfederal physician office visits attended by physicians, PAs or NPs.
- Results exclude 'non-physicians with independent patient daily rosters and those with independent practices'.
- Due to office-based physicians who do not employ non-physician providers, findings are subject to underestimation.
- Expanding the NAMCS sampling units to non-physician providers can enrich the reliability of the utilization of PAs and NPs.

INTRODUCTION

Patient needs in healthcare are changing as a result of shifts in demographics and disease characteristics.[1-3] For instance, the proportion of the U.S. population over 65 years is increasing, such that by 2050, seniors are projected to make up at least 35% of the total population.[4] Likewise, by the second decade of this century, the occurrence of obesity and diabetes had reached epidemic proportions.[5,6] Aside from the interaction of demographic shifts and the increased burden of disease, the Patient Protection and Affordable Care Act (ACA) expansion of health insurance benefits to an estimated 20 million, mainly low-income Americans, have created more demand for medical services without a concomitant growth in physician services.

The Association of American Medical Colleges predicts a national shortage of 46,000–90,400 physicians by 2025. If this prediction is realized, then the physician workforce pipeline will be inadequate to meet the growing demand.[7] Expanding roles of physician assistants (PAs), nurse practitioners (NPs), and certified nurse midwives (CNMs), as a solution to physician shortages has been discussed.[8,9] This innovative use of health professionals has not gone unnoticed and their utilization has grown nationwide. In 2013, the Bureau of Labor Statistics (BLS) estimated that there were 50,510 PAs and 52,860 NPs. By 2018 the estimates on the number of clinically active physicians and surgeons was at 713,800, NPs at 155,500, and PAs at 106,200, with growth projections from 2016 to 2026 at 13%, 36%, and 37%, respectively.[10,11] During this same 10-year period the U.S. population is expected to grow from 320 to 346 million, further increasing the need to expand the roles of medical provider workforce.[12]

Medical care delivered by physicians, PAs and NPs take place in many locations, including (but not limited to) physician offices, clinics, hospitals, community health centers, and rehabilitation facilities. However, it is physician office visits (POVs) that form the bulwark of ambulatory care in America.[13] And it is in the office setting where PA and NP employment not only began but has grown well into this century.[14,15] After five decades of utilization and deployment we wondered if there was some aspect of healthcare delivery that might have changed in how this care is operationalized. In this study, we turned to the largest and longest running survey of ambulatory care in the U.S., the National Ambulatory Medical Care Survey

(NAMCS). Our intent was to describe trends in use of PAs or NPs for improved modeling of healthcare delivery. More specifically, we wanted to know about POVs by type of provider. There are a number of reasons for this. Consolidation of physician offices has been a trend since the new century.[16] Health insurance policy has evolved in the U.S. during this same period. Concurrently the utilization of PAs and NPs has spread as well. What began primarily as a dependent relationship with physicians the employment of PAs and NPs has evolved into a collaborative one instead. Our objective was to investigate whether significant changes in collaborative practice arrangements are observable over time. Collaboration of a PA or NP-physician is of interest as there is some evidence that team-based care is growing.[9] We build on the previous work in documentation of this shift in the provision of care in POVs.[9,17-19] Important to this investigation is the available documentation on the provider type in a POV across the survey years 2007-2016.

METHODS

Study Design, Data Source, and Setting

A temporal ecological study was undertaken that compared POVs' characteristics across three provider types' (physicians, PAs, and NPs) solo or team-based practice in years 2007–2011 and 2012–2016. The dataset was NAMCS which draws annually on independent samples of physician practices. NAMCS is conducted by the National Center for Health Statistics (NCHS), a component of the Centers for Disease Control and Prevention (CDC), under the Department of Health and Human Services (DHHS). The NAMCS data collection methods have been described in detail.[9,20] Briefly, the NAMCS is a voluntary probability sample survey of patients' visit to nonfederal, office-based physicians and surgeons (group or solo practice). Sampled physicians are selected from the American Medical Association (AMA) and the American Osteopathic Association (AOA) master files.[9] For the objective of this study, i.e., assessing trends in team collaboration in physician offices, we used documentation on the provider type which is captured in the NAMCS Survey Instrument 'Patient Record Form'. Data obtained prior to 2006 differs with the current versions in that all providers in an encounter are systematically collected.[21] As a consequence, we limit our data to 2007–2016, the publicly available data at the time of the study. As the NAMCS

data excludes 'non-physicians with independent patient daily rosters and those with independent practices', and it includes office-based physicians who do not employ any advanced practice providers, our findings are subject to underestimation. [9]

NAMCS Data Availability

Data are available in an open access repository with linkage to access NAMCS, 1973–1992 and NAMCS, 1993–2016.[22] The majority of NAMCS variables are publicly available. Accessing restricted NAMCS variables, through CDC Research Data Center (RDC), is possible.[23] We used publicly available data.

Data Abstraction and Participants

The NAMCS is based on a sample of visits rather than a sample of people.[24] According to the NCHS guideline, survey years with the same Patient Record Form (survey instrument) can be combined.[24] In view of the underestimated visits with a non-physician privider (PAs or NPs), to ensure we had an adequate sample to assess trends in team-based practice, the NAMCS public use linkage was downloaded to create a pooled analysis of 10-years (2007–2016). **Supplemental Figure 1** summarizes the data filtering process. In this investigation, the 2007–2016 years data were concatenated. As providers seen at POVs include visits to physicians, PAs and NPs, as well as other providers (e.g. mental health provider, registered nurse/licensed practical nurse, or other visits without a provider),[21] the data were limited to the visits with at least a physicians or PA or NP seen (irrespective of other providers). Thus, we excluded a small portion (1.6%) of visits not attended by at least one of these three providers. Also as one of the major changes in the NAMCS data collection process over time is related to the community health centers (CHCs) which samples up to 3 providers, whether NP, PA, nurse midwife or physician,[9] this analysis is only centered on visits to the main sampled setting, i.e., POVs, both solo and group practices (86.2%). Additionally, as year to year changes in the sampling frame might introduce an inordinate amount of variability, whereas a longer-term average would be the more robust way to report the results, the pooled data was divided to two 5-year timespans of 2007–2011 and 2012–2016. As the ACA was adopted over time and in different ways across states within the US,

these two timespans can present potential changes in collaborative practice that resulted from this legislation.

Measures of Interest

Provider-types were medical doctors (MDs)/doctors of osteopathy (DOs), PAs, NPs, and CNMs. CNMs and NPs were collapsed to NPs consistent with NCHS protocol, as the number and percentages of CNMs in POVs are considered too small to be calculated separately.[9] We categorized provider-type to:

Solo physician (a physician, without a PA or NP, and irrespective of other providers;

Solo PA (a PA, without a physician or an NP, and irrespective of other providers;

Solo NP (an NP, without a physician or a PA, irrespective of other providers);

or a 'collaborative practice' to mean two different professions (physician-PA or physician-NP) involved in the provision of care during a patient visit, irrespective of other providers seen.[25] Other collaborations included a triad of a physician, NP and PA, or a dyad of NP and PA.

We explored whether collaborative practice differed by patient demographic characteristics, reason for visit, and visit specialty. Patient characteristics included age (categorized as <15, 15–24, 25–44, 45–64, 65–74, and 75+ years), gender, race, and ethnicity (categorized as white, black, and other; and Hispanic/Latino and non-Hispanic/Latino, respectively). Reason for visit were four groups: acute, chronic (i.e. routine or flare-up), pre-/post- surgery, and preventive care. Type of visit specialty were primary care, medical specialty, and surgical specialty. NAMCS excludes physicians in the specialties of anesthesiology, pathology, and radiology, and their designated sub-specialties.[9]

Statistical Analysis

We accounted for the complex survey design, included strata and cluster, and applied patient visit weights to all analyses to achieve nationally representative estimates and confidence intervals. Patient demographic characteristics, reason for visit, and visit specialty by provider-type were stratified for sub-group analyses and comparisons within the two 5-year timespans. Chi-square test was used to compare parameter estimates over time.. To assess the probability

of collaborative work we adjusted for the covariates of patient age, number of chronic conditions and their interaction. The *a priori* alpha value was set at 0.05. Findings are generalizable to physician offices across the U.S. All statistical analyses were performed using SAS software 9.4 (SAS, Hickory, North Carolina).

Patient and Public Involvement

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

RESULTS

There were an estimated 8.5 billion patient visits to physician offices between 2007–2016 (10 years). Two time periods were examined; Time 1 (2007–2011) produced 4.4 billion POVs (51.3% of the total), and Time 2 (2012–2016) produced 4.1 billion POVs (48.7%) **(Supplemental Figure 1)**. Solo physicians had the highest proportion of visits, followed by Physician-PA, Physician-NP, solo-PA, solo-NP, and other collaborations (P <.01). However, despite this ranking similarity between Times 1 and 2, the unadjusted proportion of visits per provider differed significantly between these two timespans (P <.01) **(Supplemental Table 1)**.

To visualize the two quantifiable timespan visits a mosaic plot was selected. **Figure 1** shows the unadjusted proportion of POVs provided by each provider type (solo or dyad, excluding solo-Physician) across the two 5-year intervals. Comparing the two timespans, the absolute rate of POVs with a solo PA (0.43% vs 0.21%, P <.01) or NP (0.31% vs 0.17%, P <.01) decreased. Likewise, the rate of POVs with a conjoined Physician-PA (1.98% vs 2.34%, P=0.46) or Physician-NP (0.49% vs. 0.97%, P <.01) increased. Overall, this suggests that collaborative practice, in particular Physician-NP, was increased in recent years (2012–2016) (p <.01), while visits handled by a solo-PA or solo-NP seem to have decreased (P <.01) **(Figure 1)**. When adjusted for POVs' patient age and number of chronic conditions and their interaction, still the probability of team work (Physician-PA or Physician-NP and other collaborations) in years 2012-2016 compared to

years 2007–2011 was significantly higher, odds ratio (OR) 1.35, 95% confidence interval (CI) 1.01, 1.79.

The 2007–2016 percent of PAs and/or NPs at a POV show an increasing trend (P=0.05). The highest annual percentage of POVs with PA or NP solo or collaborative work was seen in 2015 (10.5%, 95% CI 6.2, 14.7) and the lowest in 2007 (5.5%, 95% CI 3.7, 7.3), and 2016 (5.6%, 95% CI 3.1, 8.1) **(Figure 2)**. When we adjust for the POVs' patient age and number of chronic conditions, the probability of higher visits with a PA or NP, with or without an MD is insignificant (OR: 1.03, 95% CI 0.99, 1.06). A slight decrease in solo physician visits was also seen in recent years (P=.17) **(Supplemental Table 1)**.

Patient Characteristics

Number of chronic conditions: The mean number of patient chronic conditions in Time 2 compared to Time 1 was significantly higher, 1.28 (95% CI 1.23, 1.32) vs 1.16 (95% CI 1.11, 1.21). The demographics for patients by provider type within the two time-spans are presented in Table 1A (Time 1) and 1B (Time 2). Of interest are the differences in patient sex, race, and age.

Sex: Overall, irrespective of provider, there was no significant difference in sex distribution of patients (P=.86); women had almost 1.4 times more visits than men across the 10-year period (58.3% female patient visits versus 41.7% male patient visits). When stratified by provider type, despite significant sex distribution within years 2007–2011 (P=.01), patients' sex did not differ by provider within 2012–2016 (P=.36).

Race and ethnicity: No significant differences by patient race were observed between the two timespans (P=.40). When stratified by provider type, compared to the years 2007–2011, patient race for solo-NP was significantly different in the years 2012–2016, with the most increase seen in visits of patients of other races (non-white, non-black) and decrease in visits of black and white patients (P=.01). For the Physician-PA visits there was a significant change in the race pattern between the years of 2007–2011, and 2012–2016. The most dramatic increases were seen in visits of patients of other races (non-white, non-black) and decrease in visits of white and black

patients. Overall, no significant changes were seen across the two time periods by ethnicity (P=.10). However, when stratifying by timespans and provider type, for the Physician-PA visits there was a significant increase in proportion of Hispanic patients seen between the years of 2007–2011 and 2012–2016 (from 12.1% to 23.8%, P <.01).

Age: The mean age of patients significantly differed between Time 1 and Time 2 (P <.01). Overall, the number of visits by older patients (≥45) increased (from 56.4% in Time 1 to 59.6% in Time 2). Within years 2007–2011, compared to physicians, PAs and NPs were visited more by patients <45 years old; PAs (56.3%), NPs (60.2%), physicians (43.5%) (P <.01). Within years 2012–2016, compared to physicians, NPs had more patients <45 years (55.3% versus 40.4%, P=.02), while within the same timespan, PA visits of patients <45 years did not differ with physicians (40.3% versus 40.4%, P=.99).

Major Reason for Visit

Overall, irrespective of provider type, reason for visit differed between years 2007–2011 and 2012–2016 (P <.01). In essence, the proportion of acute and chronic visits increased (33.9% versus 36.9%), and (39.0% vs. 45.9%), respectively. The proportion of visits for pre/post-surgery and preventive care decreased (7.0% versus 4.3%), and (20% versus 13.0%), respectively. These changes varied by provider type. For example, in the stratified data by provider type, within Time 1, compared to Time 2, solo-PA visits for preventive care and acute problem decreased (21.3% versus 12.5%), and (40.3% versus 34.0%), respectively; while solo-PA share of chronic problem increased drastically (31.0% vs. 47.3%, P <.01). A similar trend in proportion of acute and chronic problem, as well as preventive care visits was seen among Physician-PA practice between Time 1 and Time 2 was seen (P=.04). The major reason for visits for solo-NP and Physician-NP over time showed less variability. Preventive visits declined among all providers (**Figure 3**).

Visit Specialty

Regardless of provider type, the specialty of visits differed between years 2007–2011 and 2012–2016 (P <.01). Within recent years (2012–2016), proportionally less primary care visits occurred

(52.7% versus 56.7%), and more visits with medical specialty (27.0% versus 22.7%) occurred. Surgical visits remained almost the same between these two timespans. Of note, solo-PA visits had a significant change in specialty pattern with decreased visits with primary care specialty (37.6% versus 56.3%), and increased medical care and surgical care specialties (36.6% versus 25.0%), and (25.8% versus 18.7%), respectively. **Figure 4** illustrates risk ratios of teamwork versus solo work (the reference group) per provider in each timespan independently, stratified by visit specialty (primary, medical, and surgical). Within 2012–2016, PAs had a higher probability of having primary care visits in a dyad practice versus solo (RR 1.49, 95% CI 1.08, 2.06), and less probability of a medical specialty visit in a dyad practice versus solo (RR 0.53, 95% CI 0.32, 0.87). However, within same timespan, primary care visits were more likely as a solo-NP (RR 0.68, 95% CI 0.49, 0.93). For medical specialty care in 2012–2016, NPs had higher probability of working with a physician at a visit (RR 3.72, 95% CI 1.72, 8.06).

Table 1A: Patients' demographic characteristics, stratified by provider type, NAMCS 2007–2011

	n*1000 % (95% Confidence Interval)							
Characteristic	**Total**	**Solo-Phys.**	**Solo-PA**	**Solo-NP**	**Phys.-PA**	**Phys.-NP**	**Other collaboration**	**P**
Sex								
Female	2,547,042	2,387,457	21,125	17,604	96,690	23,610	554	.01
	58.4 (57.6, 59.1)	**58.4 (57.6, 59.1)**	**57.8 (54.2, 61.3)**	**67.5 (62.5, 72.5)**	**57.5 (54.8, 60.3)**	**57.2 (53.9, 60.4)**	**54.5 (31.9, 77.1)**	
Male	1,817,122	1,703,712	15,452	8,474	71,323	17,698	462	
	41.6 (40.9, 42.4)	**41.6 (40.9, 42.4)**	**42.2 (38.7, 45.8)**	**32.5 (27.5, 37.5)**	**42.5 (39.7, 45.2)**	**42.8 (39.6, 46.1)**	**45.5 (22.9, 68.1)**	
Race								
White	3,668,660	3,443,589	31,305	22,994	135,002	35,133	634	-
	84.1 (82.3, 85.8)	**84.2 (82.4, 86.0)**	**85.6 (81.9, 89.2)**	**88.2 (82.0, 94.3)**	**80.4 (76.5, 84.2)**	**85.1 (80.3, 89.8)**	**62.4 (47.3, 77.4)**	
Black	477,217	438,902	3,744	2,707	26,378	5,100	382	
	10.9 (9.3, 12.5)	**10.7 (9.1, 12.3)**	**10.2 (6.8, 13.7)**	**10.4 (4.4, 16.3)**	**15.7 (11.2, 20.2)**	**12.3 (7.7, 17.0)**	**37.6 (22.6, 52.7)**	
Other	218,287	208,677	1,528	376	6,631	1,073		
	5.0 (4.1, 6.0)	**5.1 (4.1, 6.1)**	**4.2 (2.3, 6.1)**	**1.4 (0.2, 2.7)**	**3.9 (2.0, 5.9)**	**2.6 (1.1, 4.1)**	-	
Ethnicity								
Hispanic/Latino	493,353	456,838	7,484	3,584	20,360	5,052	33	.18
	11.3 (9.3, 13.4)	**11.2 (9.1, 13.2)**	**20.5 (13.2, 27.8)**	**13.7 (1.4, 26.1)**	**12.1 (7.5, 16.7)**	**12.2 (5.1, 19.4)**	**3.3 (0.0, 11.0)**	
Non-Hispanic/Latino	3,870,812	3,634,331	29,093	22,494	147,652	36,256	983	
	88.7 (86.7, 90.7)	**88.8 (86.8, 90.9)**	**79.5 (72.2, 86.9)**	**86.3 (73.9, 98.6)**	**87.9 (83.3, 92.5)**	**87.8 (80.6, 95.0)**	**96.7 (89.0, 100)**	
Age								
<15	716,249	667,405	8,692	6,869	22,255	10,847	177	<.01
	16.4 (15.5, 17.4)	**16.3 (15.3, 17.3)**	**23.8 (13.2, 34.3)**	**26.3 (13.9, 38.8)**	**13.2 (8.2,18.3)**	**26.3 (13.8, 38.7)**	**17.5 (8.8, 26.2)**	
15–24	326,815	305,553	3,680	3,293	11,911	2,364	11	
	7.5 (7.2, 7.8)	**7.5 (7.2, 7.8)**	**10.1 (7.2, 12.9)**	**12.6 (9.1, 16.2)**	**7.1 (5.7, 8.5)**	**5.7 (4.1, 7.4)**	**1.1 (0.4, 1.9)**	
25–44	858,223	807,176	8,191	5,545	29,840	7,251	216	
	19.7 (19.0, 20.4)	**19.7 (19.0, 20.4)**	**22.4 (17.3, 27.5)**	**21.3 (15.4, 27.1)**	**17.8 (14.6, 21.0)**	**17.6 (13.4, 21.7)**	**21.3 (13.2, 29.4)**	
45–64	1,287,176	1,208,896	9,082	5,560	53,018	10,253	365	
	29.5 (28.8, 30.1)	**29.5 (28.9, 30.2)**	**24.8 (19.6, 30.0)**	**21.3 (16.2, 26.5)**	**31.6 (28.9, 34.2)**	**24.8 (19.2, 30.4)**	**35.9 (16.9, 55.0)**	
65–74	584,405	544,484	4,213	2,491	27,595	5,441	177	
	13.4 (13.0, 13.8)	**13.3 (12.9, 13.7)**	**11.5 (8.2, 14.9)**	**9.6 (6.0, 13.1)**	**16.4 (14.1, 18.7)**	**13.2 (9.1, 17.3)**	**17.5 (10.4, 24.5)**	
≥75	5,912,954	557,652	2,716	2,317	23,391	5,149	68	
	13.5 (12.9, 14.2)	**13.6 (13.0, 14.3)**	**7.4 (5.0, 9.8)**	**8.9 (5.1, 12.7)**	**13.9 (11.3, 16.5)**	**12.5 (7.8, 17.2)**	**6.7 (0.0, 13.4)**	
Total per provider	**4,364,165**	**4,091,169**	**36,577**	**26,078**	**168,013**	**41,308**	**1,017**	
%*	**100%**	**93.74%**	**0.84%**	**0.60%**	**3.85%**	**0.95%**	**0.02%**	

* The percentages in total rows are percent of provider out of the total visits.

Table 1B: Patients' demographic characteristics, stratified by provider type, NAMCS 2012–2016

Characteristic	Total	Solo-Phys.	Solo-PA	Solo-NP	Phys.-PA	Phys.-NP	Other collaboration	P
	n*1000 **% (95% Confidence Interval)**							
Sex								
Female	2,410,872	2,222,316	9,787	8,107	121,084	48,499	1,076	.36
	58.3 (57.6, 59.0)	**58.1 (57.4, 58.9)**	**54.6 (48.4, 60.8)**	**54.9 (45.5, 64.4)**	**60.9 (56.6, 65.3)**	**59.1 (55.9, 62.2)**	**61.4 (48.7, 74.1)**	
Male	1,726,453	1,599,754	8,133	6,657	77,613	33,618	676	
	41.7 (41.0, 42.4)	**41.9 (41.2, 42.6)**	**45.4 (39.2, 51.6)**	**45.1 (35.6, 54.6)**	**39.1 (34.7, 43.4)**	**40.9 (37.8, 44.1)**	**38.6 (25.9, 51.3)**	
Race								
White	3,457,833	3,207,866	15,800	12,958	149,073	70,607	1,526	<.01
	83.6 (82.4, 84.7)	**83.9 (82.8, 85.1)**	**88.2 (83.7, 92.7)**	**87.8 (81.9, 93.6)**	**75.0 (68.6, 81.4)**	**86.0 (82.8, 89.1)**	**87.0 (75.4, 98.7)**	
Black	434,501	393,206	1,640	1,083	30,356	8,006	207	
	10.5 (9.9, 11.2)	**10.3 (9.7, 10.9)**	**9.2 (5.0, 13.4)**	**7.3 (4.1, 10. 6)**	**15.3 (10.6, 20.0)**	**9.8 (7.5, 12.0)**	**11.9 (0.5, 23.3)**	
Other	244,991	220,998	479	723	19,267	3,502	191	
	5.9 (4.9, 6.9)	**5.8 (4.7, 6.8)**	**2.7 (1.0, 4.3)**	**4.9 (1.0, 8.9)**	**9.7 (6.3, 13.1)**	**4.3 (2.5, 6.1)**	**1.1 (0.0, 2.8)**	
Ethnicity								
Hispanic/Latino	551,903	491,346	3,036	1,903	47,233	8,259	124	<.01
	13.3 (12.3, 14.4)	**12.9 (11.8, 14.0)**	**16.9 (8.6, 25.3)**	**12.9 (4.4, 21.4)**	**23.8 (19.4, 28.2)**	**10.1 (7.6, 12.6)**	**7.1 (3.0, 11.2)**	
Non-Hispan./Latino	3,585,422	3,330,724	14,884	12,862	151,464	73,857	1,629	
	86.7 (85.6, 87.7)	**87.1 (86.0, 88.3)**	**83.1 (74.7, 91.5)**	**87.1 (78.6, 95.6)**	**76.2 (71.8, 80.7)**	**89.9 (87.5, 92.4)**	**92.9 (88.8, 97.0)**	
Age								
<15	593,134	540,191	2,496	3,354	31,860	15,001	229	.02
	14.3 (13.3, 15.4)	**14.1 (13.1, 15.2)**	**13.9 (5.4, 22.4)**	**22.7 (11.7, 33.7)**	**16.0 (9.0, 23.1)**	**18.3 (8.9, 27.7)**	**13.1 (0.0, 30.0)**	
15–24	298,158	278,863	1,349	998	11,239	5,566	142	
	7.2 (6.8, 7.6)	**7.3 (6.9, 7.7)**	**7.5 (4.3, 10.8)**	**6.8 (4.5, 9.1)**	**5.7 (4.0, 7.3)**	**6.8 (4.7, 8.8)**	**8.1 (1.9, 14.3)**	
25–44	778,408	725,937	3,392	3,802	32,094	12,940	241	
	18.8 (18.1, 19.5)	**19.0 (18.3, 19.7)**	**18.9 (14.2, 23.7)**	**25.8 (16.5, 35.0)**	**16.2 (12.0, 20.3)**	**15.8 (12.1, 19.5)**	**13.8 (3.3, 24.2)**	
45–64	1,250,891	1,144,988	5,624	3,683	73,499	22,497	597	
	30.2 (29.5, 30.9)	**30.0 (29.3, 30.6)**	**31.4 (25.7, 37.1)**	**25.0 (17.7, 32.2)**	**37.0 (31.7, 42.3)**	**27.4 (23.4, 31.4)**	**34.1 (24.2, 44.0)**	
65–74	644,858	596,011	2,615	1,732	30,836	13,394	267	
	15.6 (15.1,16.1)	**15.6 (15.1, 16.1)**	**14.6 (10.7, 18.5)**	**11.7 (6.8, 16.6)**	**15.5 (12.4, 18.6)**	**16.3 (11.0, 21.7)**	**15.3 (8.2, 22.4)**	
≥75	571,874	536,079	2,441	1,192	19,168	12,717	275	
	13.8 (13.2, 14.4)	**14.0 (13.4, 14.6)**	**13.6 (9.2, 18.1)**	**8.1 (3.4, 12.8)**	**9.7 (7.7, 11.6)**	**15.5 (11.8, 19.2)**	**15.7 (6.6, 24.8)**	
Total per provider	**4,137,326**	**3,822,071**	**17,920**	**14,765**	**198,698**	**82,117**	**1,753**	
%*	**100%**	**92.38%**	**0.43%**	**0.36%**	**4.80%**	**1.98%**	**0.04%**	

* The percentages in total rows are percent of provider out of the total visits.

