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Regional Variation in Health Care Utilization for Medicare Beneficiaries: A Cross-sectional Study Based on the Health and Retirement Study

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Abstract

Objectives

To investigate whether regional variation changes with different types of beneficiary health insurance coverage.

Design

A cross-sectional study of the Health Retirement Study (HRS) in 2018 was used.

Setting

We categorized Medicare beneficiaries into two groups: 1) those only covered by Medicare (group 1); 2) those covered by Medicare and other health insurance (group 2). Outcomes included health care utilization measures: 1) whether beneficiaries have a hospital stay and 2) the number of hospital stays for those with at least one stay; 3) whether beneficiaries have a doctor's visit and 4) the number of doctor's visits for those with at least one visit. We compared health care utilization in both groups across the five regions: 1) New England & Mid Atlantic; 2) East North Central & West North Central; 3) South Atlantic; 4) East South Central & West South Central; 5) Mountain & Pacific. We used logistic regression for binary outcomes and negative binomial regression for count outcomes in each group.

Participants

We identified 8,749 Medicare beneficiaries, of which 4,098 in group 1 and 4,651 in group2.

Results

We set beneficiaries residing in New England & Mid Atlantic as the reference group. Negative binomial regression results suggested that individuals living in all non-reference regions (except South Atlanta) had significantly lower incident rates of hospital stays in group 2, which is not significant in group 1.

Logistic regression results suggested that individuals living in all non-reference regions had a significantly lower probability of seeking a doctor's visit in group 1, which is not significant in group 2.

Conclusion:

Regional variation in the likelihood of having a doctor's visit was reduced in Medicare beneficiaries covered by supplemental health insurance. Regional variation in hospital stays was accentuated among Medicare beneficiaries covered by supplemental health insurance.

Strengths and limitations of this study

- This is a large nationwide study, which identified 8,749 Medicare beneficiaries. 4,098 in those only covered by Medicare (group 1) and 4,651 in those covered by Medicare and other health insurance (group 2).
- Regional variation broadly exists in Medicare beneficiaries. However, this variation is not in the same direction when considering different health care settings among different Medicare beneficiary groups. Therefore, different types of beneficiary health insurance coverage play a role in changing regional variation in Medicare.
- Health insurance coverage plays a role in changing regional variation. For different subgroups, the government can adjust different health insurance coverage to reduce regional variation.
- Our study was limited to general doctor's visits and hospital stays and we could not study any other specific health care services.
- Medicare has undergone substantial changes including the growth of Medicare Advantage and the introduction of numerous pay-for-performance and value-based programs. We cannot identify these specific plans in the data, which limits our ability to assess the extent to which our estimated regional variations are driven by these different Medicare plans.

Introduction

Equal access to health care is important to reduce health disparity.[1] People should be given the same chance of getting appropriate treatment if they share the same type and degree of health need.[2] The 2010 Patient Protection and Affordable Care Act (PPACA) was a substantial health care reform aiming to change the health care payment system and to improve quality of care while reducing cost.[3] Since equal access is not the primary goal of this health care reform, the concern of important geographic variation in the use of health care services have been raised.[4,5]

Medicare aims to cover all elderly individuals who are over 65, as well as individuals less than 65 years of age with disabilities and renal disease. Medicare experienced many changes in the PPACA health care reform. Since Medicare is managed by the federal government with nearly the same standard across the nation, regional variation may be a primary factor for unequal access to health care. Individuals in some regions will have barriers to access necessary health resources. These unequal access to healthcare may be related to possible inefficiencies and inequality in the supply of health care. Since many Medicare beneficiaries are also covered by other health insurance, an interesting question arises, "does regional variation change across beneficiaries with different types of health insurance coverage?" Many studies have explored regional variation in health care utilization among Medicare beneficiaries, but these studies have some limitations.[5–12] Most studies were conducted over decades ago, but Medicare has experienced important changes in recent years. Thus, these studies may no longer reflect the current situation. Moreover, few studies have considered how regional variation may change with different types of beneficiary health insurance coverage.

Therefore, it is necessary to revisit the question of regional variation in health utilization among Medicare beneficiaries post-PPACA. Our new study bridges this research gap. We aim to identify 1) whether regional variation still exists among Medicare beneficiaries and 2) whether regional variation changes across Medicare beneficiaries with different types of health insurance coverage.

Method

Source of data

Data are based on the Health and Retirement Study (HRS) in 2018. HRS is a nationally representative longitudinal survey, which has been fielded every 