DISCUSSION

The results of this analysis are consistent with other observations that collaborative practice has increased at physician offices in the U.S. [26] Simultaneously, there has been a significant shift in the reason for visits handled by a PA or NP or in a collaborative practice. Another important finding is the division of labor that seems to be occurring with American PAs and NPs. PAs are less represented in primary care and more in medical and surgical specialties than NPs. This shifting in roles and utilization has been a US trend at least since 2000 and reported in a number of studies.[27-29]

The increased observation of PAs and NPs in POVs may be due to a number of reasons. For example, the ACA may have influenced the employment of PAs and NPs by physicians at a time when staffing expansion was needed. However, the market (demand) for PAs and NPs began decades before and has been increasing as healthcare service delivery has consolidated and the traditional 'solo physician' model is becoming an anachronism.[16] Growth of PAs and NPs is underway. PAs graduated almost 10,000 and NPs graduated 22,000 in 2018.[30,31]

The interchangeability of PAs and NPs may be at work as well, since salaries are similar when roles are compared.[32,33] Enabling PA and NP legislation by states also expanded during the study timeframe, which may have facilitated greater utilization.[34,35]

Changes in healthcare service delivery trends may partially explain these findings. On the medical side, new arrangements include consolidation of physician offices into medical centers, enlargement of hospitals and number of beds, the emergence of retail clinics, outpatient surgery, and team-based care.[16,36] At the same time, the ubiquity of chronic disease is increasing as an aging population places larger demands on medical systems.[37] The timing of our study, overlapping with the implementation and national roll-out of the ACA, also affords the possibility that this largescale change in federal medical insurance policy may have impacted the growth of collaborative care practices. As a federal policy enactment, the ACA was supportive of PAs and advanced practice registered nurses (APRNs) and may have served as an accelerant for PA and NP program growth.[38]

We find that collaborative care, where the physician-PA or -NP is linked in a patient encounter, is growing in proportion as well.[37] One possible explanation is due to the growth in employment among PAs and NPs. As of 2018 the BLS puts clinically employed PAs at 106,200 and NPs at 155,500.[10,11] Their growth is projected from 2016 to 2026 at 36%, and 37%, respectively with physician growth somewhat lower at 13%.[10,11] This forecast is predicated on increasing demand for healthcare services and decreasing annual physician productivity.[39,40] The growing number of studies on the ability of PAs and NPs to manage complex patients with the same outcome as physicians is not only reassuring but informs a wide variety of health systems that their inclusion in team based medicine may be in the patient's best interest as much as the system's best interest.[41-44]

Two theories might explain the rise in the observed collaborative medical care services. The economic explanation is that a visit with a PA or NP conjoined with a physician is reimbursed by Medicare at 100% of the prevailing community rate. The PA or NP that sees the patient as a sole provider is reimbursed for that visit at 85% of the prevailing rate.[45] The policy stipulates that services must be rendered under the direct supervision of a physician, meaning the physician must be present in the office suite and immediately available.[46] Since the median wage of a PA or NP is less than half that of a family physician this 15% discount in federal reimbursement is considered negligible by some employers.[27] Furthermore, reimbursement of PA and NP services occurs in full in the extensive private insurance system in the US.

The social explanation is that consumers of medical services are more accepting of diverse types of providers as primary care undergoes changes in style and organization.[40] This opens more opportunities for physician practices as well as medical centers, clinics, and other settings to employ PAs and APRNs.[47] After a half century of PAs and NPs providing high-quality healthcare in the U.S., they appear to be well integrated into collaborative relationships in physician office medicine.[48] We also suggest this broad, 10-year observation, sets the stage for more granular investigation about physician-PA or NP collaboration, what it means, and where the margins of collaboration remain. There are suggestions that collaboration contributes to job satisfaction and may decrease burnout rates in family medicine.[49-51]

With regard to the observed decrease in preventive care, we find the decline consistent with other Medicare visits since 2013. Such reduction in preventive care has been the subject of some investigation.[52] A growing shortage of primary care providers and insufficient reimbursement for preventative visits are speculated.

Our study has some limitations. Although the NAMCS is a rich, reliable, and widely used database, in existence since 1973 and freqently drawn upon for various and sundry questions about health services, the question on provider type may not be equally valid for all providers. The NAMCS samples physician.[9] As a result PAs and NPs who work autonomously with their own schedule of patients or those with independent practices are underrepresented. Also the NAMCS includes office-based physicians who do not employ any advanced practice providers.[9] These limitations are counterbalanced by a number of important strengths. First, we used a national dataset with a robust sampling technique that has been validated in a large number of studies over half a century. Second, the longitudinal nature of the data and the large number of nationwide samples allow for exploration of trends over time. Lastly, our examination of proportions rather than absolute numbers permits us to identify changes in POVs and collaborative care reliably enough to identify temporal changes in populations. With an improved NAMCS survey methods, expanding current sampling units to non-physician providers, a trend of higher probability of collaborative practice is warranted.

CONCLUSIONS

Collaborative medical care that involves a PA or an NP and a physician is a growing practice in American medicine. The finding from this analysis of two 5-year timespans of patient visits in 2007–2011 and 2012–2016 is that in the recent years collaborative practice has become an integral part of healthcare delivery at physician practices. Not only is the presence of PAs and NPs more visible in physician office settings, but their share of visits appears to be growing.

CONTRIBUTORSHIP

SN, TH, and RH were involved in the data analysis, interpretation and drafting the manuscript. All authors reviewed/edited the manuscript and approved the final version.

COMPETING INTERESTS

None declared.

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None

ETHICS APPROVAL

As we used the NAMCS publicly available data, not containing identifying variables, this study was determined exempt from review by the authors' Institutional Review Board (IRB 00124136).

FIGURE LEGENDS

Figure 1: Distribution of non-physician providers weighted visits to physician offices by two 5-year timespans (NAMCS)

Figure 2: Temporal trend of percent of PAs and/or NPs present at a physician office visit: NAMCS 2007–2016

Figure 3: Percent change in major reason for visit between years 2007–2011 and 2012–2016, NAMCS

Figure 4: Risk ratios for the association between specialty visit (primary, medical, surgical) and provider's practice type [(dyad vs solo (Ref.)] in time series 1 (2007–2011) and 2 (2012–2016)

SUPPLEMENTAL FILES

Supplemental Table 1: Physician office visits by provider type, controlling for two 5-year timespans, NAMCS

Supplemental Figure 1: Flow of NAMCS data for study

REFERENCES

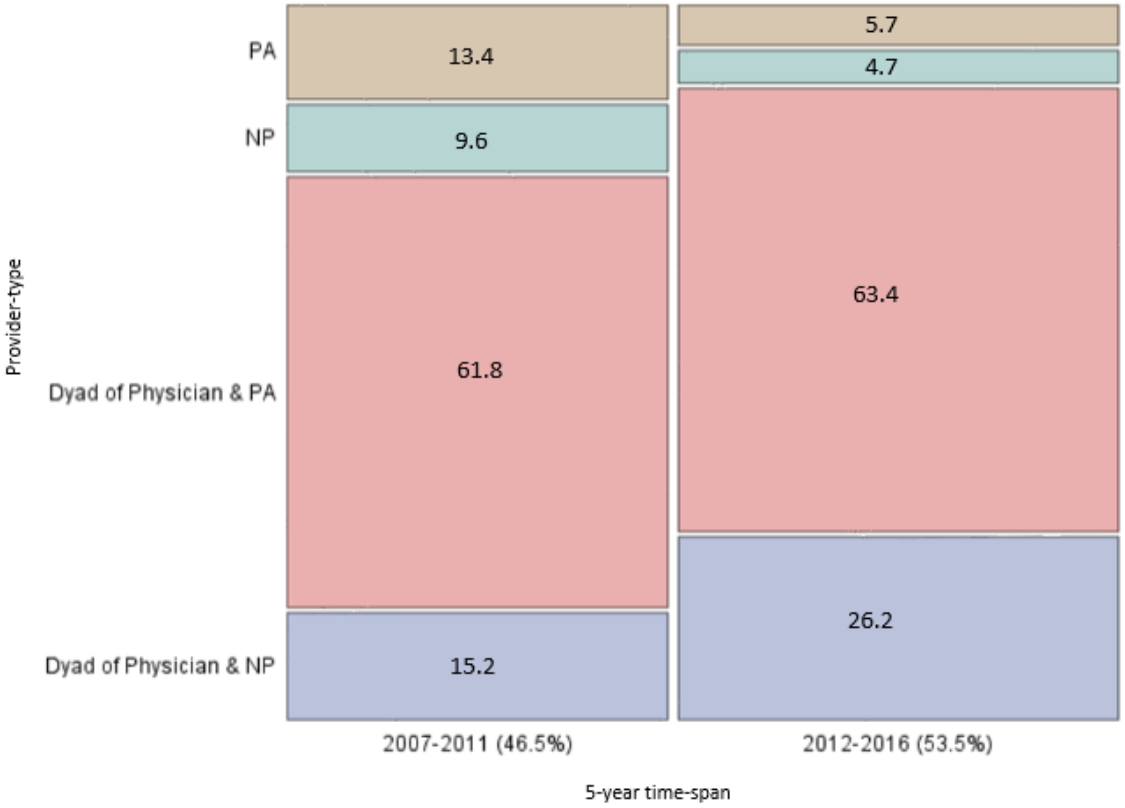
1. Kimberly J, Cronk I. Making value a priority: how this paradigm shift is changing the landscape in health care. *Annals of the New York Academy of Sciences.* 2016;1381(1):162-167.
2. Dall TM, Gallo PD, Chakrabarti R, West T, Semilla AP, Storm MV. An aging population and growing disease burden will require a large and specialized health care workforce by 2025. *Health affairs (Project Hope).* 2013;32(11):2013-2020.
3. Bauer UE, Briss PA, Goodman RA, Bowman BA. Prevention of chronic disease in the 21st century: elimination of the leading preventable causes of premature death and disability in the USA. *Lancet (London, England).* 2014;384(9937):45-52.
4. Institute of Medicine Committee on the Long-Run Macroeconomic Effects of the Aging USP. The National Academies Collection: Reports funded by National Institutes of Health. In: *Aging and the Macroeconomy: Long-Term Implications of an Older Population.* Washington (DC): National Academies Press (US); 2012.
5. Vecchie A, Dallegri F, Carbone F, et al. Obesity phenotypes and their paradoxical association with cardiovascular diseases. *European journal of internal medicine.* 2018;48:6-17.
6. Kaplan RM, Milstein A. Contributions of Health Care to Longevity: A Review of 4 Estimation Methods. *Ann Fam Med.* 2019;17(3):267-272.
7. AAMC/IHS. *The complexities of physician supply and demand: Projections from 2017 to 2032.* 2019.
8. Morgan P, Everett CM, Humeniuk KM, Valentin VL. Physician assistant specialty choice: distribution, salaries, and comparison with physicians. *JAAPA : official journal of the American Academy of Physician Assistants.* 2016;29(7):46-52.
9. Lau DT, McCaig LF, Hing E. Toward a More Complete Picture of Outpatient, Office-Based Health Care in the U.S. *American journal of preventive medicine.* 2016;51(3):403-409.
10. BLS. Physician Assistants. https://www.bls.gov/ooh/healthcare/physician-assistants.htm. Published 2019. Accessed 5/8/2019.
11. BLS. Nurse Anesthetists, Nurse Midwives, and Nurse Practitioners. https://www.bls.gov/ooh/healthcare/nurse-anesthetists-nurse-midwives-and-nurse-practitioners.htm. Published 2019. Accessed 5/8/2019.
12. Colby SL, Ortman JM. *Projections of the Size and Composition of the U.S. Population: 2014 to 2060, Current Population Reports.* Washington DC: Census Bureau;2014.
13. Hooker RS, Benitez JA, Coplan BH, Dehn RW. Ambulatory and chronic disease care by physician assistants and nurse practitioners. *J Ambul Care Manage.* 2013;36(4):293-301.
14. Hooker RS, Cawley JF, Everett CM. *Physician Assistants: Policy and Practice.* 4 ed. Philadelphia: FA Davis; 2017.

15. Fairman J. *Making room in the clinic : nurse practitioners and the evolution of modern health care.* New Brunswick, N.J.: Rutgers University Press; 2008.
16. Kanter GP, Polsky D, Werner RM. Changes in physician consolidation with the spread of accountable care organizations. *Health affairs (Project Hope).* 2019;38(11):1936-1943.
17. Aparasu RR, Hegge M. Autonomous ambulatory care by nurse practitioners and physician assistants in office-based settings. *J Allied Health.* 2001;30(3):153-159.
18. Hing E, Hooker RS, Ashman JJ. Primary health care in community health centers and comparison with office-based practice. *J Community Health.* 2011;36(3):406-413.
19. Hing E, Hsiao CJ. In which states are physician assistants or nurse practitioners more likely to work in primary care? *JAAPA : official journal of the American Academy of Physician Assistants.* 2015;28(9):46-53.
20. CDC. Ambulatory health care data. https://www.cdc.gov/nchs/ahcd/. Published 2019. Accessed 15/10/2019, 2019.
21. CDC. Survey Instruments. https://www.cdc.gov/nchs/ahcd/ahcd_survey_instruments.htm. Published 2019. Accessed 12/10/2019, 2019.
22. NCHS. Questionnaires, Datasets, and Related Documentation. https://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm. Published 2017. Accessed.
23. NCHS. National Ambulatory Medical Care Survey (NAMCS) and National Hospital Ambulatory Medical Care Survey (NHAMCS) Restricted Variables. https://www.cdc.gov/rdc/b1datatype/dt1224a.htm. Published 2011. Accessed 31/10/2019, 2019.
24. NCHS. Ambulatory Health Care Data: Frequently Asked Questions. https://www.cdc.gov/nchs/ahcd/ahcd_faq.htm. Published 2019. Accessed 03/10/2019, 2019.
25. WHO. Interprofessional Collaborative Practice in Primary Health Care: Nursing and Midwifery Perspectives. http://www.who.int/hrh/resources/observer Published 2013. Accessed 12/11/2019, 2019.
26. Dai M, Ingham RC, Peterson LE. Scope of Practice and Patient Panel Size of Family Physicians Who Work With Nurse Practitioners or Physician Assistants. *Family medicine.* 2019;51(4):311-318.
27. Hooker RS, Brock DM, Cook ML. Characteristics of nurse practitioners and physician assistants in the United States. *Journal of the American Association of Nurse Practitioners.* 2016;28(1):39-46.
28. Maier CB, Batenburg R, Birch S, Zander B, Elliott R, Busse R. Health workforce planning: which countries include nurse practitioners and physician assistants and to what effect? *Health policy (Amsterdam, Netherlands).* 2018;122(10):1085-1092.
29. Mafi JN, Wee CC, Davis RB, Landon BE. Comparing use of low-value health care services among US advanced practice clinicians and physicians *Annals of Internal Medicine.* 2016;165(4):237-244.
30. PAEA. *Physician Assistant Education Association, By the Numbers: Program Report 34: Data from the 2018 Program.* Washington DC2019.
31. American-Association-of-Colleges-of-Nursing. 2018-2019 Enrollment and Graduations in Baccalaureate and Graduate Programs in Nursing. In. Washington DC2019.
32. McMichael BJ. Occupational licensing and legal liability: the effect of regulation and litigation on nurse practitioners, physician assistants, and the healthcare system. In: Vanderbilt University Press; 2015.
33. Hooker RS, McMichael BJ. Are physician assistants and nurse practitioners interchangeable? *Journal of the American Academy of Physician Assistants.* 2019;32(8).
34. Davis A, Radix S, Cawley JF, Hooker RS, Walker C. Access and innovation in a time of rapid change: physician assistant scope of practice. *Annals of Health Law.* 2015;24(1):286-336.

35. Buerhaus P. Nurse practitioners: a solution to America's primary care crisis. In: American Enterprise Institute; 2018.
36. Basu S, Phillips RS, Song Z, Bitton A, Landon BE. High levels of capitation payments needed to shift primary care toward proactive team and nonvisit care. *Health affairs (Project Hope).* 2017;36(9):1599-1605.
37. Ray KN, Martsolf GR, Mehrotra A, Barnett ML. Trends in visits to specialist physicians involving nurse practitioners and physician assistants, 2001 to 2013. *JAMA Intern Med.* 2017;177(8):1213-1216.
38. Henry L. Physician assistants, nurse practitioners, and community health centers under the Affordable Care Act. *Human Organization.* 2015;74(1):42.
39. Essary AC, Green EP, Gans DN. Compensation and production in family medicine by practice ownership. *Health Serv Res Manag Epidemiol.* 2016;3:2333392815624111.
40. Hedden L, Barer ML, Cardiff K, McGrail KM, Law MR, Bourgeault IL. The implications of the feminization of the primary care physician workforce on service supply: a systematic review. *Human resources for health.* 2014;12:32.
41. Virani SS, Akeroyd JM, Ramsey DJ, et al. Comparative effectiveness of outpatient cardiovascular disease and diabetes care delivery between advanced practice providers and physician providers in primary care: Implications for care under the Affordable Care Act. *Am Heart J.* 2016;181:74-82.
42. Kurtzman ET, Barnow BS. A Comparison of nurse practitioners, physician assistants, and primary care physicians' patterns of practice and quality of care in health centers. *Med Care.* 2017;55(6):615-622.
43. Morgan PA, Smith VA, Berkowitz TSZ, et al. Impact of physicians, nurse practitioners, and physician assistants on utilization and costs for complex patients. *Health affairs (Project Hope).* 2019;38(6):1028-1036.
44. Everett CM, Morgan P, Jackson GL. Primary care physician assistant and advance practice nurses roles: Patient healthcare utilization, unmet need, and satisfaction. *Healthc (Amst).* 2016;4(4):327-333.
45. Medpac. Improving Medicare's payment policies for advanced practice registered nurses and physician assistants. http://www.medpac.gov/-blog-/the-commission-recommends-aprns-and-pas-bill-medicare-directly-/2019/02/15/improving-medicare's-payment-policies-for-aprns-and-pas. Published 2019. Accessed 19/10/2019, 2019.
46. Leszinsky L, Candon M. Primary care appointments for Medicaid beneficiaries with advanced practitioners. *Ann Fam Med.* 2019;17(4):363-366.
47. Dill MJ, Pankow S, Erikson C, Shipman S. Survey shows consumers open to a greater role for physician assistants and nurse practitioners. *Health affairs (Project Hope).* 2013;32(6):1135-1142.
48. Kilo CM, Wasson JH. Practice redesign and the patient-centered medical home: history, promises, and challenges. *Health affairs (Project Hope).* 2010;29(5):773-778.
49. Henry LR, Hooker RS. Caring for the disadvantaged: the role of physician assistants. *JAAPA : official journal of the American Academy of Physician Assistants.* 2014;27(1):36-42.
50. Reid RJ, Coleman K, Johnson EA, et al. The Group Health medical home at year two: cost savings, higher patient satisfaction, and less burnout for providers. *Health affairs (Project Hope).* 2010;29(5):835-843.
51. Helfrich CD, Dolan ED, Simonetti J, et al. Elements of team-based care in a patient-centered medical home are associated with lower burnout among VA primary care employees. *Journal of general internal medicine.* 2014;29 Suppl 2:S659-666.

52. Chung S, Lesser LI, Lauderdale DS, Johns NE, Palaniappan LP, Luft HS. Medicare annual preventive care visits: use increased among fee-for-service patients, but many do not participate. *Health affairs (Project Hope).* 2015;34(1):11-20.

Figure 1: Distribution of non-physician providers weighted visits to physician offices by two 5-year time-spans (NAMCS)



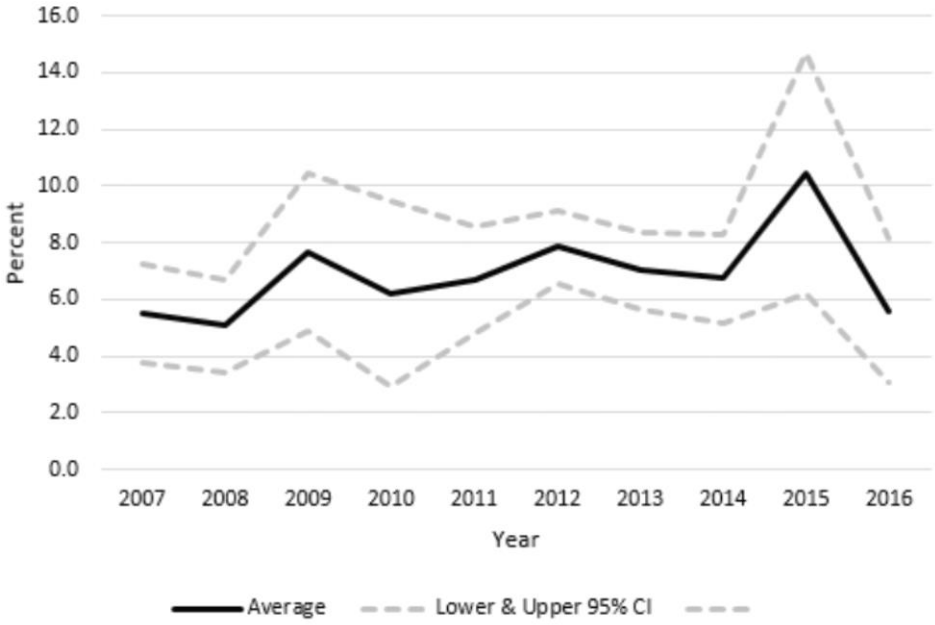


Figure 2: Temporal trend of percent of PAs and/or NPs present at a physician office visit: NAMCS 2007-2016

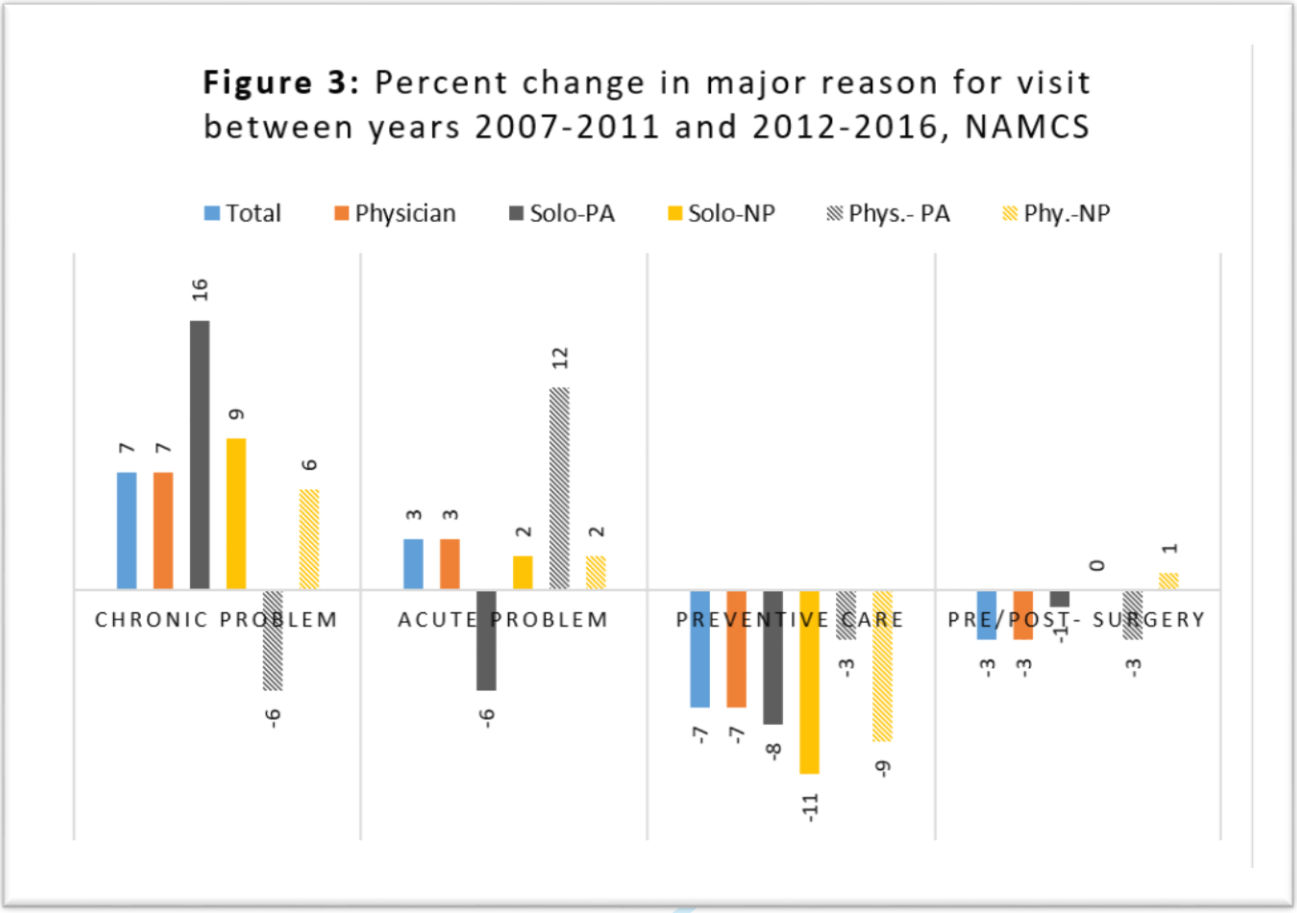
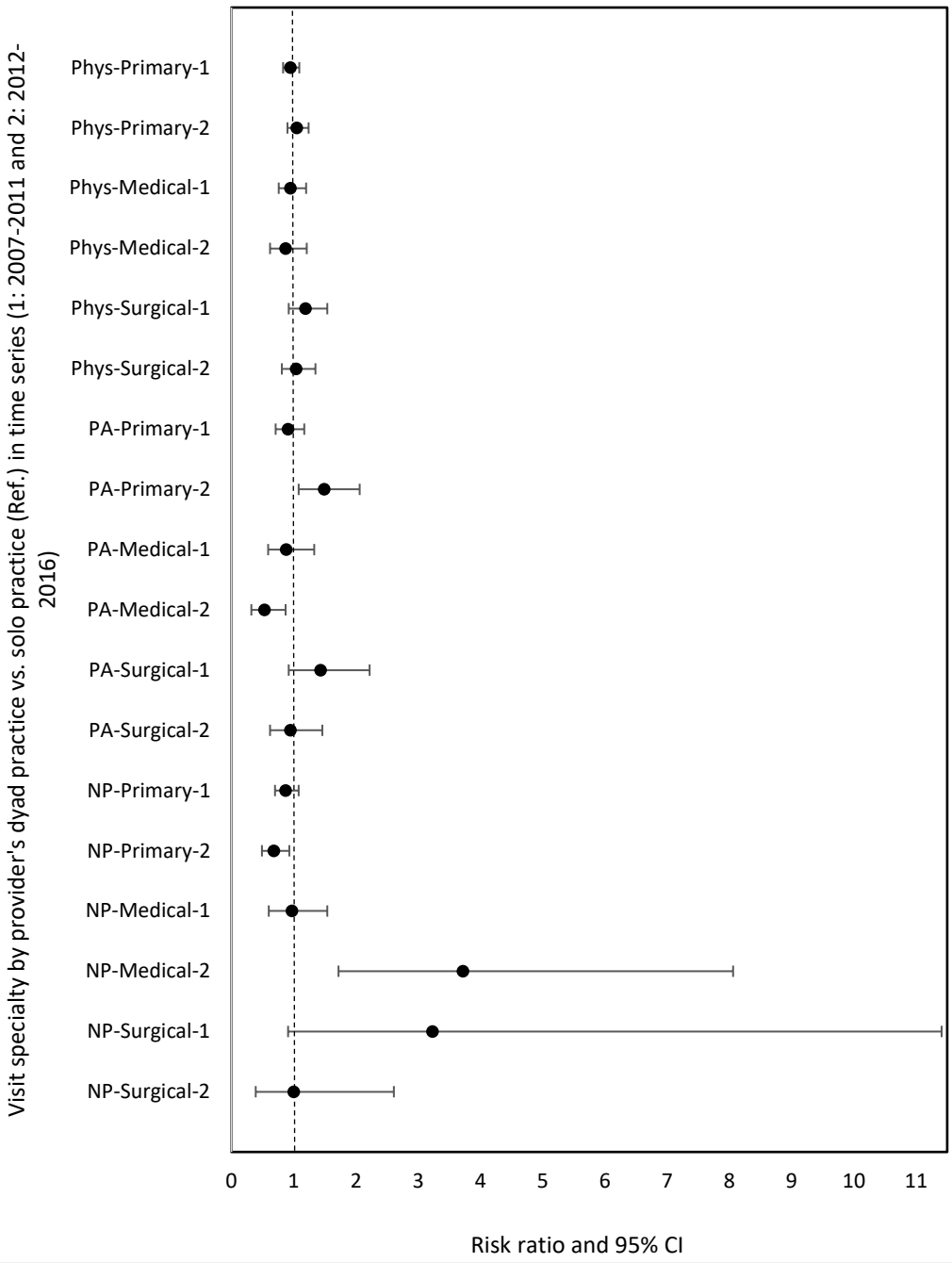
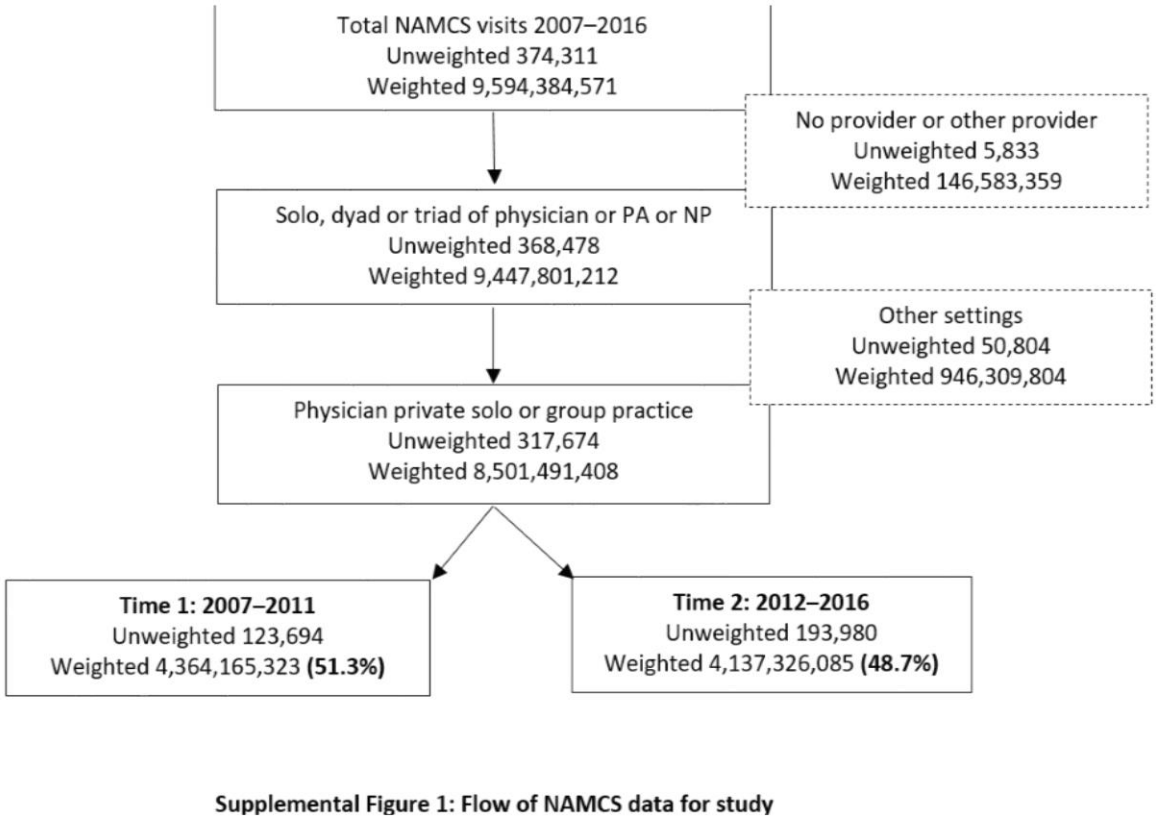


Figure 3: Percent change in major reason for visit between years 2007-2011 and 2012-2016, NAMCS

Figure 4: Risk ratios for the association between specialty visit (primary, medical, surgical) and provider's practice type [dyad vs solo (Ref.)] in time series 1 (2007-2011) and 2 (2012-2016)





Supplemental Figure 1: Flow of NAMCS data for study

Supplemental Table 1: Physician office visits by provider type, controlling for two 5-year time-span, NAMCS

Provider type	Overall[a]		2007–2011[b]		2012–2016[c]		P
	n*1000	% 95% CI	n*1000	% 95% CI	n*1000	% 95% CI	
Solo Physician	7,913,241	93.1 92.1, 94.1	4,091,169	51.7 49.3, 54.1	3,822,071	48.3 45.9, 50.7	.17
Solo-PA	54,498	0.6 0.5, 0.8	36,577	67.1 61.9, 72.3	17,920	32.9 27.7, 38.1	<.01*
Solo-NP	40,844	0.5 0.3, 0.6	26,078	63.8 56.2, 71.5	14,765	36.2 28.5, 43.8	<.01*
Physician-PA	366,711	4.3 3.3, 5.3	168,013	45.8 34.7, 56.9	198,698	54.2 43.1, 65.3	.46
Physician-NP	123,425	1.5 1.1, 1.8	41,308	33.5 25.3, 41.7	82,117	66.5 58.3, 74.7	<.01*
Other Collaborations	2,770	0.03 0.01, 0.05	1,017	36.7 0.0, 84.7	1,753	63.3 15.3, 100.0	.46
Total	8,501,491	100	4,364,165	-	4,137,326	-	

CI: Confidence Interval

[a] Overall 10-year of 2007–2016; [b] Time 1: 5-year time-span of 2007–2011; [c] Time 2: 5-year time-span of 2012–2016

* Significant at alpha=.05

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 the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	2, 5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2, 5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—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 *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	2, 5-6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A 6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	None

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	Supplemental Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		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	7-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-10
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	None
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	None, page 16

*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

COLLABORATIVE PRACTICE TRENDS IN U.S. PHYSICIAN OFFICE VISITS: AN ANALYSIS OF THE NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS), 2007–2016

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Primary Subject Heading:	Health policy
Secondary Subject Heading:	Health policy, Health services research, General practice / Family practice
Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PRIMARY CARE, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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TITLE PAGE

COLLABORATIVE PRACTICE TRENDS IN U.S. PHYSICIAN OFFICE VISITS: AN ANALYSIS OF THE NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS), 2007–2016

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Word Count:
3,719

ABSTRACT

Objective: Practice arrangements in physician offices were characterized by examining the share of visits that involved physician assistants (PAs) and nurse practitioners (NPs). The hypothesis was that collaborative practice (i.e. care delivered by a dyad of physician-PA and/or physician-NP) was increasing.

Design: Temporal ecological study.

Setting: Non-federal physician offices.

Participants: Patient visits to a physician, PA or NP, spanning years 2007–2016.

Methods: A stratified random sample of visits to office-based physicians were pooled through the National Ambulatory Medical Care Survey (NAMCS) public use linkage file. Among 317,674 visits to physicians, PAs, or NPs, solo and collaborative practices were described and compared over two timespans of 2007–2011, and 2012–2016. Weighted patient visits were aggregated in bivariate analyses to achieve nationally representative estimates. Survey statistics assessed patient demographic characteristics, reason for visit, and visit specialty by provider type.

Results: Within years 2007–2011, and 2012–2016 there were 4.4 billion, and 4.1 billion physician office visits (POVs), respectively. Comparing the two timespans, the rate of POVs with a solo PA (0.43% vs 0.21%) or NP (0.31% vs 0.17%) decreased. Likewise, the rate of POVs with collaborative practice [physician-PA (1.98% vs 2.34%) or physician-NP (0.49% vs. 0.97%)] increased. Overall, collaborative practice, in particular physician-NP, has increased in recent years (P <.01), while visits handled by a solo PA or NP decreased (P <.01). . In models adjusted for patient age and chronic conditions, the odds of collaborative practice in years 2012–2016 compared to years 2007–2011 was 35% higher (95% confidence interval 1.01, 1.79). Furthermore, in 2012–2016 NPs provided more independent primary care, and PAs provided more independent care in a non-primary care medical specialty. Preventive visits declined among all providers.

Conclusions: In non-federal physician offices, collaborative care with a physician-PA or -NP appears to be a growing part of office-based healthcare delivery.

KEYWORDS
Healthcare; Health Policy

Strengths and limitations of this study:

- NAMCS is the leading source of nationally representative data on care delivered in physician offices and on-going since 1973.
- The data were confined to nonfederal physician office visits attended by physicians, PAs, or NPs.
- Results excluded PAs, or NPs with independent patient daily rosters and those with independent practices.
- Due to office-based physicians who do not employ PAs or NPs, findings are subject to underestimation of the role of these providers.
- Expanding the NAMCS sampling units can enrich the reliability of the utilization of PAs and NPs in American medicine.

COLLABORATIVE PRACTICE TRENDS IN U.S. PHYSICIAN OFFICE VISITS: AN ANALYSIS OF THE NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS), 2007–2016

INTRODUCTION

Patient needs in healthcare are changing as a result of shifts in demographics and disease characteristics.[1-3] For instance, the proportion of the U.S. population over 65 years is increasing, such that by 2050, seniors are projected to make up at least 35% of the total population.[4] Likewise, by the second decade of this century, the occurrence of obesity and diabetes had reached epidemic proportions.[5,6] Aside from the interaction of demographic shifts and the increased burden of disease, the Patient Protection and Affordable Care Act (ACA) expansion of health insurance benefits to an estimated 20 million, mainly low-income Americans, have created more demand for medical services without a concomitant growth in physician services.

The Association of American Medical Colleges predicts a national shortage of 46,000–90,400 physicians by 2025. If this prediction is realized, then the physician workforce pipeline will be inadequate to meet the growing demand.[7] Expanding roles of physician assistants (PAs), nurse practitioners (NPs), and certified nurse midwives (CNMs), as a solution to physician shortages has been discussed.[8,9] This innovative use of health professionals has not gone unnoticed and their utilization has grown nationwide. In 2013, the Bureau of Labor Statistics (BLS) estimated that there were 50,510 PAs and 52,860 NPs. By 2018 the estimates on the number of clinically active physicians and surgeons was at 713,800, NPs at 155,500, and PAs at 106,200, with growth projections from 2016 to 2026 at 13%, 36%, and 37%, respectively.[10,11] During this same 10-year period the U.S. population is expected to grow from 320 to 346 million, further increasing the need to expand the roles of the medical provider workforce.[12]

Medical care delivered by physicians, PAs, and NPs takes place in many locations, including (but not limited to) physician offices, clinics, hospitals, community health centers, and rehabilitation facilities. However, it is physician office visits (POVs) that form the bulwark of

ambulatory care in America.[13] And it is in the office setting where PA and NP employment not only began, but has grown well into this century.[14,15] After five decades of utilization and deployment of PAs and NPs, it is possible that how this care is operationalized in physician offices has changed.

To address this question of organizational change in outpatient medicine we turned to the largest and longest running survey of ambulatory care in the U.S., the National Ambulatory Medical Care Survey (NAMCS). Our intent was to describe trends in use of PAs or NPs for improved modeling of healthcare delivery. More specifically, we wanted to examine trends in POVs by type of provider, as well as collaborative visits between providers. There are a number of reasons for this. Consolidation of physician offices has been a trend since the new century;[16] and health insurance policy has evolved in the U.S. during this same period. Concurrently the utilization of PAs and NPs has increased. What began primarily as a dependent relationship with physicians, the employment of PAs and NPs has evolved into a collaborative one instead. Our objective was to build upon the previous work in documentation of this shift in the provision of care in POVs,[9,17-19] by investigating whether significant changes in collaborative practice arrangements are observable over time. Collaboration between a PA or NP and physician is of interest, as there is some evidence that team-based care is growing.[9]

METHODS

Study Design, Data Source, and Setting

A temporal ecological study was undertaken that compared POVs' characteristics across three provider types (physicians, PAs, and NPs) solo or team-based practice in years 2007–2011 and 2012–2016. The dataset was NAMCS which draws annually on independent samples of physician practices. NAMCS is conducted by the National Center for Health Statistics (NCHS), a component of the Centers for Disease Control and Prevention (CDC), under the Department of Health and Human Services (DHHS). The NAMCS data collection methods have been described in detail.[9,20-22] Briefly, the NAMCS is a voluntary probability sample survey of patient visits to nonfederal, office-based physicians and surgeons (group or solo practice). Sampled physicians are selected from the American Medical Association (AMA) and the American Osteopathic Association (AOA)

master files.[9] For the objective of this study, i.e., assessing trends in collaborative practice in physician offices, we used documentation on the provider type which is captured in the NAMCS Survey Instrument 'Patient Record Form'. Data obtained prior to 2006 differs with the current versions in that all providers in an encounter are systematically collected.[23] As a consequence, we limit our data to 2007–2016, the publicly available data at the time of the study. As the NAMCS data excludes PAs or NPs with independent patient daily rosters and those with independent practices, and it includes office-based physicians who do not employ PAs or NPs, our findings are subject to underestimation. [9] However, as there is not a reason to assume that estimation accuracy varies differentially over time, time trends in provider practice, and specifically collaborative practice, should accurately reflect changes in care delivery within U.S. POVs and are the focus of our current analysis.

Data Abstraction and Participants

The NAMCS is based on a sample of visits rather than a sample of people.[24] According to the NCHS guideline, survey years with the same *Patient Record Form* (survey instrument) can be combined.[24] In view of the underestimated visits with PAs or NPs, and to ensure we had an adequate sample to assess trends in team-based practice, the NAMCS public use linkage was downloaded to create a pooled analysis of 10-years (2007–2016). **Supplemental Figure 1** summarizes the data filtering process. In this investigation, the 2007–2016 years data were concatenated. Medical providers seen at POVs include visits to physicians, PAs, and NPs, but may include other providers (e.g. mental health provider, registered nurse/licensed practical nurse, or other visits without a provider).[23] The data were restricted to the visits with at least a physician or PA or NP seen (irrespective of other providers). Thus, we excluded a small portion (1.6%) of visits not attended by at least one of these three provider types. This analysis is centered on visits to the main sampled setting, i.e., POVs, both solo and group practices (86.2%). Additionally, as year to year changes in the sampling frame might introduce an inordinate amount of variability, whereas a longer-term average would be the more robust way to report the results, the pooled data was divided to two 5-year timespans of 2007–2011 and 2012–2016.

Measures of Interest

Provider-types were medical doctors (MDs)/doctors of osteopathy (DOs), PAs, NPs, and CNMs. CNMs and NPs were collapsed to NPs consistent with NCHS protocol, as the number and percentages of CNMs in POVs are considered too small to be calculated separately.[9] Provider-visits were categorized as:

- Solo physician (a physician, without a PA or NP), irrespective of other providers;
- Solo PA (a PA, without a physician or an NP), irrespective of other providers;
- Solo NP (an NP, without a physician or a PA), irrespective of other providers);
- A 'collaborative practice' (or dyad) to mean two different professions (physician-PA or physician-NP) involved in the provision of care during a patient visit, irrespective of other providers.[25] Other collaborations included a triad of a physician, NP and PA, or a dyad of NP and PA.

We explored whether collaborative practice differed by patient demographic characteristics, reason for visit, and visit specialty. Patient characteristics included age (categorized as <15, 15–24, 25–44, 45–64, 65–74, and 75+ years), gender, race, and ethnicity (categorized as white, black, and other; and Hispanic/Latino and non-Hispanic/Latino, respectively). Reason for visit were four groups: acute, chronic (i.e. routine or flare-up), pre-/post- surgery, and preventive care. Type of visit specialty were primary care, medical specialty, and surgical specialty. NAMCS excludes physicians in the specialties of anesthesiology, pathology, and radiology, and their designated sub-specialties.[9]

Statistical Analysis

To account for the complex survey design, we included strata and cluster, as well as applied patient visit weights to all analyses to achieve nationally representative estimates and confidence intervals. Patient demographic characteristics, reason for visit, and visit specialty by provider-type were stratified for sub-group analyses and comparisons within the two 5-year timespans. Chi-square test was used to compare parameter estimates over time. To assess the probability of collaborative work we adjusted for the covariates of patient age, number of chronic conditions and their interaction. The *a priori* alpha value was set at 0.05. Findings are generalizable to

physician offices across the U.S. All statistical analyses were performed using SAS software 9.4 (SAS, Hickory, North Carolina).

Patient and Public Involvement

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

RESULTS

There were an estimated 8.5 billion patient visits to physician offices between 2007–2016 (10 years). Two time periods were examined: Time 1 (2007–2011) produced 4.4 billion POVs (51.3% of the total); Time 2 (2012–2016) produced 4.1 billion POVs (48.7%) **(Supplemental Figure 1)**. In both timespans, solo physicians had the highest proportion of visits, followed by physician-PA, physician-NP, solo-PA, solo-NP, and other collaborations (P <.01). However, despite this similarity, the unadjusted proportion of visits per provider differed significantly between these two timespans (P <.01) **(Supplemental Table 1)**.

Figure 1 shows the unadjusted proportion of POVs provided by each provider type (solo or dyad, excluding solo physician) across the two 5-year intervals. Comparing the two timespans, the absolute rate of POVs with a solo PA (0.43% vs 0.21%, P <.01) or NP (0.31% vs 0.17%, P <.01) decreased. Likewise, the rate of POVs with a collaborative physician-PA (1.98% vs 2.34%, P=0.46) or physician-NP (0.49% vs. 0.97%, P <.01) increased. Overall, this suggests that collaborative practice, in particular physician-NP, increased in recent years (2012–2016) (p <.01), while visits handled by a solo-PA or solo-NP decreased (P <.01) **(Figure 1)**. When adjusted for patient age, number of chronic conditions, and their interaction, the probability of collaborative practice in years 2012-2016 compared to years 2007–2011 was significantly higher, [odds ratio (OR) 1.35, 95% confidence interval (CI) 1.01, 1.79].

Spanning the 10-year period of observation the percent of PAs and/or NPs at a POV increased (P=0.05). The highest annual percentage of POVs with PA or NP solo or collaborative work was seen in 2015 (10.5%, 95% CI 6.2, 14.7) and the lowest in 2007 (5.5%, 95% CI 3.7, 7.3),

and 2016 (5.6%, 95% CI 3.1, 8.1) **(Figure 2)**. When we adjust for POV patient age and number of chronic conditions, the probability of higher visits with a PA or NP, with or without an MD is insignificant (OR: 1.03, 95% CI 0.99, 1.06). A slight decrease in solo physician visits was also seen in recent years (P=.17) **(Supplemental Table 1)**.

Patient Characteristics

Number of chronic conditions: The mean number of patient chronic conditions in Time 2 compared to Time 1 was significantly higher, [OR 1.28 (95% CI 1.23, 1.32) vs 1.16 (95% CI 1.11, 1.21)].

The demographics for patients by provider type within the two timespans are presented in Table 1A (Time 1) and 1B (Time 2).

Sex: Overall, irrespective of provider, there was no significant difference in sex distribution of patients (P=.86); women had almost 1.4 times more visits than men across the 10-year period (58.3% female patient visits vs 41.7% male patient visits). Within years 2007–2011, sex of patient significantly differed by provider type (P=.01). Within years 2012–2016, no difference in sex of patient by provider type was seen (P=.36).

Race and ethnicity: No significant differences by patient race were observed between the two timespans (P=.40). When stratified by provider type, compared to the years 2007–2011, patient race for solo NP was significantly different in the years 2012–2016, with the most increase seen in visits of patients of other races (non-white, non-black) and decrease in visits of black and white patients (P=.01). For the physician-PA visits, there was a significant change in the race pattern between the years of 2007–2011, and 2012–2016. The most dramatic increases were seen in visits of patients of other races (non-white, non-black) and decrease in visits of white and black patients. In total, no significant changes were seen across the two time periods by ethnicity (P=.10). However, when stratifying by timespans and provider type, for the physician-PA visits there was a significant increase in proportion of Hispanic patients seen between the years of 2007–2011 and 2012–2016 (from 12.1% to 23.8%, P <.01).

Age: The mean age of patients significantly differed between Time 1 and Time 2 (P <.01). Overall, the number of visits by older patients (≥45) increased (from 56.4% in Time 1 to 59.6% in Time 2). Within years 2007–2011, compared to physicians, PAs and NPs were visited more by patients <45 years old; PAs (56.3%), NPs (60.2%), physicians (43.5%) (P <.01). Within years 2012–2016, compared to physicians, NPs had more patients <45 years (55.3% vs 40.4%, P=.02), while within the same timespan, PA visits of patients <45 years did not differ with physicians (40.3% vs 40.4%, P=.99).

Major Reason for Visit

Overall, irrespective of provider type, reason for visit differed between years 2007–2011 and 2012–2016 (P <.01). In essence, the proportion of acute and chronic visits increased (33.9% vs 36.9%), and (39.0% vs. 45.9%), respectively. The proportion of visits for pre/post-surgery and preventive care decreased (7.0% vs 4.3%), and (20% vs 13.0%), respectively. These changes varied by provider type. For example, in the stratified data by provider type, within Time 1, compared to Time 2, solo PA visits for preventive care and acute problem decreased (21.3% vs 12.5%), and (40.3% vs 34.0%), respectively; while solo PA share of chronic problem increased drastically (31.0% vs. 47.3%, P <.01). A similar trend in proportion of acute and chronic problem, as well as preventive care visits was seen among physician-PA practice between Time 1 and Time 2 (P=.04). The major reason for visits for solo NP and physician-NP over time showed less variability. Preventive visits declined among all providers (**Figure 3**).

Visit Specialty

Regardless of provider type, the specialty of visits differed between the two time periods (P <.01). Within recent years (2012–2016), proportionally less primary care visits occurred (52.7% vs 56.7%), and more visits with medical specialty (27.0% vs 22.7%) occurred. Surgical visits remained almost the same between these two timespans. Of note, solo PA visits had a significant change in specialty pattern - notably decreased visits with primary care specialty (37.6% vs 56.3%) and increased medical care and surgical care specialties (36.6% vs 25.0%), and (25.8% vs 18.7%),

respectively. **Figure 4** illustrates risk ratios of collaborative practice versus solo work (the reference group) per provider in each timespan independently, stratified by visit specialty (primary, medical, and surgical). Within 2012–2016, PAs had a higher probability of having primary care visits in a dyad practice versus solo (RR 1.49, 95% CI 1.08, 2.06), and less probability of a medical specialty visit in a dyad practice versus solo (RR 0.53, 95% CI 0.32, 0.87). However, within same timespan, primary care visits were more likely as a solo NP (RR 0.68, 95% CI 0.49, 0.93). For medical specialty care in 2012–2016, NPs had higher probability of working with a physician at a visit (RR 3.72, 95% CI 1.72, 8.06).

Table 1A: Patients' demographic characteristics, stratified by provider type, NAMCS 2007–2011

Characteristic	Total	Solo-Phys.	Solo-PA	Solo-NP	Phys.-PA	Phys.-NP	Other collaboration	P
	n*1000							
	% (95% Confidence Interval)							
Sex								
Female	2,547,042	2,387,457	21,125	17,604	96,690	23,610	554	.01
	58.4 (57.6, 59.1)	**58.4 (57.6, 59.1)**	**57.8 (54.2, 61.3)**	**67.5 (62.5, 72.5)**	**57.5 (54.8, 60.3)**	**57.2 (53.9, 60.4)**	**54.5 (31.9, 77.1)**	
Male	1,817,122	1,703,712	15,452	8,474	71,323	17,698	462	
	41.6 (40.9, 42.4)	**41.6 (40.9, 42.4)**	**42.2 (38.7, 45.8)**	**32.5 (27.5, 37.5)**	**42.5 (39.7, 45.2)**	**42.8 (39.6, 46.1)**	**45.5 (22.9, 68.1)**	
Race								
White	3,668,660	3,443,589	31,305	22,994	135,002	35,133	634	-
	84.1 (82.3, 85.8)	**84.2 (82.4, 86.0)**	**85.6 (81.9, 89.2)**	**88.2 (82.0, 94.3)**	**80.4 (76.5, 84.2)**	**85.1 (80.3, 89.8)**	**62.4 (47.3, 77.4)**	
Black	477,217	438,902	3,744	2,707	26,378	5,100	382	
	10.9 (9.3, 12.5)	**10.7 (9.1, 12.3)**	**10.2 (6.8, 13.7)**	**10.4 (4.4, 16.3)**	**15.7 (11.2, 20.2)**	**12.3 (7.7, 17.0)**	**37.6 (22.6, 52.7)**	
Other	218,287	208,677	1,528	376	6,631	1,073		
	5.0 (4.1, 6.0)	**5.1 (4.1, 6.1)**	**4.2 (2.3, 6.1)**	**1.4 (0.2, 2.7)**	**3.9 (2.0, 5.9)**	**2.6 (1.1, 4.1)**	-	
Ethnicity								
Hispanic/Latino	493,353	456,838	7,484	3,584	20,360	5,052	33	.18
	11.3 (9.3, 13.4)	**11.2 (9.1, 13.2)**	**20.5 (13.2, 27.8)**	**13.7 (1.4, 26.1)**	**12.1 (7.5, 16.7)**	**12.2 (5.1, 19.4)**	**3.3 (0.0, 11.0)**	
Non-Hispanic/Latino	3,870,812	3,634,331	29,093	22,494	147,652	36,256	983	
	88.7 (86.7, 90.7)	**88.8 (86.8, 90.9)**	**79.5 (72.2, 86.9)**	**86.3 (73.9, 98.6)**	**87.9 (83.3, 92.5)**	**87.8 (80.6, 95.0)**	**96.7 (89.0, 100)**	
Age								
<15	716,249	667,405	8,692	6,869	22,255	10,847	177	<.01
	16.4 (15.5, 17.4)	**16.3 (15.3, 17.3)**	**23.8 (13.2, 34.3)**	**26.3 (13.9, 38.8)**	**13.2 (8.2,18.3)**	**26.3 (13.8, 38.7)**	**17.5 (8.8, 26.2)**	
15–24	326,815	305,553	3,680	3,293	11,911	2,364	11	
	7.5 (7.2, 7.8)	**7.5 (7.2, 7.8)**	**10.1 (7.2, 12.9)**	**12.6 (9.1, 16.2)**	**7.1 (5.7, 8.5)**	**5.7 (4.1, 7.4)**	**1.1 (0.4, 1.9)**	
25–44	858,223	807,176	8,191	5,545	29,840	7,251	216	
	19.7 (19.0, 20.4)	**19.7 (19.0, 20.4)**	**22.4 (17.3, 27.5)**	**21.3 (15.4, 27.1)**	**17.8 (14.6, 21.0)**	**17.6 (13.4, 21.7)**	**21.3 (13.2, 29.4)**	
45–64	1,287,176	1,208,896	9,082	5,560	53,018	10,253	365	
	29.5 (28.8, 30.1)	**29.5 (28.9, 30.2)**	**24.8 (19.6, 30.0)**	**21.3 (16.2, 26.5)**	**31.6 (28.9, 34.2)**	**24.8 (19.2, 30.4)**	**35.9 (16.9, 55.0)**	
65–74	584,405	544,484	4,213	2,491	27,595	5,441	177	
	13.4 (13.0, 13.8)	**13.3 (12.9, 13.7)**	**11.5 (8.2, 14.9)**	**9.6 (6.0, 13.1)**	**16.4 (14.1, 18.7)**	**13.2 (9.1, 17.3)**	**17.5 (10.4, 24.5)**	
≥75	5,912,954	557,652	2,716	2,317	23,391	5,149	68	
	13.5 (12.9, 14.2)	**13.6 (13.0, 14.3)**	**7.4 (5.0, 9.8)**	**8.9 (5.1, 12.7)**	**13.9 (11.3, 16.5)**	**12.5 (7.8, 17.2)**	**6.7 (0.0, 13.4)**	
Total per provider	**4,364,165**	**4,091,169**	**36,577**	**26,078**	**168,013**	**41,308**	**1,017**	
%*	**100%**	**93.74%**	**0.84%**	**0.60%**	**3.85%**	**0.95%**	**0.02%**	

* The percentages in total rows are percent of provider out of the total visits.

Table 1B: Patients' demographic characteristics, stratified by provider type, NAMCS 2012–2016

	n*1000 % (95% Confidence Interval)							
Characteristic	**Total**	**Solo-Phys.**	**Solo-PA**	**Solo-NP**	**Phys.-PA**	**Phys.-NP**	**Other collaboration**	**P**
Sex								
Female	2,410,872	2,222,316	9,787	8,107	121,084	48,499	1,076	.36
	58.3 (57.6, 59.0)	**58.1 (57.4, 58.9)**	**54.6 (48.4, 60.8)**	**54.9 (45.5, 64.4)**	**60.9 (56.6, 65.3)**	**59.1 (55.9, 62.2)**	**61.4 (48.7, 74.1)**	
Male	1,726,453	1,599,754	8,133	6,657	77,613	33,618	676	
	41.7 (41.0, 42.4)	**41.9 (41.2, 42.6)**	**45.4 (39.2, 51.6)**	**45.1 (35.6, 54.6)**	**39.1 (34.7, 43.4)**	**40.9 (37.8, 44.1)**	**38.6 (25.9, 51.3)**	
Race								
White	3,457,833	3,207,866	15,800	12,958	149,073	70,607	1,526	<.01
	83.6 (82.4, 84.7)	**83.9 (82.8, 85.1)**	**88.2 (83.7, 92.7)**	**87.8 (81.9, 93.6)**	**75.0 (68.6, 81.4)**	**86.0 (82.8, 89.1)**	**87.0 (75.4, 98.7)**	
Black	434,501	393,206	1,640	1,083	30,356	8,006	207	
	10.5 (9.9, 11.2)	**10.3 (9.7, 10.9)**	**9.2 (5.0, 13.4)**	**7.3 (4.1, 10. 6)**	**15.3 (10.6, 20.0)**	**9.8 (7.5, 12.0)**	**11.9 (0.5, 23.3)**	
Other	244,991	220,998	479	723	19,267	3,502	191	
	5.9 (4.9, 6.9)	**5.8 (4.7, 6.8)**	**2.7 (1.0, 4.3)**	**4.9 (1.0, 8.9)**	**9.7 (6.3, 13.1)**	**4.3 (2.5, 6.1)**	**1.1 (0.0, 2.8)**	
Ethnicity								
Hispanic/Latino	551,903	491,346	3,036	1,903	47,233	8,259	124	<.01
	13.3 (12.3, 14.4)	**12.9 (11.8, 14.0)**	**16.9 (8.6, 25.3)**	**12.9 (4.4, 21.4)**	**23.8 (19.4, 28.2)**	**10.1 (7.6, 12.6)**	**7.1 (3.0, 11.2)**	
Non-Hispan./Latino	3,585,422	3,330,724	14,884	12,862	151,464	73,857	1,629	
	86.7 (85.6, 87.7)	**87.1 (86.0, 88.3)**	**83.1 (74.7, 91.5)**	**87.1 (78.6, 95.6)**	**76.2 (71.8, 80.7)**	**89.9 (87.5, 92.4)**	**92.9 (88.8, 97.0)**	
Age								
<15	593,134	540,191	2,496	3,354	31,860	15,001	229	.02
	14.3 (13.3, 15.4)	**14.1 (13.1, 15.2)**	**13.9 (5.4, 22.4)**	**22.7 (11.7, 33.7)**	**16.0 (9.0, 23.1)**	**18.3 (8.9, 27.7)**	**13.1 (0.0, 30.0)**	
15–24	298,158	278,863	1,349	998	11,239	5,566	142	
	7.2 (6.8, 7.6)	**7.3 (6.9, 7.7)**	**7.5 (4.3, 10.8)**	**6.8 (4.5, 9.1)**	**5.7 (4.0, 7.3)**	**6.8 (4.7, 8.8)**	**8.1 (1.9, 14.3)**	
25–44	778,408	725,937	3,392	3,802	32,094	12,940	241	
	18.8 (18.1, 19.5)	**19.0 (18.3, 19.7)**	**18.9 (14.2, 23.7)**	**25.8 (16.5, 35.0)**	**16.2 (12.0, 20.3)**	**15.8 (12.1, 19.5)**	**13.8 (3.3, 24.2)**	
45–64	1,250,891	1,144,988	5,624	3,683	73,499	22,497	597	
	30.2 (29.5, 30.9)	**30.0 (29.3, 30.6)**	**31.4 (25.7, 37.1)**	**25.0 (17.7, 32.2)**	**37.0 (31.7, 42.3)**	**27.4 (23.4, 31.4)**	**34.1 (24.2, 44.0)**	
65–74	644,858	596,011	2,615	1,732	30,836	13,394	267	
	15.6 (15.1,16.1)	**15.6 (15.1, 16.1)**	**14.6 (10.7, 18.5)**	**11.7 (6.8, 16.6)**	**15.5 (12.4, 18.6)**	**16.3 (11.0, 21.7)**	**15.3 (8.2, 22.4)**	
≥75	571,874	536,079	2,441	1,192	19,168	12,717	275	
	13.8 (13.2, 14.4)	**14.0 (13.4, 14.6)**	**13.6 (9.2, 18.1)**	**8.1 (3.4, 12.8)**	**9.7 (7.7, 11.6)**	**15.5 (11.8, 19.2)**	**15.7 (6.6, 24.8)**	
Total per provider	**4,137,326**	**3,822,071**	**17,920**	**14,765**	**198,698**	**82,117**	**1,753**	
%*	**100%**	**92.38%**	**0.43%**	**0.36%**	**4.80%**	**1.98%**	**0.04%**	

* The percentages in total rows are percent of provider out of the total visits.

DISCUSSION

The results of this analysis are consistent with other observations that collaborative practice has increased at physician offices in the U.S.[26] Simultaneously, there has been a significant shift in the reason for visits handled by a PA or NP or in a collaborative practice. Another important finding is the division of labor that seems to be occurring with American PAs and NPs. PAs are less represented in primary care and more in medical and surgical specialties than NPs. This shifting in roles and utilization has been a U.S. trend at least since 2000 and has been reported in a number of studies.[27-29]

The increased observation of PAs and NPs in POVs may be due to a number of reasons. For example, the ACA may have influenced the employment of PAs and NPs by physicians at a time when staffing expansion was needed. However, the market (demand) for PAs and NPs began decades before and has been increasing as healthcare service delivery has consolidated and the traditional 'solo physician' model is becoming an anachronism.[16] Growth of PAs and NPs is underway. PAs graduated almost 10,000 and NPs graduated 22,000 in 2018.[30,31]

The interchangeability of PAs and NPs may be at work as well, since salaries are similar when roles are compared.[32,33] Enabling PA and NP legislation by states also expanded during the study timeframe, which may have facilitated greater utilization.[34,35]

Changes in healthcare services, the patient population served by the PA, NP, and physician workforce, or the growth of PA programs all may partially explain our findings of increased collaborative practice over time. In terms of healthcare services, these changes have included consolidation of physician offices into medical centers, enlargement of hospitals, the emergence of retail clinics and outpatient surgery centers, and perhaps most germane to our current analysis, an increasing emphasis on team-based care.[16,36] Additionally, the timing of our study, overlapping with the implementation and national roll-out of the ACA, also affords the possibility that this largescale change in federal medical insurance policy may have impacted the growth of collaborative care. As a federal policy enactment, the ACA was supportive of PAs and advanced practice registered nurses (APRNs) and may have served as an accelerant for PA and NP program growth.[37] In terms of changes to the patient population, the increasing prevalence

of chronic disease, coupled with an aging population, produces increased complexity of care required, which may help explain some of the increased collaborative practice we observe in our study.[38] Last, the increased growth in PA programs, and the graduates they produce, may partially explain these findings. As of 2018 the BLS puts clinically employed PAs at 106,200 and NPs at 155,500.[10,11] Their growth is projected from 2016 to 2026 at 36%, and 37%, respectively with physician growth somewhat lower at 13%.[10,11] This forecast is predicated on increasing demand for healthcare services and decreasing annual physician productivity.[39,40] The growing number of studies on the ability of PAs and NPs to manage complex patients with the same outcome as physicians is not only reassuring but informs a wide variety of health systems that their inclusion in team-based medicine may be in the patient's best interest as much as the system's best interest.[41-44]

Two additional theories that might explain the rise in the observed collaborative medical care services are economic and social. The economic explanation is that a visit with a PA or NP conjoined with a physician is reimbursed by Medicare at 100% of the prevailing community rate. The PA or NP that sees the patient as a sole provider is reimbursed for that visit at 85% of the prevailing rate.[45] The policy stipulates that services must be rendered under the direct supervision of a physician, meaning the physician must be present in the office suite and immediately available.[46] Since the median wage of a PA or NP is less than half that of a family physician, this 15% discount in federal reimbursement is considered negligible by some employers.[27] Furthermore, reimbursement of PA and NP services occurs in full in the extensive private insurance system in the U.S.

The social explanation is that consumers of medical services are more accepting of diverse types of providers as primary care undergoes changes in style and organization.[40] This opens more opportunities for physician practices as well as medical centers, clinics, and other settings to employ PAs and APRNs.[47] After a half century of PAs and NPs providing high-quality healthcare in the U.S., they appear to be well integrated into collaborative relationships in physician office medicine.[48] We also suggest this broad, 10-year observation, sets the stage for more granular investigation about physician-PA or NP collaboration, what it means, and where the margins of collaboration remain. There are suggestions that collaboration contributes to job satisfaction

and may decrease burnout rates in family medicine.[49-51] Ultimately, teasing apart the underlying reason for increased collaborative practice is difficult as the extant literature is largely silent on this topic.

With regard to the observed decrease in preventive care, we find the decline consistent with other Medicare visits since 2013. Such reduction in preventive care has been the subject of some investigation.[52] A growing shortage of primary care providers and insufficient reimbursement for preventative visits are speculated.

Our study has some limitations. Although the NAMCS is a rich, reliable, and widely used database, in existence since 1973 and freqently drawn upon for various and sundry questions about health services, the question on provider type may not be equally valid for all providers. The NAMCS samples physician offices[9] and it excludes PAs and NPs who work autonomously with their own schedule of patients or those with independent practices. Also the NAMCS includes office-based physicians who do not employ PAs or NPs.

In summary, we used a national dataset with a robust sampling technique that has been validated in a large number of studies over half a century. Second, the longitudinal nature of the data and the large number of nationwide samples allow for exploration of trends over time. Lastly, our examination of proportions rather than absolute numbers permits us to identify changes in POVs and collaborative care reliably enough to identify temporal changes in populations. [9] What emerged in this study was a trend in healthcare staffing that corroborates other observations that a variety of medical providers may improve flexibility and adaptability of service delivery. [49-51] With an improved NAMCS survey methods, expanding current sampling units to PAs and NPs, the stage is set for exploring this observation.

CONCLUSIONS

We find that collaborative practice, involving a PA or an NP and a physician, is a growing practice in physician office visits. Not only is the presence of PAs and NPs more visible in physician office settings, but their share of visits appears to be rising. The underlying cause, efficiency, and productivity of solo versus collaborative practice in POVs remains to be evaluated.

CONTRIBUTORSHIP

SN, TJH, and RSH were involved in the data analysis, interpretation and drafting the manuscript. All authors reviewed/edited the manuscript and approved the final version.

COMPETING INTERESTS

None declared.

FUNDING

None

ETHICS APPROVAL

As we used the NAMCS publicly available data, not containing identifying variables, this study was determined exempt from review by the authors' Institutional Review Board (IRB 00124136).

NAMCS Data Availability

Data are available in a public, open access repository. NCHS has a public use linkage to access NAMCS, 1973–1992 and NAMCS, 1993–2016. The majority of NAMCS variables are publicly available. Accessing restricted NAMCS variables, through CDC Research Data Center (RDC), is possible. We used publicly available data.

FIGURE LEGENDS

Figure 1: Distribution of non-physician providers weighted visits to physician offices by two 5-year timespans (NAMCS)

Figure 2: Temporal trend of percent of PAs and/or NPs present at a physician office visit: NAMCS 2007–2016

Figure 3: Percent change in major reason for visit between years 2007–2011 and 2012–2016, NAMCS

Figure 4: Risk ratios for the association between specialty visit (primary, medical, surgical) and provider's practice type [(dyad vs solo (Ref.)] in time series 1 (2007–2011) and 2 (2012–2016)

SUPPLEMENTAL FILES

Supplemental Table 1: Physician office visits by provider type, controlling for two 5-year timespans, NAMCS

Supplemental Figure 1: Flow of NAMCS data for study

REFERENCES

1. Kimberly J, Cronk I. Making value a priority: how this paradigm shift is changing the landscape in health care. *Annals of the New York Academy of Sciences.* 2016;1381(1):162-167.
2. Dall TM, Gallo PD, Chakrabarti R, West T, Semilla AP, Storm MV. An aging population and growing disease burden will require a large and specialized health care workforce by 2025. *Health affairs (Project Hope).* 2013;32(11):2013-2020.
3. Bauer UE, Briss PA, Goodman RA, Bowman BA. Prevention of chronic disease in the 21st century: elimination of the leading preventable causes of premature death and disability in the USA. *Lancet (London, England).* 2014;384(9937):45-52.
4. Institute of Medicine Committee on the Long-Run Macroeconomic Effects of the Aging USP. The National Academies Collection: Reports funded by National Institutes of Health. In: *Aging and the Macroeconomy: Long-Term Implications of an Older Population.* Washington (DC): National Academies Press (US); 2012.
5. Vecchie A, Dallegri F, Carbone F, et al. Obesity phenotypes and their paradoxical association with cardiovascular diseases. *European journal of internal medicine.* 2018;48:6-17.
6. Kaplan RM, Milstein A. Contributions of Health Care to Longevity: A Review of 4 Estimation Methods. *Ann Fam Med.* 2019;17(3):267-272.
7. AAMC/IHS. *The complexities of physician supply and demand: Projections from 2017 to 2032.* 2019.

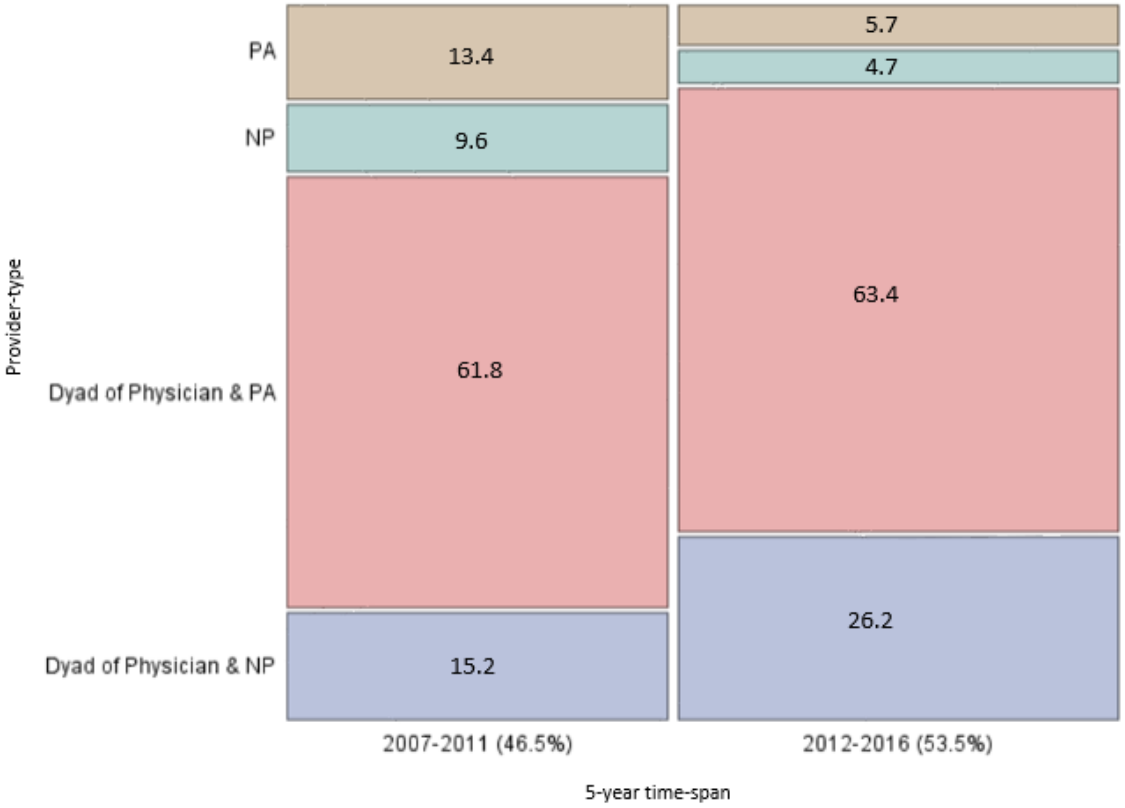
8. Morgan P, Everett CM, Humeniuk KM, Valentin VL. Physician assistant specialty choice: distribution, salaries, and comparison with physicians. *JAAPA : official journal of the American Academy of Physician Assistants.* 2016;29(7):46-52.
9. Lau DT, McCaig LF, Hing E. Toward a More Complete Picture of Outpatient, Office-Based Health Care in the U.S. *American journal of preventive medicine.* 2016;51(3):403-409.
10. BLS. Physician Assistants. https://www.bls.gov/ooh/healthcare/physician-assistants.htm. Published 2019. Accessed 5/8/2019.
11. BLS. Nurse Anesthetists, Nurse Midwives, and Nurse Practitioners. https://www.bls.gov/ooh/healthcare/nurse-anesthetists-nurse-midwives-and-nurse-practitioners.htm. Published 2019. Accessed 5/8/2019.
12. Colby SL, Ortman JM. *Projections of the Size and Composition of the U.S. Population: 2014 to 2060, Current Population Reports.* Washington DC: Census Bureau;2014.
13. Hooker RS, Benitez JA, Coplan BH, Dehn RW. Ambulatory and chronic disease care by physician assistants and nurse practitioners. *J Ambul Care Manage.* 2013;36(4):293-301.
14. Hooker RS, Cawley JF, Everett CM. *Physician Assistants: Policy and Practice.* 4 ed. Philadelphia: FA Davis; 2017.
15. Fairman J. *Making room in the clinic : nurse practitioners and the evolution of modern health care.* New Brunswick, N.J.: Rutgers University Press; 2008.
16. Kanter GP, Polsky D, Werner RM. Changes in physician consolidation with the spread of accountable care organizations. *Health affairs (Project Hope).* 2019;38(11):1936-1943.
17. Aparasu RR, Hegge M. Autonomous ambulatory care by nurse practitioners and physician assistants in office-based settings. *J Allied Health.* 2001;30(3):153-159.
18. Hing E, Hooker RS, Ashman JJ. Primary health care in community health centers and comparison with office-based practice. *J Community Health.* 2011;36(3):406-413.
19. Hing E, Hsiao CJ. In which states are physician assistants or nurse practitioners more likely to work in primary care? *JAAPA : official journal of the American Academy of Physician Assistants.* 2015;28(9):46-53.
20. CDC. Ambulatory health care data. https://www.cdc.gov/nchs/ahcd/. Published 2019. Accessed 15/10/2019, 2019.
21. NCHS. Questionnaires, Datasets, and Related Documentation. https://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm. Published 2017. Accessed.
22. NCHS. National Ambulatory Medical Care Survey (NAMCS) and National Hospital Ambulatory Medical Care Survey (NHAMCS) Restricted Variables. https://www.cdc.gov/rdc/b1datatype/dt1224a.htm. Published 2011. Accessed 31/10/2019, 2019.
23. CDC. Survey Instruments. https://www.cdc.gov/nchs/ahcd/ahcd_survey_instruments.htm. Published 2019. Accessed 12/10/2019, 2019.
24. NCHS. Ambulatory Health Care Data: Frequently Asked Questions. https://www.cdc.gov/nchs/ahcd/ahcd_faq.htm. Published 2019. Accessed 03/10/2019, 2019.
25. WHO. Interprofessional Collaborative Practice in Primary Health Care: Nursing and Midwifery Perspectives. http://www.who.int/hrh/resources/observer Published 2013. Accessed 12/11/2019, 2019.
26. Dai M, Ingham RC, Peterson LE. Scope of Practice and Patient Panel Size of Family Physicians Who Work With Nurse Practitioners or Physician Assistants. *Family medicine.* 2019;51(4):311-318.
27. Hooker RS, Brock DM, Cook ML. Characteristics of nurse practitioners and physician assistants in the United States. *Journal of the American Association of Nurse Practitioners.* 2016;28(1):39-46.

28. Maier CB, Batenburg R, Birch S, Zander B, Elliott R, Busse R. Health workforce planning: which countries include nurse practitioners and physician assistants and to what effect? *Health policy (Amsterdam, Netherlands).* 2018;122(10):1085-1092.
29. Mafi JN, Wee CC, Davis RB, Landon BE. Comparing use of low-value health care services among US advanced practice clinicians and physicians *Annals of Internal Medicine.* 2016;165(4):237-244.
30. PAEA. *Physician Assistant Education Association, By the Numbers: Program Report 34: Data from the 2018 Program.* Washington DC2019.
31. American-Association-of-Colleges-of-Nursing. 2018-2019 Enrollment and Graduations in Baccalaureate and Graduate Programs in Nursing. In. Washington DC2019.
32. McMichael BJ. Occupational licensing and legal liability: the effect of regulation and litigation on nurse practitioners, physician assistants, and the healthcare system. In: Vanderbilt University Press; 2015.
33. Hooker RS, McMichael BJ. Are physician assistants and nurse practitioners interchangeable? *Journal of the American Academy of Physician Assistants.* 2019;32(8).
34. Davis A, Radix S, Cawley JF, Hooker RS, Walker C. Access and innovation in a time of rapid change: physician assistant scope of practice. *Annals of Health Law.* 2015;24(1):286-336.
35. Buerhaus P. Nurse practitioners: a solution to America's primary care crisis. In: American Enterprise Institute; 2018.
36. Basu S, Phillips RS, Song Z, Bitton A, Landon BE. High levels of capitation payments needed to shift primary care toward proactive team and nonvisit care. *Health affairs (Project Hope).* 2017;36(9):1599-1605.
37. Henry L. Physician assistants, nurse practitioners, and community health centers under the Affordable Care Act. *Human Organization.* 2015;74(1):42.
38. Ray KN, Martsolf GR, Mehrotra A, Barnett ML. Trends in visits to specialist physicians involving nurse practitioners and physician assistants, 2001 to 2013. *JAMA Intern Med.* 2017;177(8):1213-1216.
39. Essary AC, Green EP, Gans DN. Compensation and production in family medicine by practice ownership. *Health Serv Res Manag Epidemiol.* 2016;3:2333392815624111.
40. Hedden L, Barer ML, Cardiff K, McGrail KM, Law MR, Bourgeault IL. The implications of the feminization of the primary care physician workforce on service supply: a systematic review. *Human resources for health.* 2014;12:32.
41. Virani SS, Akeroyd JM, Ramsey DJ, et al. Comparative effectiveness of outpatient cardiovascular disease and diabetes care delivery between advanced practice providers and physician providers in primary care: Implications for care under the Affordable Care Act. *Am Heart J.* 2016;181:74-82.
42. Kurtzman ET, Barnow BS. A Comparison of nurse practitioners, physician assistants, and primary care physicians' patterns of practice and quality of care in health centers. *Med Care.* 2017;55(6):615-622.
43. Morgan PA, Smith VA, Berkowitz TSZ, et al. Impact of physicians, nurse practitioners, and physician assistants on utilization and costs for complex patients. *Health affairs (Project Hope).* 2019;38(6):1028-1036.
44. Everett CM, Morgan P, Jackson GL. Primary care physician assistant and advance practice nurses roles: Patient healthcare utilization, unmet need, and satisfaction. *Healthc (Amst).* 2016;4(4):327-333.
45. Medpac. Improving Medicare's payment policies for advanced practice registered nurses and physician assistants. http://www.medpac.gov/-blog-/the-commission-recommends-aprns-and-

pas-bill-medicare-directly-/2019/02/15/improving-medicare's-payment-policies-for-aprns-and-pas. Published 2019. Accessed 19/10/2019, 2019.

46. Leszinsky L, Candon M. Primary care appointments for Medicaid beneficiaries with advanced practitioners. *Ann Fam Med.* 2019;17(4):363-366.
47. Dill MJ, Pankow S, Erikson C, Shipman S. Survey shows consumers open to a greater role for physician assistants and nurse practitioners. *Health affairs (Project Hope).* 2013;32(6):1135-1142.
48. Kilo CM, Wasson JH. Practice redesign and the patient-centered medical home: history, promises, and challenges. *Health affairs (Project Hope).* 2010;29(5):773-778.
49. Henry LR, Hooker RS. Caring for the disadvantaged: the role of physician assistants. *JAAPA : official journal of the American Academy of Physician Assistants.* 2014;27(1):36-42.
50. Reid RJ, Coleman K, Johnson EA, et al. The Group Health medical home at year two: cost savings, higher patient satisfaction, and less burnout for providers. *Health affairs (Project Hope).* 2010;29(5):835-843.
51. Helfrich CD, Dolan ED, Simonetti J, et al. Elements of team-based care in a patient-centered medical home are associated with lower burnout among VA primary care employees. *Journal of general internal medicine.* 2014;29 Suppl 2:S659-666.
52. Chung S, Lesser LI, Lauderdale DS, Johns NE, Palaniappan LP, Luft HS. Medicare annual preventive care visits: use increased among fee-for-service patients, but many do not participate. *Health affairs (Project Hope).* 2015;34(1):11-20.

Figure 1: Distribution of non-physician providers weighted visits to physician offices by two 5-year time-spans (NAMCS)



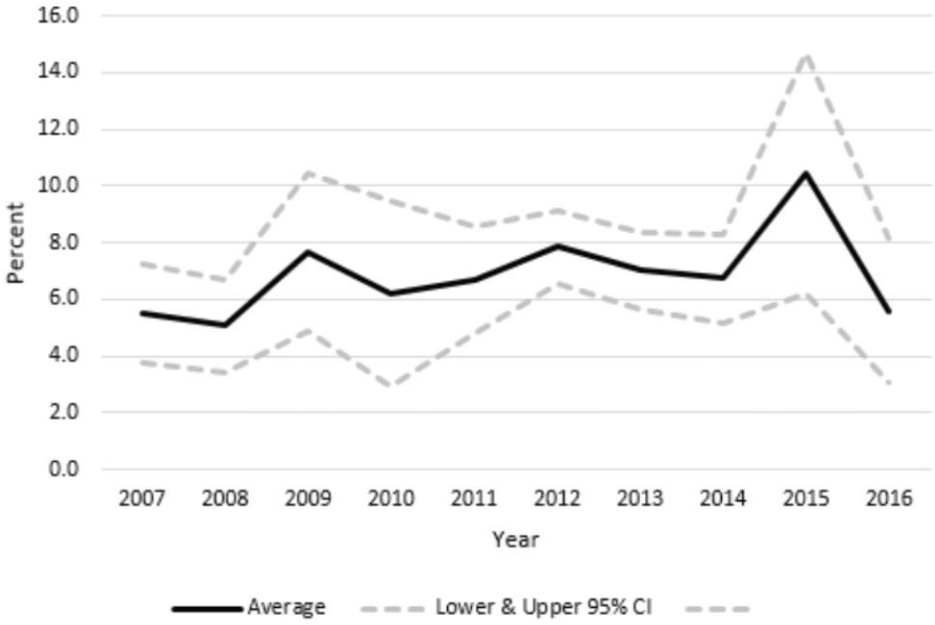


Figure 2: Temporal trend of percent of PAs and/or NPs present at a physician office visit: NAMCS 2007-2016

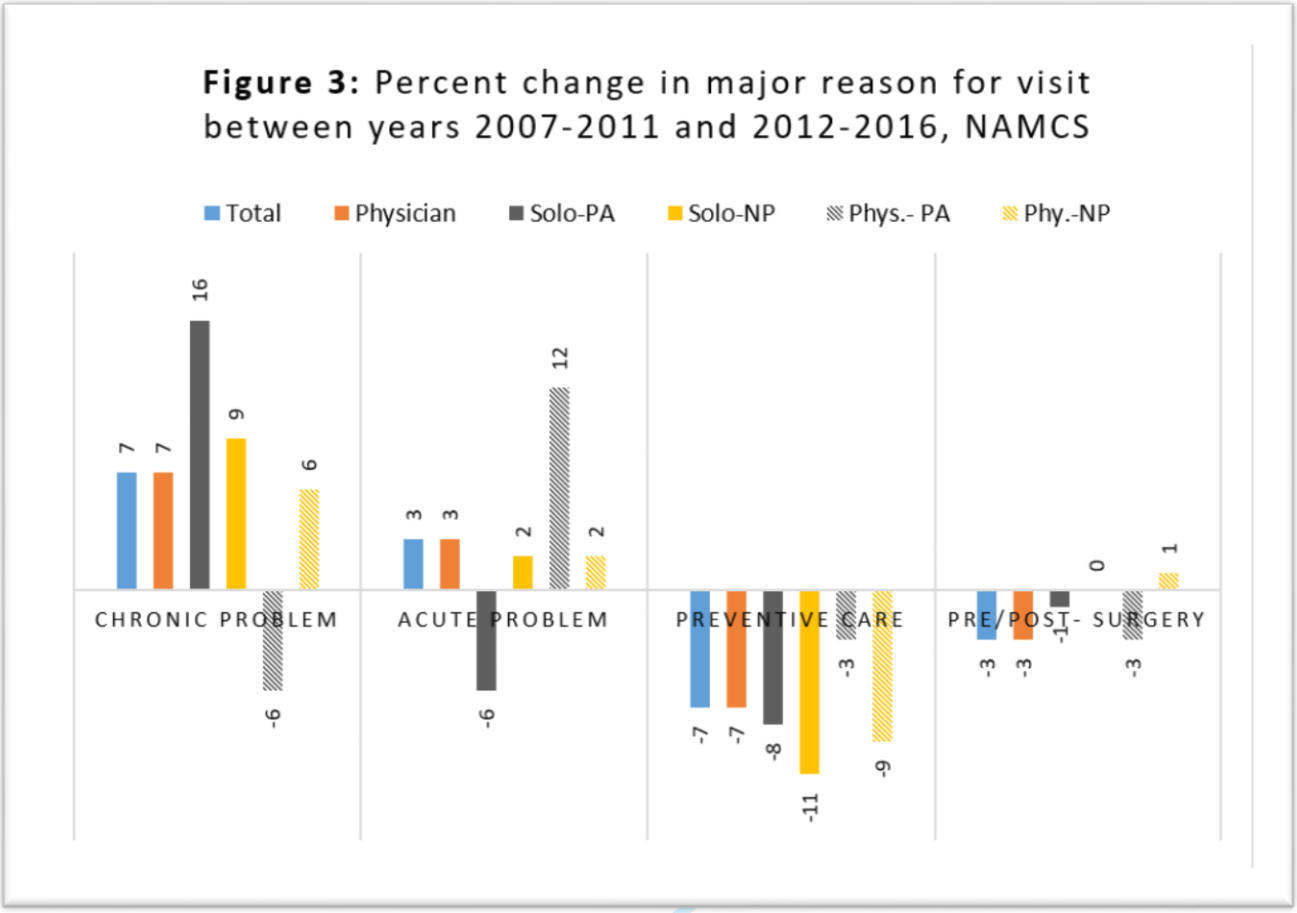
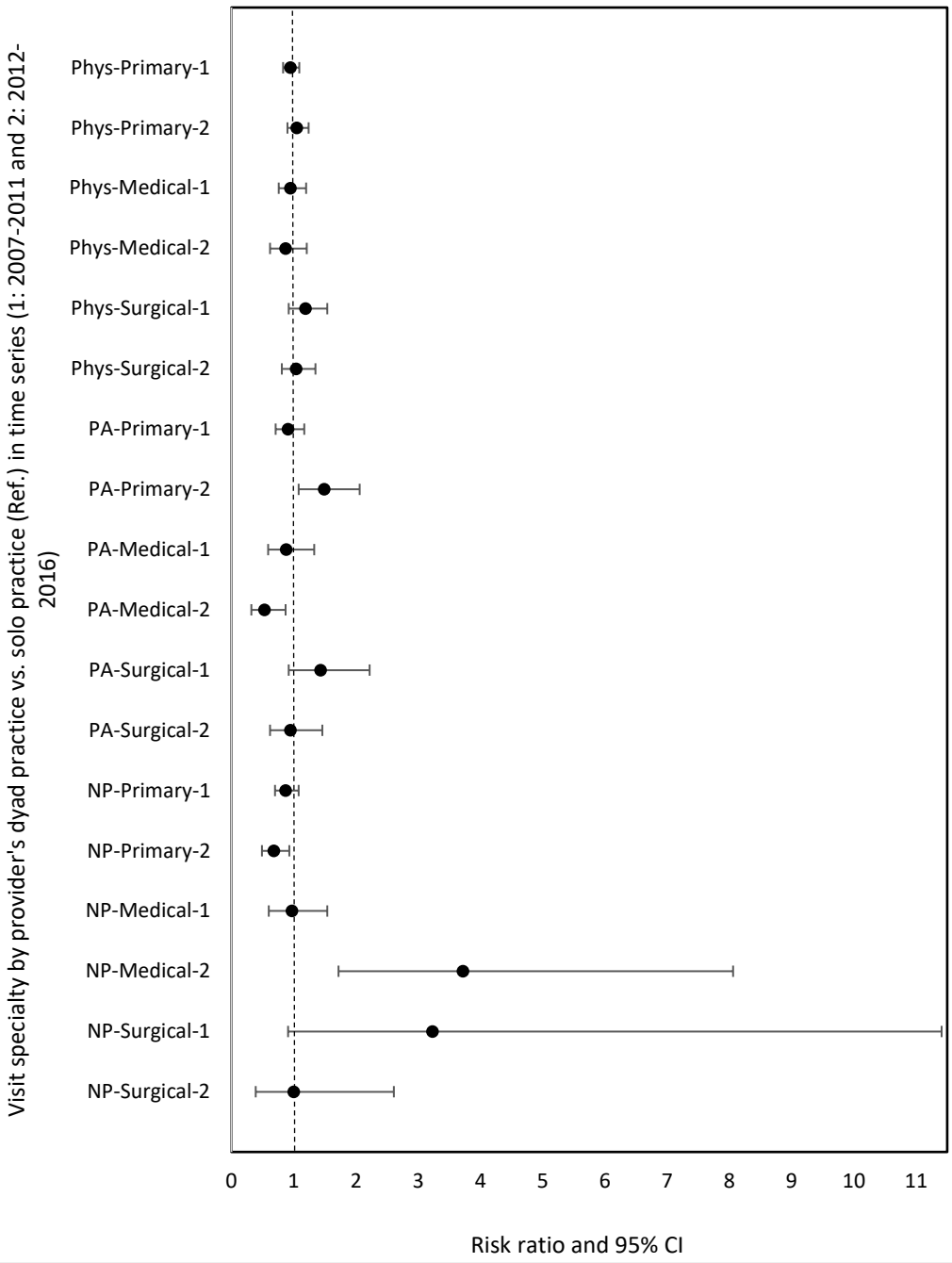
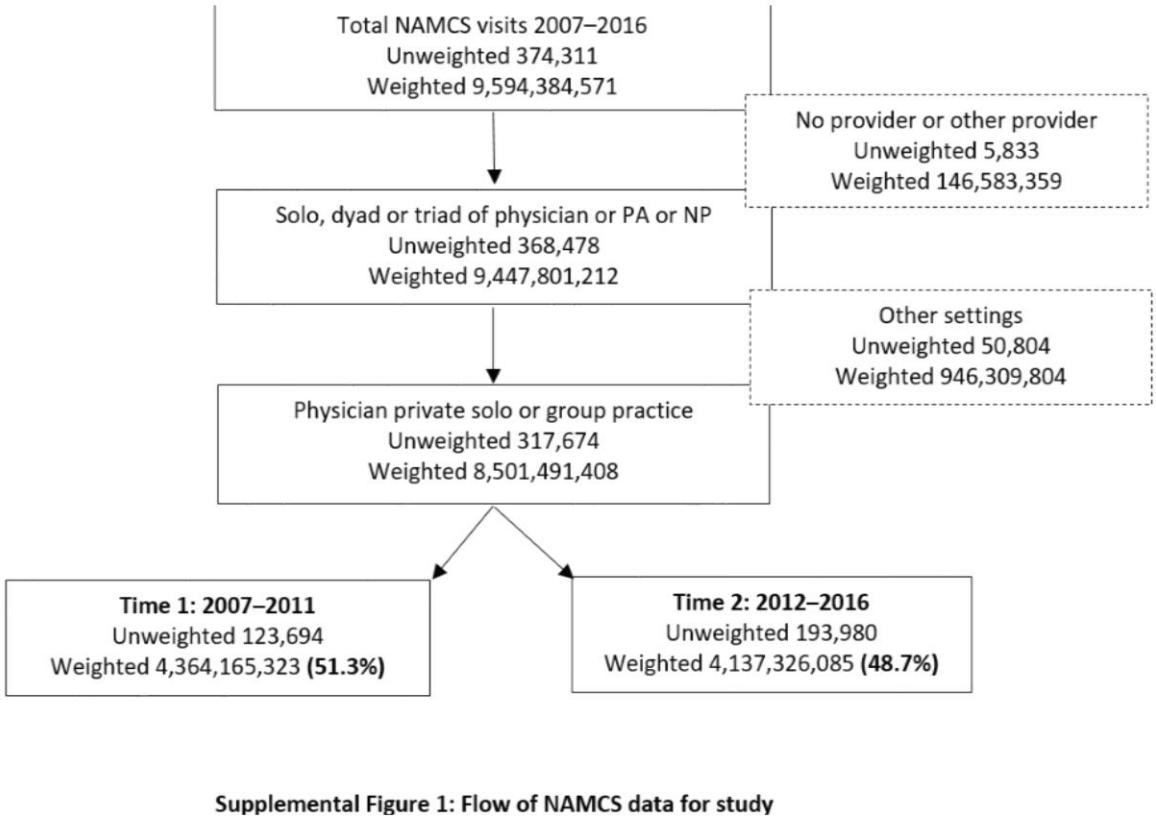


Figure 3: Percent change in major reason for visit between years 2007-2011 and 2012-2016, NAMCS

Figure 4: Risk ratios for the association between specialty visit (primary, medical, surgical) and provider's practice type [dyad vs solo (Ref.)] in time series 1 (2007-2011) and 2 (2012-2016)





Supplemental Figure 1: Flow of NAMCS data for study

Supplemental Table 1: Physician office visits by provider type, controlling for two 5-year time-span, NAMCS

Provider type	Overall[a]		2007–2011[b]		2012–2016[c]		P
	n*1000	% 95% CI	n*1000	% 95% CI	n*1000	% 95% CI	
Solo Physician	7,913,241	93.1 92.1, 94.1	4,091,169	51.7 49.3, 54.1	3,822,071	48.3 45.9, 50.7	.17
Solo-PA	54,498	0.6 0.5, 0.8	36,577	67.1 61.9, 72.3	17,920	32.9 27.7, 38.1	<.01*
Solo-NP	40,844	0.5 0.3, 0.6	26,078	63.8 56.2, 71.5	14,765	36.2 28.5, 43.8	<.01*
Physician-PA	366,711	4.3 3.3, 5.3	168,013	45.8 34.7, 56.9	198,698	54.2 43.1, 65.3	.46
Physician-NP	123,425	1.5 1.1, 1.8	41,308	33.5 25.3, 41.7	82,117	66.5 58.3, 74.7	<.01*
Other Collaborations	2,770	0.03 0.01, 0.05	1,017	36.7 0.0, 84.7	1,753	63.3 15.3, 100.0	.46
Total	8,501,491	100	4,364,165	-	4,137,326	-	

CI: Confidence Interval

[a] Overall 10-year of 2007–2016; [b] Time 1: 5-year time-span of 2007–2011; [c] Time 2: 5-year time-span of 2012–2016

* Significant at alpha=.05

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 the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	2, 5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2, 5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—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 *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	2, 5-6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A 6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	None

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	Supplemental Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		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	7-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-10
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	None
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	None, page 16

*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

COLLABORATIVE PRACTICE TRENDS IN U.S. PHYSICIAN OFFICE VISITS: AN ANALYSIS OF THE NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS), 2007–2016

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Secondary Subject Heading:	Health policy, Health services research, General practice / Family practice
Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PRIMARY CARE, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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TITLE PAGE

COLLABORATIVE PRACTICE TRENDS IN U.S. PHYSICIAN OFFICE VISITS: AN ANALYSIS OF THE NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS), 2007–2016

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ABSTRACT

Objective: Practice arrangements in physician offices were characterized by examining the share of visits that involved physician assistants (PAs) and nurse practitioners (NPs). The hypothesis was that collaborative practice (i.e. care delivered by a dyad of physician-PA and/or physician-NP) was increasing.

Design: Temporal ecological study.

Setting: Non-federal physician offices.

Participants: Patient visits to a physician, PA or NP, spanning years 2007–2016.

Methods: A stratified random sample of visits to office-based physicians were pooled through the National Ambulatory Medical Care Survey (NAMCS) public use linkage file. Among 317,674 visits to physicians, PAs, or NPs, solo and collaborative practices were described and compared over two timespans of 2007–2011, and 2012–2016. Weighted patient visits were aggregated in bivariate analyses to achieve nationally representative estimates. Survey statistics assessed patient demographic characteristics, reason for visit, and visit specialty by provider type.

Results: Within years 2007–2011, and 2012–2016 there were 4.4 billion, and 4.1 billion physician office visits (POVs), respectively. Comparing the two timespans, the rate of POVs with a solo PA (0.43% vs 0.21%) or NP (0.31% vs 0.17%) decreased. Rate of POVs with a collaborative physician-PA increased non-significantly. Rate of POVs with a collaborative physician-NP (0.49% vs 0.97%, P <.01) increased. Overall, collaborative practice, in particular physician-NP, has increased in recent years (P <.01), while visits handled by a solo PA or NP decreased (P <.01). In models adjusted for patient age and chronic conditions, the odds of collaborative practice in years 2012–2016 compared to years 2007–2011 was 35% higher (95% confidence interval 1.01, 1.79). Furthermore, in 2012–2016 NPs provided more independent primary care, and PAs provided more independent care in a non-primary care medical specialty. Preventive visits declined among all providers.

Conclusions: In non-federal physician offices, collaborative care with a physician-PA or -NP appears to be a growing part of office-based healthcare delivery.

KEYWORDS
Healthcare; Health Policy

Strengths and limitations of this study:

- NAMCS is the leading source of nationally representative data on care delivered in physician offices and on-going since 1973.
- The data were confined to nonfederal physician office visits attended by physicians, PAs, or NPs.
- Results excluded PAs, or NPs with independent patient daily rosters and those with independent practices.
- Due to office-based physicians who do not employ PAs or NPs, findings are subject to underestimation of the role of these providers.
- Expanding the NAMCS sampling units can enrich the reliability of the utilization of PAs and NPs in American medicine.

COLLABORATIVE PRACTICE TRENDS IN U.S. PHYSICIAN OFFICE VISITS: AN ANALYSIS OF THE NATIONAL AMBULATORY MEDICAL CARE SURVEY (NAMCS), 2007–2016

INTRODUCTION

Patient needs in healthcare are changing as a result of shifts in demographics and disease characteristics.[1-3] For instance, the proportion of the U.S. population over 65 years is increasing, such that by 2050, older adults are projected to make up at least 35% of the total population.[4] Likewise, by the second decade of this century, the occurrence of obesity and diabetes had reached epidemic proportions.[5,6] Aside from the interaction of demographic shifts and the increased burden of disease, the Patient Protection and Affordable Care Act (ACA) expansion of health insurance benefits to an estimated 20 million, mainly low-income Americans, have created more demand for medical services without a concomitant growth in physician services.

The Association of American Medical Colleges predicts a national shortage of 46,000–90,400 physicians by 2025. If this prediction is realized, then the physician workforce pipeline will be inadequate to meet the growing demand.[7] Expanding roles of physician assistants (PAs), nurse practitioners (NPs), and certified nurse midwives (CNMs), as a solution to physician shortages has been discussed.[8,9] This innovative use of health professionals has not gone unnoticed and their utilization has grown nationwide. In 2013, the Bureau of Labor Statistics (BLS) estimated that there were 50,510 PAs and 52,860 NPs. By 2018 the estimates on the number of clinically active physicians and surgeons was at 713,800, NPs at 155,500, and PAs at 106,200, with growth projections from 2016 to 2026 at 13%, 36%, and 37%, respectively.[10,11] During this same 10-year period the U.S. population is expected to grow from 320 to 346 million, further increasing the need to expand the roles of the medical provider workforce.[12]

Medical care delivered by physicians, PAs, and NPs takes place in many locations, including (but not limited to) physician offices, clinics, hospitals, community health centers, and rehabilitation facilities. However, it is physician office visits (POVs) that form the bulwark of

ambulatory care in America.[13] And it is in the office setting where PA and NP employment not only began, but has grown well into this century.[14,15] After five decades of utilization and deployment of PAs and NPs, it is possible that how this care is operationalized in physician offices has changed.

To address this question of organizational change in outpatient medicine we turned to the largest and longest running survey of ambulatory care in the U.S., the National Ambulatory Medical Care Survey (NAMCS). Our intent was to describe trends in use of PAs or NPs for improved modeling of healthcare delivery. More specifically, we wanted to examine trends in POVs by type of provider, as well as collaborative visits between providers. There are a number of reasons for this. Consolidation of physician offices has been a trend since the new century;[16] and health insurance policy has evolved in the U.S. during this same period. Concurrently the utilization of PAs and NPs has increased. What began primarily as a dependent relationship with physicians, the employment of PAs and NPs has evolved into a collaborative one instead. Our objective was to build upon the previous work in documentation of this shift in the provision of care in POVs,[9,17-19] by investigating whether significant changes in collaborative practice arrangements are observable over time. Collaboration between a PA or NP and physician is of interest, as there is some evidence that team-based care is growing.[9]

METHODS

Study Design, Data Source, and Setting

A temporal ecological study was undertaken that compared POVs' characteristics across three provider types (physicians, PAs, and NPs) solo or team-based practice in years 2007–2011 and 2012–2016. The dataset was NAMCS which draws annually on independent samples of physician practices. NAMCS is conducted by the National Center for Health Statistics (NCHS), a component of the Centers for Disease Control and Prevention (CDC), under the Department of Health and Human Services (DHHS). The NAMCS data collection methods have been described in detail.[9,20-22] Briefly, the NAMCS is a voluntary probability sample survey of patient visits to nonfederal, office-based physicians and surgeons (group or solo practice). Sampled physicians are selected from the American Medical Association (AMA) and the American Osteopathic Association (AOA)

master files.[9] For the objective of this study, i.e., assessing trends in collaborative practice in physician offices, we used documentation on the provider type which is captured in the NAMCS Survey Instrument 'Patient Record Form'. Data obtained prior to 2006 differs with the current versions in that all providers in an encounter are systematically collected.[23] As a consequence, we limit our data to 2007–2016, the publicly available data at the time of the study. As the NAMCS data excludes PAs or NPs with independent patient daily rosters and those with independent practices, and it includes office-based physicians who do not employ PAs or NPs, our findings are subject to underestimation. [9] However, as there is not a reason to assume that estimation accuracy varies differentially over time, time trends in provider practice, and specifically collaborative practice, should accurately reflect changes in care delivery within U.S. POVs and are the focus of our current analysis.

Data Abstraction and Participants

The NAMCS is based on a sample of visits rather than a sample of people.[24] According to the NCHS guideline, survey years with the same *Patient Record Form* (survey instrument) can be combined.[24] In view of the underestimated visits with PAs or NPs, and to ensure we had an adequate sample to assess trends in team-based practice, the NAMCS public use linkage was downloaded to create a pooled analysis of 10-years (2007–2016). **Supplemental Figure 1** summarizes the data filtering process. In this investigation, the 2007–2016 years data were concatenated. Medical providers seen at POVs include visits to physicians, PAs, and NPs, but may include other providers (e.g. mental health provider, registered nurse/licensed practical nurse, or other visits without a provider).[23] The data were restricted to the visits with at least a physician or PA or NP seen (irrespective of other providers). Thus, we excluded a small portion (1.6%) of visits not attended by at least one of these three provider types. This analysis is centered on visits to the main sampled setting, i.e., POVs, both solo and group practices (86.2%). Additionally, as year to year changes in the sampling frame might introduce an inordinate amount of variability, whereas a longer-term average would be the more robust way to report the results, the pooled data was divided to two 5-year timespans of 2007–2011 and 2012–2016.

Measures of Interest

Provider-types were medical doctors (MDs)/doctors of osteopathy (DOs), PAs, NPs, and CNMs. CNMs and NPs were collapsed to NPs consistent with NCHS protocol, as the number and percentages of CNMs in POVs are considered too small to be calculated separately.[9] Provider-visits were categorized as:

- Solo physician (a physician, without a PA or NP), irrespective of other providers;
- Solo PA (a PA, without a physician or an NP), irrespective of other providers;
- Solo NP (an NP, without a physician or a PA), irrespective of other providers);
- A 'collaborative practice' (or dyad) to mean two different professions (physician-PA or physician-NP) involved in the provision of care during a patient visit, irrespective of other providers.[25] Other collaborations included a triad of a physician, NP and PA, or a dyad of NP and PA.

We explored whether collaborative practice differed by patient demographic characteristics, reason for visit, and visit specialty. Patient characteristics included age (categorized as <15, 15–24, 25–44, 45–64, 65–74, and 75+ years), gender, race, and ethnicity (categorized as white, black, and other; and Hispanic/Latino and non-Hispanic/Latino, respectively). Reason for visit were four groups: acute, chronic (i.e. routine or flare-up), pre-/post- surgery, and preventive care. Type of visit specialty were primary care, medical specialty, and surgical specialty. NAMCS excludes physicians in the specialties of anesthesiology, pathology, and radiology, and their designated sub-specialties.[9]

Statistical Analysis

To account for the complex survey design, we included strata and cluster, as well as applied patient visit weights to all analyses to achieve nationally representative estimates and confidence intervals. Patient demographic characteristics, reason for visit, and visit specialty by provider-type were stratified for sub-group analyses and comparisons within the two 5-year timespans. Chi-square test was used to compare parameter estimates over time. To assess the probability of collaborative work we adjusted for the covariates of patient age, number of chronic conditions and their interaction. The *a priori* alpha value was set at 0.05. Findings are generalizable to

physician offices across the U.S. All statistical analyses were performed using SAS software 9.4 (SAS, Hickory, North Carolina).

Patient and Public Involvement

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

RESULTS

There were an estimated 8.5 billion patient visits to physician offices between 2007–2016 (10 years). Two time periods were examined: Time 1 (2007–2011) produced 4.4 billion POVs (51.3% of the total); Time 2 (2012–2016) produced 4.1 billion POVs (48.7%) **(Supplemental Figure 1)**. In both timespans, solo physicians had the highest proportion of visits, followed by physician-PA, physician-NP, solo-PA, solo-NP, and other collaborations (P <.01). However, despite this similarity, the unadjusted proportion of visits per provider differed significantly between these two timespans (P <.01) **(Supplemental Table 1)**.

Figure 1 shows the unadjusted proportion of POVs provided by each provider type (solo or dyad, excluding solo physician) across the two 5-year intervals. Comparing the two timespans, the absolute rate of POVs with a solo PA (0.43% vs 0.21%, P <.01) or NP (0.31% vs 0.17%, P <.01) decreased. Likewise, the rate of POVs with a collaborative physician-PA (1.98% vs 2.34%, P=0.46) increased non-significantly and the rate of POVs with a collaborative physician-NP (0.49% vs 0.97%, P <.01) increased. Overall, this suggests that collaborative practice, in particular physician-NP, increased in recent years (2012–2016) (p <.01), while visits handled by a solo-PA or solo-NP decreased (P <.01) **(Figure 1)**. When adjusted for patient age, number of chronic conditions, and their interaction, the probability of collaborative practice in years 2012-2016 compared to years 2007–2011 was significantly higher, [odds ratio (OR) 1.35, 95% confidence interval (CI) 1.01, 1.79].

Spanning the 10-year period of observation the percent of PAs and/or NPs at a POV increased (P=0.05). The highest annual percentage of POVs with PA or NP solo or collaborative

work was seen in 2015 (10.5%, 95% CI 6.2, 14.7) and the lowest in 2007 (5.5%, 95% CI 3.7, 7.3), and 2016 (5.6%, 95% CI 3.1, 8.1) **(Figure 2)**. When we adjust for POV patient age and number of chronic conditions, the probability of higher visits with a PA or NP, with or without an MD is insignificant (OR: 1.03, 95% CI 0.99, 1.06). A slight decrease in solo physician visits was also seen in recent years (P=.17) **(Supplemental Table 1)**.

Patient Characteristics

Number of chronic conditions: The mean number of patient chronic conditions in Time 2 compared to Time 1 was significantly higher, [OR 1.28 (95% CI 1.23, 1.32) vs 1.16 (95% CI 1.11, 1.21)].

The demographics for patients by provider type within the two timespans are presented in Table 1A (Time 1) and 1B (Time 2).

Sex: Overall, irrespective of provider, there was no significant difference in sex distribution of patients (P=.86); women had almost 1.4 times more visits than men across the 10-year period (58.3% female patient visits vs 41.7% male patient visits). Within years 2007–2011, sex of patient significantly differed by provider type (P=.01). Within years 2012–2016, no difference in sex of patient by provider type was seen (P=.36).

Race and ethnicity: No significant differences by patient race were observed between the two timespans (P=.40). When stratified by provider type, compared to the years 2007–2011, patient race for solo NP was significantly different in the years 2012–2016, with the most increase seen in visits of patients of other races (non-white, non-black) and decrease in visits of black and white patients (P=.01). For the physician-PA visits, there was a significant change in the race pattern between the years of 2007–2011, and 2012–2016. The most dramatic increases were seen in visits of patients of other races (non-white, non-black) and decrease in visits of white and black patients. In total, no significant changes were seen across the two time periods by ethnicity (P=.10). However, when stratifying by timespans and provider type, for the physician-PA visits

there was a significant increase in proportion of Hispanic patients seen between the years of 2007–2011 and 2012–2016 (from 12.1% to 23.8%, P <.01).

Age: The mean age of patients significantly differed between Time 1 and Time 2 (P <.01). Overall, the number of visits by older patients (≥45) increased (from 56.4% in Time 1 to 59.6% in Time 2). Within years 2007–2011, compared to physicians, PAs and NPs were visited more by patients <45 years old; PAs (56.3%), NPs (60.2%), physicians (43.5%) (P <.01). Within years 2012–2016, compared to physicians, NPs had more patients <45 years (55.3% vs 40.4%, P=.02), while within the same timespan, PA visits of patients <45 years did not differ with physicians (40.3% vs 40.4%, P=.99).

Major Reason for Visit

Overall, irrespective of provider type, reason for visit differed between years 2007–2011 and 2012–2016 (P <.01). In essence, the proportion of acute and chronic visits increased (33.9% vs 36.9%), and (39.0% vs 45.9%), respectively. The proportion of visits for pre/post-surgery and preventive care decreased (7.0% vs 4.3%), and (20% vs 13.0%), respectively. These changes varied by provider type. For example, in the stratified data by provider type, within Time 1, compared to Time 2, solo PA visits for preventive care and acute problem decreased (21.3% vs 12.5%), and (40.3% vs 34.0%), respectively; while solo PA share of chronic problem increased drastically (31.0% vs 47.3%, P <.01). A similar trend in proportion of acute and chronic problem, as well as preventive care visits was seen among physician-PA practice between Time 1 and Time 2 (P=.04). The major reason for visits for solo NP and physician-NP over time showed less variability. Preventive visits declined among all providers (**Figure 3**).

Visit Specialty

Regardless of provider type, the specialty of visits differed between the two time periods (P <.01). Within recent years (2012–2016), proportionally less primary care visits occurred (52.7% vs 56.7%), and more visits with medical specialty (27.0% vs 22.7%) occurred. Surgical visits remained almost the same between these two timespans. Of note, solo PA visits had a significant

change in specialty pattern - notably decreased visits with primary care specialty (37.6% vs 56.3%) and increased medical care and surgical care specialties (36.6% vs 25.0%), and (25.8% vs 18.7%), respectively. **Figure 4** illustrates risk ratios of collaborative practice versus solo work (the reference group) per provider in each timespan independently, stratified by visit specialty (primary, medical, and surgical). Within 2012–2016, PAs had a higher probability of having primary care visits in a dyad practice versus solo (RR 1.49, 95% CI 1.08, 2.06), and less probability of a medical specialty visit in a dyad practice versus solo (RR 0.53, 95% CI 0.32, 0.87). However, within same timespan, primary care visits were more likely as a solo NP (RR 0.68, 95% CI 0.49, 0.93). For medical specialty care in 2012–2016, NPs had higher probability of working with a physician at a visit (RR 3.72, 95% CI 1.72, 8.06).

Table 1A: Patients' demographic characteristics, stratified by provider type, NAMCS 2007–2011

	n*1000 % (95% Confidence Interval)							
Characteristic	**Total**	**Solo-Phys.**	**Solo-PA**	**Solo-NP**	**Phys.-PA**	**Phys.-NP**	**Other collaboration**	**P**
Sex								
Female	2,547,042	2,387,457	21,125	17,604	96,690	23,610	554	.01
	58.4 (57.6, 59.1)	**58.4 (57.6, 59.1)**	**57.8 (54.2, 61.3)**	**67.5 (62.5, 72.5)**	**57.5 (54.8, 60.3)**	**57.2 (53.9, 60.4)**	**54.5 (31.9, 77.1)**	
Male	1,817,122	1,703,712	15,452	8,474	71,323	17,698	462	
	41.6 (40.9, 42.4)	**41.6 (40.9, 42.4)**	**42.2 (38.7, 45.8)**	**32.5 (27.5, 37.5)**	**42.5 (39.7, 45.2)**	**42.8 (39.6, 46.1)**	**45.5 (22.9, 68.1)**	
Race								
White	3,668,660	3,443,589	31,305	22,994	135,002	35,133	634	-
	84.1 (82.3, 85.8)	**84.2 (82.4, 86.0)**	**85.6 (81.9, 89.2)**	**88.2 (82.0, 94.3)**	**80.4 (76.5, 84.2)**	**85.1 (80.3, 89.8)**	**62.4 (47.3, 77.4)**	
Black	477,217	438,902	3,744	2,707	26,378	5,100	382	
	10.9 (9.3, 12.5)	**10.7 (9.1, 12.3)**	**10.2 (6.8, 13.7)**	**10.4 (4.4, 16.3)**	**15.7 (11.2, 20.2)**	**12.3 (7.7, 17.0)**	**37.6 (22.6, 52.7)**	
Other	218,287	208,677	1,528	376	6,631	1,073		
	5.0 (4.1, 6.0)	**5.1 (4.1, 6.1)**	**4.2 (2.3, 6.1)**	**1.4 (0.2, 2.7)**	**3.9 (2.0, 5.9)**	**2.6 (1.1, 4.1)**	-	
Ethnicity								
Hispanic/Latino	493,353	456,838	7,484	3,584	20,360	5,052	33	.18
	11.3 (9.3, 13.4)	**11.2 (9.1, 13.2)**	**20.5 (13.2, 27.8)**	**13.7 (1.4, 26.1)**	**12.1 (7.5, 16.7)**	**12.2 (5.1, 19.4)**	**3.3 (0.0, 11.0)**	
Non-Hispanic/Latino	3,870,812	3,634,331	29,093	22,494	147,652	36,256	983	
	88.7 (86.7, 90.7)	**88.8 (86.8, 90.9)**	**79.5 (72.2, 86.9)**	**86.3 (73.9, 98.6)**	**87.9 (83.3, 92.5)**	**87.8 (80.6, 95.0)**	**96.7 (89.0, 100)**	
Age								
<15	716,249	667,405	8,692	6,869	22,255	10,847	177	<.01
	16.4 (15.5, 17.4)	**16.3 (15.3, 17.3)**	**23.8 (13.2, 34.3)**	**26.3 (13.9, 38.8)**	**13.2 (8.2,18.3)**	**26.3 (13.8, 38.7)**	**17.5 (8.8, 26.2)**	
15–24	326,815	305,553	3,680	3,293	11,911	2,364	11	
	7.5 (7.2, 7.8)	**7.5 (7.2, 7.8)**	**10.1 (7.2, 12.9)**	**12.6 (9.1, 16.2)**	**7.1 (5.7, 8.5)**	**5.7 (4.1, 7.4)**	**1.1 (0.4, 1.9)**	
25–44	858,223	807,176	8,191	5,545	29,840	7,251	216	
	19.7 (19.0, 20.4)	**19.7 (19.0, 20.4)**	**22.4 (17.3, 27.5)**	**21.3 (15.4, 27.1)**	**17.8 (14.6, 21.0)**	**17.6 (13.4, 21.7)**	**21.3 (13.2, 29.4)**	
45–64	1,287,176	1,208,896	9,082	5,560	53,018	10,253	365	
	29.5 (28.8, 30.1)	**29.5 (28.9, 30.2)**	**24.8 (19.6, 30.0)**	**21.3 (16.2, 26.5)**	**31.6 (28.9, 34.2)**	**24.8 (19.2, 30.4)**	**35.9 (16.9, 55.0)**	
65–74	584,405	544,484	4,213	2,491	27,595	5,441	177	
	13.4 (13.0, 13.8)	**13.3 (12.9, 13.7)**	**11.5 (8.2, 14.9)**	**9.6 (6.0, 13.1)**	**16.4 (14.1, 18.7)**	**13.2 (9.1, 17.3)**	**17.5 (10.4, 24.5)**	
≥75	5,912,954	557,652	2,716	2,317	23,391	5,149	68	
	13.5 (12.9, 14.2)	**13.6 (13.0, 14.3)**	**7.4 (5.0, 9.8)**	**8.9 (5.1, 12.7)**	**13.9 (11.3, 16.5)**	**12.5 (7.8, 17.2)**	**6.7 (0.0, 13.4)**	
Total per provider	**4,364,165**	**4,091,169**	**36,577**	**26,078**	**168,013**	**41,308**	**1,017**	
%*	**100%**	**93.74%**	**0.84%**	**0.60%**	**3.85%**	**0.95%**	**0.02%**	

* The percentages in total rows are percent of provider out of the total visits.

Table 1B: Patients' demographic characteristics, stratified by provider type, NAMCS 2012–2016

Characteristic	Total	Solo-Phys.	Solo-PA	Solo-NP	Phys.-PA	Phys.-NP	Other collaboration	P
	n*1000 **% (95% Confidence Interval)**							
Sex								
Female	2,410,872	2,222,316	9,787	8,107	121,084	48,499	1,076	.36
	58.3 (57.6, 59.0)	**58.1 (57.4, 58.9)**	**54.6 (48.4, 60.8)**	**54.9 (45.5, 64.4)**	**60.9 (56.6, 65.3)**	**59.1 (55.9, 62.2)**	**61.4 (48.7, 74.1)**	
Male	1,726,453	1,599,754	8,133	6,657	77,613	33,618	676	
	41.7 (41.0, 42.4)	**41.9 (41.2, 42.6)**	**45.4 (39.2, 51.6)**	**45.1 (35.6, 54.6)**	**39.1 (34.7, 43.4)**	**40.9 (37.8, 44.1)**	**38.6 (25.9, 51.3)**	
Race								
White	3,457,833	3,207,866	15,800	12,958	149,073	70,607	1,526	<.01
	83.6 (82.4, 84.7)	**83.9 (82.8, 85.1)**	**88.2 (83.7, 92.7)**	**87.8 (81.9, 93.6)**	**75.0 (68.6, 81.4)**	**86.0 (82.8, 89.1)**	**87.0 (75.4, 98.7)**	
Black	434,501	393,206	1,640	1,083	30,356	8,006	207	
	10.5 (9.9, 11.2)	**10.3 (9.7, 10.9)**	**9.2 (5.0, 13.4)**	**7.3 (4.1, 10. 6)**	**15.3 (10.6, 20.0)**	**9.8 (7.5, 12.0)**	**11.9 (0.5, 23.3)**	
Other	244,991	220,998	479	723	19,267	3,502	191	
	5.9 (4.9, 6.9)	**5.8 (4.7, 6.8)**	**2.7 (1.0, 4.3)**	**4.9 (1.0, 8.9)**	**9.7 (6.3, 13.1)**	**4.3 (2.5, 6.1)**	**1.1 (0.0, 2.8)**	
Ethnicity								
Hispanic/Latino	551,903	491,346	3,036	1,903	47,233	8,259	124	<.01
	13.3 (12.3, 14.4)	**12.9 (11.8, 14.0)**	**16.9 (8.6, 25.3)**	**12.9 (4.4, 21.4)**	**23.8 (19.4, 28.2)**	**10.1 (7.6, 12.6)**	**7.1 (3.0, 11.2)**	
Non-Hispan./Latino	3,585,422	3,330,724	14,884	12,862	151,464	73,857	1,629	
	86.7 (85.6, 87.7)	**87.1 (86.0, 88.3)**	**83.1 (74.7, 91.5)**	**87.1 (78.6, 95.6)**	**76.2 (71.8, 80.7)**	**89.9 (87.5, 92.4)**	**92.9 (88.8, 97.0)**	
Age								
<15	593,134	540,191	2,496	3,354	31,860	15,001	229	.02
	14.3 (13.3, 15.4)	**14.1 (13.1, 15.2)**	**13.9 (5.4, 22.4)**	**22.7 (11.7, 33.7)**	**16.0 (9.0, 23.1)**	**18.3 (8.9, 27.7)**	**13.1 (0.0, 30.0)**	
15–24	298,158	278,863	1,349	998	11,239	5,566	142	
	7.2 (6.8, 7.6)	**7.3 (6.9, 7.7)**	**7.5 (4.3, 10.8)**	**6.8 (4.5, 9.1)**	**5.7 (4.0, 7.3)**	**6.8 (4.7, 8.8)**	**8.1 (1.9, 14.3)**	
25–44	778,408	725,937	3,392	3,802	32,094	12,940	241	
	18.8 (18.1, 19.5)	**19.0 (18.3, 19.7)**	**18.9 (14.2, 23.7)**	**25.8 (16.5, 35.0)**	**16.2 (12.0, 20.3)**	**15.8 (12.1, 19.5)**	**13.8 (3.3, 24.2)**	
45–64	1,250,891	1,144,988	5,624	3,683	73,499	22,497	597	
	30.2 (29.5, 30.9)	**30.0 (29.3, 30.6)**	**31.4 (25.7, 37.1)**	**25.0 (17.7, 32.2)**	**37.0 (31.7, 42.3)**	**27.4 (23.4, 31.4)**	**34.1 (24.2, 44.0)**	
65–74	644,858	596,011	2,615	1,732	30,836	13,394	267	
	15.6 (15.1,16.1)	**15.6 (15.1, 16.1)**	**14.6 (10.7, 18.5)**	**11.7 (6.8, 16.6)**	**15.5 (12.4, 18.6)**	**16.3 (11.0, 21.7)**	**15.3 (8.2, 22.4)**	
≥75	571,874	536,079	2,441	1,192	19,168	12,717	275	
	13.8 (13.2, 14.4)	**14.0 (13.4, 14.6)**	**13.6 (9.2, 18.1)**	**8.1 (3.4, 12.8)**	**9.7 (7.7, 11.6)**	**15.5 (11.8, 19.2)**	**15.7 (6.6, 24.8)**	
Total per provider	**4,137,326**	**3,822,071**	**17,920**	**14,765**	**198,698**	**82,117**	**1,753**	
%*	**100%**	**92.38%**	**0.43%**	**0.36%**	**4.80%**	**1.98%**	**0.04%**	

* The percentages in total rows are percent of provider out of the total visits.

DISCUSSION

The results of this analysis are consistent with other observations that collaborative practice has increased at physician offices in the U.S.[26] At the same time there have been fewer preventive and pre/post-surgical visits recorded at physician offices. Another important finding is the division of labor that seems to be occurring with American PAs and NPs. PAs are less represented in primary care and more in medical and surgical specialties than NPs. This shifting in roles and utilization has been a U.S. trend at least since 2000 and has been reported in a number of studies.[27-29]

The increased observation of PAs and NPs in POVs may be due to a number of reasons. For example, the ACA may have influenced the employment of PAs and NPs by physicians at a time when staffing expansion was needed. However, the market (demand) for PAs and NPs began decades before and has been increasing as healthcare service delivery has consolidated and the traditional 'solo physician' model is becoming an anachronism.[16] Growth of PAs and NPs is underway. PAs graduated almost 10,000 and NPs graduated 22,000 in 2018.[30,31]

The interchangeability of PAs and NPs may be at work as well, since salaries are similar when roles are compared.[32,33] Enabling PA and NP legislation by states also expanded during the study timeframe, which may have facilitated greater utilization.[34,35]

Changes in healthcare services, the patient population served by the PA, NP, and physician workforce, or the growth of PA programs all may partially explain our findings of increased collaborative practice over time. In terms of healthcare services, these changes have included consolidation of physician offices into medical centers, enlargement of hospitals, the emergence of retail clinics and outpatient surgery centers, and perhaps most germane to our current analysis, an increasing emphasis on team-based care.[16,36] Additionally, the timing of our study, overlapping with the implementation and national roll-out of the ACA, also affords the possibility that this largescale change in federal medical insurance policy may have impacted the growth of collaborative care. As a federal policy enactment, the ACA was supportive of PAs and advanced practice registered nurses (APRNs) and may have served as an accelerant for PA and NP program growth.[37] In terms of changes to the patient population, the increasing prevalence

of chronic disease, coupled with an aging population, produces increased complexity of care required, which may help explain some of the increased collaborative practice we observe in our study.[38] Last, the increased growth in PA programs, and the graduates they produce, may partially explain these findings. As of 2018 the BLS puts clinically employed PAs at 106,200 and NPs at 155,500.[10,11] Their growth is projected from 2016 to 2026 at 36%, and 37%, respectively with physician growth somewhat lower at 13%.[10,11] This forecast is predicated on increasing demand for healthcare services and decreasing annual physician productivity.[39,40] The growing number of studies on the ability of PAs and NPs to manage complex patients with the same outcome as physicians is not only reassuring but informs a wide variety of health systems that their inclusion in team-based medicine may be in the patient's best interest as much as the system's best interest.[41-44]

Two additional theories that might explain the rise in the observed collaborative medical care services are economic and social. The economic explanation is that a visit with a PA or NP conjoined with a physician is reimbursed by Medicare at 100% of the prevailing community rate. The PA or NP that sees the patient as a sole provider is reimbursed for that visit at 85% of the prevailing rate.[45] The policy stipulates that services must be rendered under the direct supervision of a physician, meaning the physician must be present in the office suite and immediately available.[46] Since the median wage of a PA or NP is less than half that of a family physician, this 15% discount in federal reimbursement is considered negligible by some employers.[27] Furthermore, reimbursement of PA and NP services occurs in full in the extensive private insurance system in the U.S.

The social explanation is that consumers of medical services are more accepting of diverse types of providers as primary care undergoes changes in style and organization.[40] This opens more opportunities for physician practices as well as medical centers, clinics, and other settings to employ PAs and APRNs.[47] After a half century of PAs and NPs providing high-quality healthcare in the U.S., they appear to be well integrated into collaborative relationships in physician office medicine.[48] We also suggest this broad, 10-year observation, sets the stage for more granular investigation about physician-PA or NP collaboration, what it means, and where the margins of collaboration remain. There are suggestions that collaboration contributes to job satisfaction

and may decrease burnout rates in family medicine.[49-51] Ultimately, teasing apart the underlying reason for increased collaborative practice is difficult as the extant literature is largely silent on this topic.

With regard to the observed decrease in preventive care, we find the decline consistent with other Medicare visits since 2013. Such reduction in preventive care has been the subject of some investigation.[52] A growing shortage of primary care providers and insufficient reimbursement for preventative visits are speculated.

Our study has some limitations. Although the NAMCS is a rich, reliable, and widely used database, in existence since 1973 and freqently drawn upon for various and sundry questions about health services, the question on provider type may not be equally valid for all providers. The NAMCS samples physician offices[9] and it excludes PAs and NPs who work autonomously with their own schedule of patients or those with independent practices. Also the NAMCS includes office-based physicians who do not employ PAs or NPs.

In summary, we used a national dataset with a robust sampling technique that has been validated in a large number of studies over half a century. Second, the longitudinal nature of the data and the large number of nationwide samples allow for exploration of trends over time. Lastly, our examination of proportions rather than absolute numbers permits us to identify changes in POVs and collaborative care reliably enough to identify temporal changes in populations. [9] What emerged in this study was a trend in healthcare staffing that corroborates other observations that a variety of medical providers may improve flexibility and adaptability of service delivery. [49-51] With an improved NAMCS survey methods, expanding current sampling units to PAs and NPs, the stage is set for exploring this observation.

CONCLUSIONS

We find that collaborative practice, involving a PA or an NP and a physician, is a growing practice in physician office visits. Not only is the presence of PAs and NPs more visible in physician office settings, but their share of visits appears to be rising. The underlying cause, efficiency, and productivity of solo versus collaborative practice in POVs remains to be evaluated.

CONTRIBUTORSHIP

SN, TJH, and RSH were involved in the data analysis, interpretation and drafting the manuscript. All authors reviewed/edited the manuscript and approved the final version.

COMPETING INTERESTS

None declared.

FUNDING

None

ETHICS APPROVAL

As we used the NAMCS publicly available data, not containing identifying variables, this study was determined exempt from review by the authors' Institutional Review Board (IRB 00124136).

NAMCS Data Availability

Data are available in a public, open access repository. NCHS has a public use linkage to access NAMCS, 1973–1992 and NAMCS, 1993–2016. The majority of NAMCS variables are publicly available. Accessing restricted NAMCS variables, through CDC Research Data Center (RDC), is possible. We used publicly available data.

FIGURE LEGENDS

Figure 1: Distribution of non-physician providers weighted visits to physician offices by two 5-year timespans (NAMCS)

Figure 2: Temporal trend of percent of PAs and/or NPs present at a physician office visit: NAMCS 2007–2016

Figure 3: Percent change in major reason for visit between years 2007–2011 and 2012–2016, NAMCS

Figure 4: Risk ratios for the association between specialty visit (primary, medical, surgical) and provider's practice type [(dyad vs solo (Ref.)] in time series 1 (2007–2011) and 2 (2012–2016)

SUPPLEMENTAL FILES

Supplemental Table 1: Physician office visits by provider type, controlling for two 5-year timespans, NAMCS

Supplemental Figure 1: Flow of NAMCS data for study

REFERENCES

1. Kimberly J, Cronk I. Making value a priority: how this paradigm shift is changing the landscape in health care. *Annals of the New York Academy of Sciences.* 2016;1381(1):162-167.
2. Dall TM, Gallo PD, Chakrabarti R, West T, Semilla AP, Storm MV. An aging population and growing disease burden will require a large and specialized health care workforce by 2025. *Health affairs (Project Hope).* 2013;32(11):2013-2020.
3. Bauer UE, Briss PA, Goodman RA, Bowman BA. Prevention of chronic disease in the 21st century: elimination of the leading preventable causes of premature death and disability in the USA. *Lancet (London, England).* 2014;384(9937):45-52.
4. Institute of Medicine Committee on the Long-Run Macroeconomic Effects of the Aging USP. The National Academies Collection: Reports funded by National Institutes of Health. In: *Aging and the Macroeconomy: Long-Term Implications of an Older Population.* Washington (DC): National Academies Press (US); 2012.
5. Vecchie A, Dallegri F, Carbone F, et al. Obesity phenotypes and their paradoxical association with cardiovascular diseases. *European journal of internal medicine.* 2018;48:6-17.
6. Kaplan RM, Milstein A. Contributions of Health Care to Longevity: A Review of 4 Estimation Methods. *Ann Fam Med.* 2019;17(3):267-272.
7. AAMC/IHS. *The complexities of physician supply and demand: Projections from 2017 to 2032.* 2019.

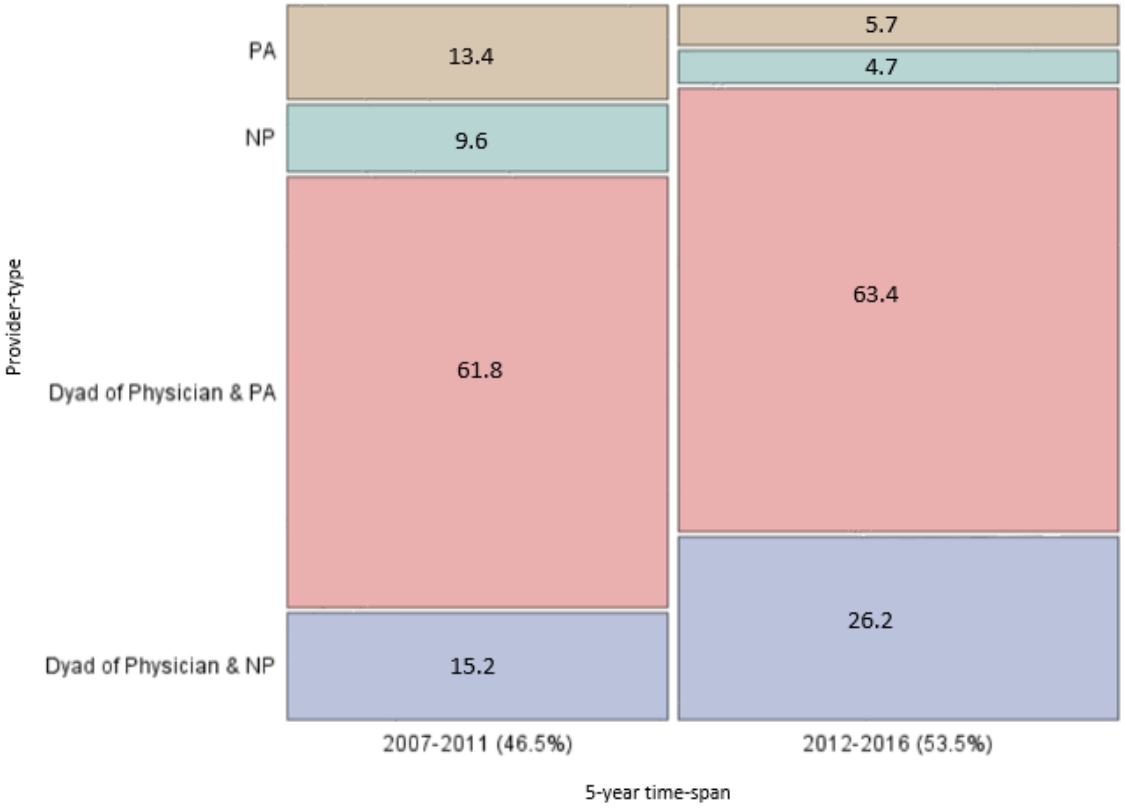
8. Morgan P, Everett CM, Humeniuk KM, Valentin VL. Physician assistant specialty choice: distribution, salaries, and comparison with physicians. *JAAPA : official journal of the American Academy of Physician Assistants.* 2016;29(7):46-52.
9. Lau DT, McCaig LF, Hing E. Toward a More Complete Picture of Outpatient, Office-Based Health Care in the U.S. *American journal of preventive medicine.* 2016;51(3):403-409.
10. BLS. Physician Assistants. https://www.bls.gov/ooh/healthcare/physician-assistants.htm. Published 2019. Accessed 5/8/2019.
11. BLS. Nurse Anesthetists, Nurse Midwives, and Nurse Practitioners. https://www.bls.gov/ooh/healthcare/nurse-anesthetists-nurse-midwives-and-nurse-practitioners.htm. Published 2019. Accessed 5/8/2019.
12. Colby SL, Ortman JM. *Projections of the Size and Composition of the U.S. Population: 2014 to 2060, Current Population Reports.* Washington DC: Census Bureau;2014.
13. Hooker RS, Benitez JA, Coplan BH, Dehn RW. Ambulatory and chronic disease care by physician assistants and nurse practitioners. *J Ambul Care Manage.* 2013;36(4):293-301.
14. Hooker RS, Cawley JF, Everett CM. *Physician Assistants: Policy and Practice.* 4 ed. Philadelphia: FA Davis; 2017.
15. Fairman J. *Making room in the clinic : nurse practitioners and the evolution of modern health care.* New Brunswick, N.J.: Rutgers University Press; 2008.
16. Kanter GP, Polsky D, Werner RM. Changes in physician consolidation with the spread of accountable care organizations. *Health affairs (Project Hope).* 2019;38(11):1936-1943.
17. Aparasu RR, Hegge M. Autonomous ambulatory care by nurse practitioners and physician assistants in office-based settings. *J Allied Health.* 2001;30(3):153-159.
18. Hing E, Hooker RS, Ashman JJ. Primary health care in community health centers and comparison with office-based practice. *J Community Health.* 2011;36(3):406-413.
19. Hing E, Hsiao CJ. In which states are physician assistants or nurse practitioners more likely to work in primary care? *JAAPA : official journal of the American Academy of Physician Assistants.* 2015;28(9):46-53.
20. CDC. Ambulatory health care data. https://www.cdc.gov/nchs/ahcd/. Published 2019. Accessed 15/10/2019, 2019.
21. NCHS. Questionnaires, Datasets, and Related Documentation. https://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm. Published 2017. Accessed.
22. NCHS. National Ambulatory Medical Care Survey (NAMCS) and National Hospital Ambulatory Medical Care Survey (NHAMCS) Restricted Variables. https://www.cdc.gov/rdc/b1datatype/dt1224a.htm. Published 2011. Accessed 31/10/2019, 2019.
23. CDC. Survey Instruments. https://www.cdc.gov/nchs/ahcd/ahcd_survey_instruments.htm. Published 2019. Accessed 12/10/2019, 2019.
24. NCHS. Ambulatory Health Care Data: Frequently Asked Questions. https://www.cdc.gov/nchs/ahcd/ahcd_faq.htm. Published 2019. Accessed 03/10/2019, 2019.
25. WHO. Interprofessional Collaborative Practice in Primary Health Care: Nursing and Midwifery Perspectives. http://www.who.int/hrh/resources/observer Published 2013. Accessed 12/11/2019, 2019.
26. Dai M, Ingham RC, Peterson LE. Scope of Practice and Patient Panel Size of Family Physicians Who Work With Nurse Practitioners or Physician Assistants. *Family medicine.* 2019;51(4):311-318.
27. Hooker RS, Brock DM, Cook ML. Characteristics of nurse practitioners and physician assistants in the United States. *Journal of the American Association of Nurse Practitioners.* 2016;28(1):39-46.

28. Maier CB, Batenburg R, Birch S, Zander B, Elliott R, Busse R. Health workforce planning: which countries include nurse practitioners and physician assistants and to what effect? *Health policy (Amsterdam, Netherlands).* 2018;122(10):1085-1092.
29. Mafi JN, Wee CC, Davis RB, Landon BE. Comparing use of low-value health care services among US advanced practice clinicians and physicians *Annals of Internal Medicine.* 2016;165(4):237-244.
30. PAEA. *Physician Assistant Education Association, By the Numbers: Program Report 34: Data from the 2018 Program.* Washington DC2019.
31. American-Association-of-Colleges-of-Nursing. 2018-2019 Enrollment and Graduations in Baccalaureate and Graduate Programs in Nursing. In. Washington DC2019.
32. McMichael BJ. Occupational licensing and legal liability: the effect of regulation and litigation on nurse practitioners, physician assistants, and the healthcare system. In: Vanderbilt University Press; 2015.
33. Hooker RS, McMichael BJ. Are physician assistants and nurse practitioners interchangeable? *Journal of the American Academy of Physician Assistants.* 2019;32(8).
34. Davis A, Radix S, Cawley JF, Hooker RS, Walker C. Access and innovation in a time of rapid change: physician assistant scope of practice. *Annals of Health Law.* 2015;24(1):286-336.
35. Buerhaus P. Nurse practitioners: a solution to America's primary care crisis. In: American Enterprise Institute; 2018.
36. Basu S, Phillips RS, Song Z, Bitton A, Landon BE. High levels of capitation payments needed to shift primary care toward proactive team and nonvisit care. *Health affairs (Project Hope).* 2017;36(9):1599-1605.
37. Henry L. Physician assistants, nurse practitioners, and community health centers under the Affordable Care Act. *Human Organization.* 2015;74(1):42.
38. Ray KN, Martsolf GR, Mehrotra A, Barnett ML. Trends in visits to specialist physicians involving nurse practitioners and physician assistants, 2001 to 2013. *JAMA Intern Med.* 2017;177(8):1213-1216.
39. Essary AC, Green EP, Gans DN. Compensation and production in family medicine by practice ownership. *Health Serv Res Manag Epidemiol.* 2016;3:2333392815624111.
40. Hedden L, Barer ML, Cardiff K, McGrail KM, Law MR, Bourgeault IL. The implications of the feminization of the primary care physician workforce on service supply: a systematic review. *Human resources for health.* 2014;12:32.
41. Virani SS, Akeroyd JM, Ramsey DJ, et al. Comparative effectiveness of outpatient cardiovascular disease and diabetes care delivery between advanced practice providers and physician providers in primary care: Implications for care under the Affordable Care Act. *Am Heart J.* 2016;181:74-82.
42. Kurtzman ET, Barnow BS. A Comparison of nurse practitioners, physician assistants, and primary care physicians' patterns of practice and quality of care in health centers. *Med Care.* 2017;55(6):615-622.
43. Morgan PA, Smith VA, Berkowitz TSZ, et al. Impact of physicians, nurse practitioners, and physician assistants on utilization and costs for complex patients. *Health affairs (Project Hope).* 2019;38(6):1028-1036.
44. Everett CM, Morgan P, Jackson GL. Primary care physician assistant and advance practice nurses roles: Patient healthcare utilization, unmet need, and satisfaction. *Healthc (Amst).* 2016;4(4):327-333.
45. Medpac. Improving Medicare's payment policies for advanced practice registered nurses and physician assistants. http://www.medpac.gov/-blog-/the-commission-recommends-aprns-and-

pas-bill-medicare-directly-/2019/02/15/improving-medicare's-payment-policies-for-aprns-and-pas. Published 2019. Accessed 19/10/2019, 2019.

46. Leszinsky L, Candon M. Primary care appointments for Medicaid beneficiaries with advanced practitioners. *Ann Fam Med.* 2019;17(4):363-366.
47. Dill MJ, Pankow S, Erikson C, Shipman S. Survey shows consumers open to a greater role for physician assistants and nurse practitioners. *Health affairs (Project Hope).* 2013;32(6):1135-1142.
48. Kilo CM, Wasson JH. Practice redesign and the patient-centered medical home: history, promises, and challenges. *Health affairs (Project Hope).* 2010;29(5):773-778.
49. Henry LR, Hooker RS. Caring for the disadvantaged: the role of physician assistants. *JAAPA : official journal of the American Academy of Physician Assistants.* 2014;27(1):36-42.
50. Reid RJ, Coleman K, Johnson EA, et al. The Group Health medical home at year two: cost savings, higher patient satisfaction, and less burnout for providers. *Health affairs (Project Hope).* 2010;29(5):835-843.
51. Helfrich CD, Dolan ED, Simonetti J, et al. Elements of team-based care in a patient-centered medical home are associated with lower burnout among VA primary care employees. *Journal of general internal medicine.* 2014;29 Suppl 2:S659-666.
52. Chung S, Lesser LI, Lauderdale DS, Johns NE, Palaniappan LP, Luft HS. Medicare annual preventive care visits: use increased among fee-for-service patients, but many do not participate. *Health affairs (Project Hope).* 2015;34(1):11-20.

Figure 1: Distribution of non-physician providers weighted visits to physician offices by two 5-year time-spans (NAMCS)



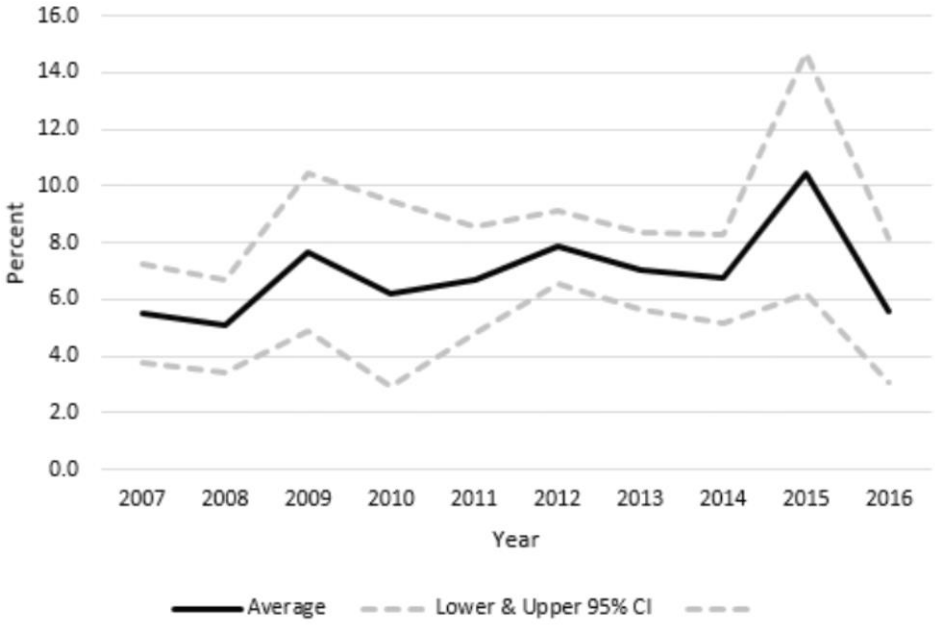


Figure 2: Temporal trend of percent of PAs and/or NPs present at a physician office visit: NAMCS 2007-2016

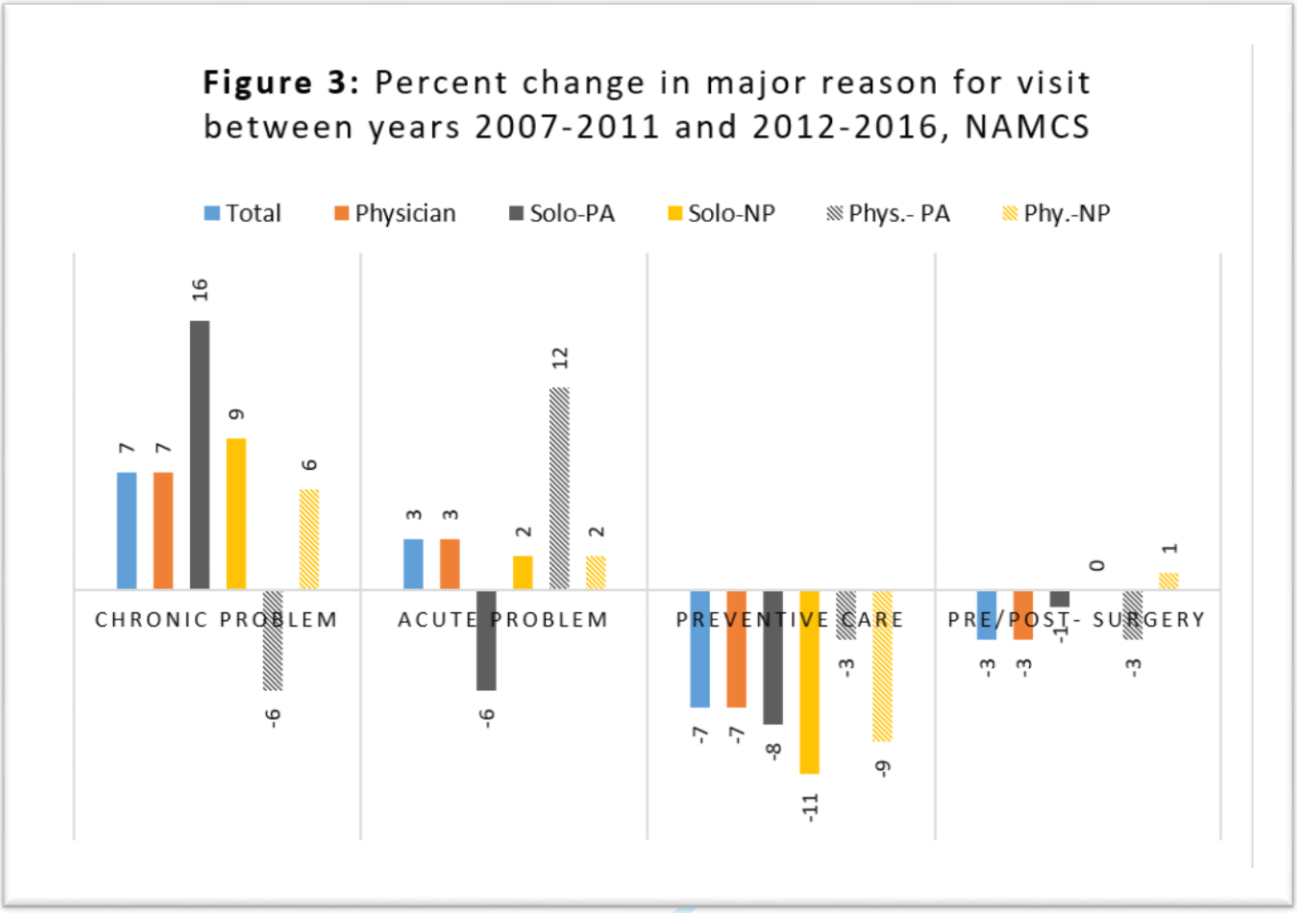
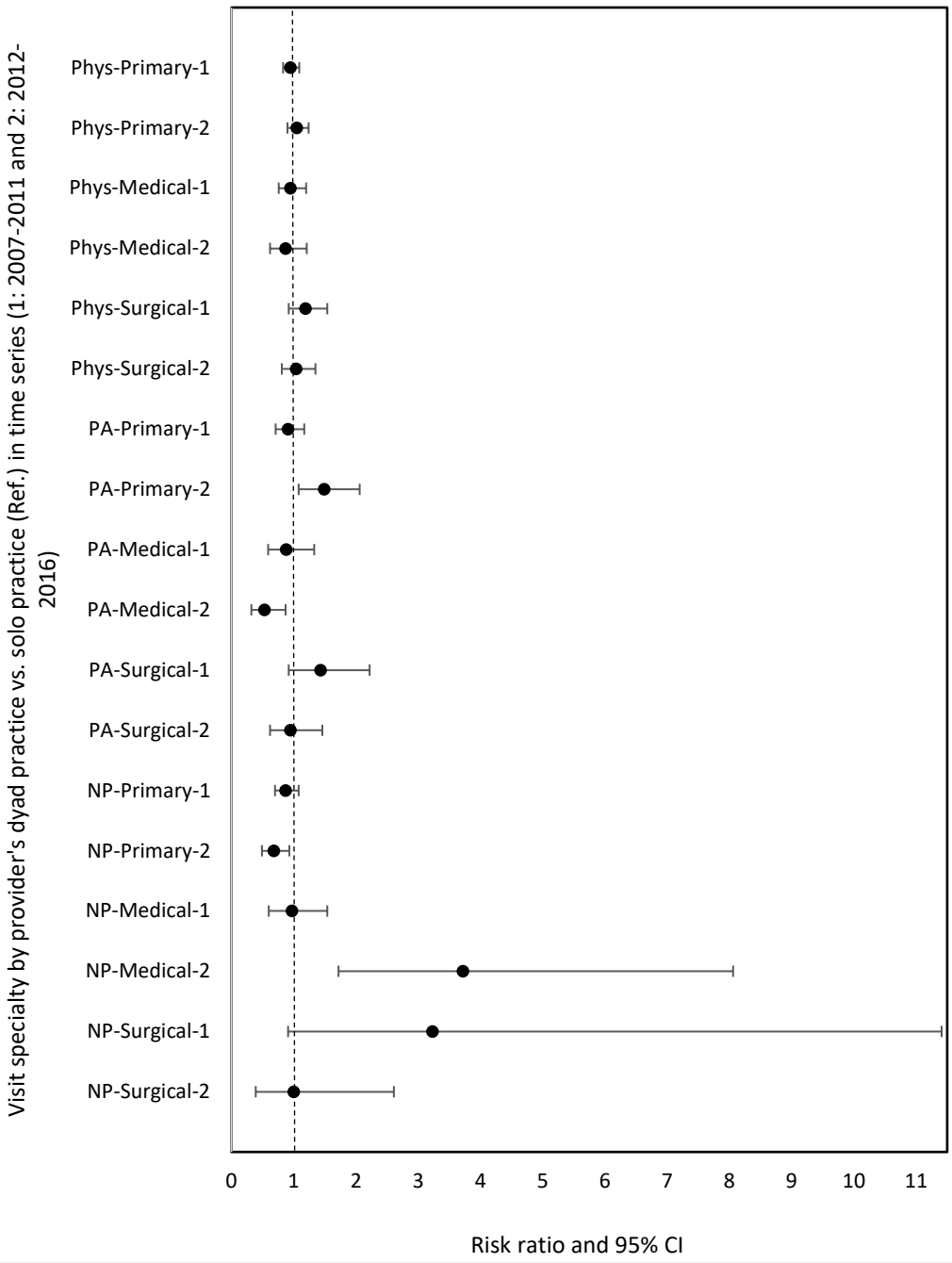
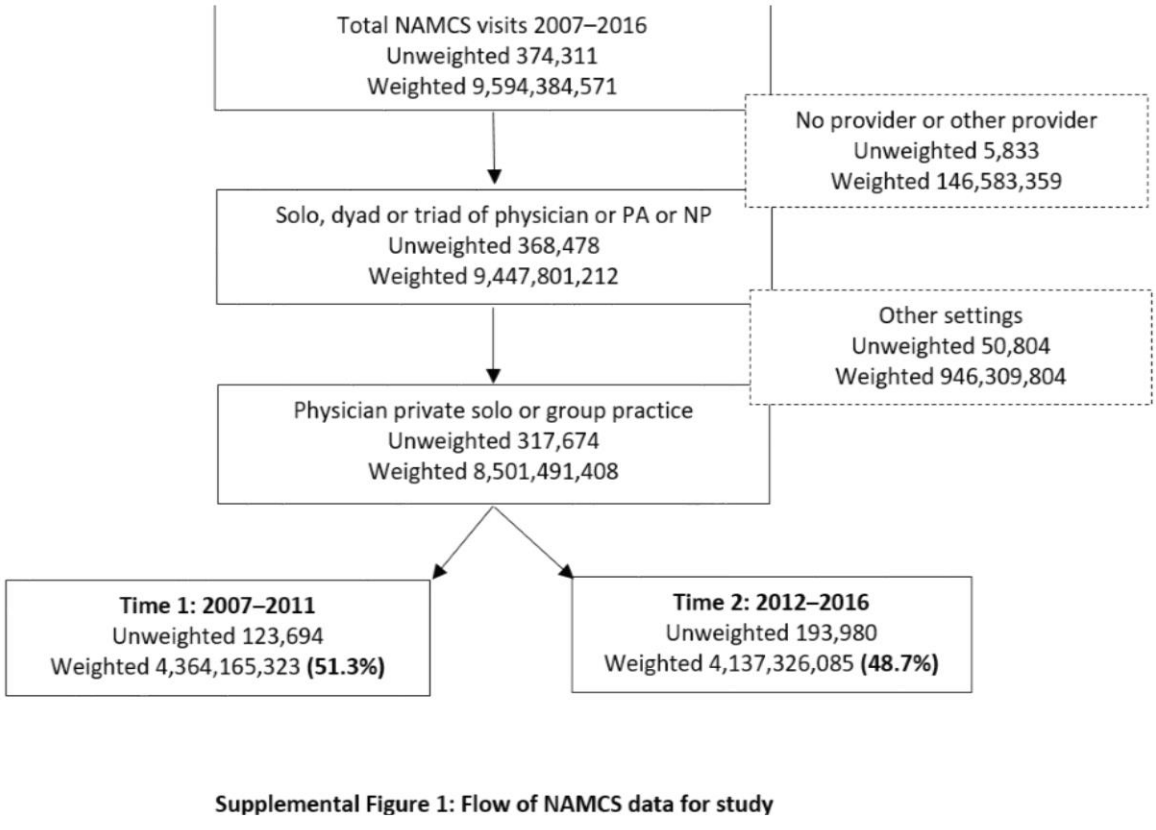


Figure 3: Percent change in major reason for visit between years 2007-2011 and 2012-2016, NAMCS

Figure 4: Risk ratios for the association between specialty visit (primary, medical, surgical) and provider's practice type [dyad vs solo (Ref.)] in time series 1 (2007-2011) and 2 (2012-2016)





Supplemental Figure 1: Flow of NAMCS data for study

Supplemental Table 1: Physician office visits by provider type, controlling for two 5-year time-span, NAMCS

Provider type	Overall[a]		2007–2011[b]		2012–2016[c]		P
	n*1000	% 95% CI	n*1000	% 95% CI	n*1000	% 95% CI	
Solo Physician	7,913,241	93.1 92.1, 94.1	4,091,169	51.7 49.3, 54.1	3,822,071	48.3 45.9, 50.7	.17
Solo-PA	54,498	0.6 0.5, 0.8	36,577	67.1 61.9, 72.3	17,920	32.9 27.7, 38.1	<.01*
Solo-NP	40,844	0.5 0.3, 0.6	26,078	63.8 56.2, 71.5	14,765	36.2 28.5, 43.8	<.01*
Physician-PA	366,711	4.3 3.3, 5.3	168,013	45.8 34.7, 56.9	198,698	54.2 43.1, 65.3	.46
Physician-NP	123,425	1.5 1.1, 1.8	41,308	33.5 25.3, 41.7	82,117	66.5 58.3, 74.7	<.01*
Other Collaborations	2,770	0.03 0.01, 0.05	1,017	36.7 0.0, 84.7	1,753	63.3 15.3, 100.0	.46
Total	8,501,491	100	4,364,165	-	4,137,326	-	

CI: Confidence Interval

[a] Overall 10-year of 2007–2016; [b] Time 1: 5-year time-span of 2007–2011; [c] Time 2: 5-year time-span of 2012–2016

* Significant at alpha=.05

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 the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	2, 5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2, 5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—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 *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	2, 5-6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A 6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	None

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	Supplemental Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		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	7-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-10
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	None
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	None, page 16

*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.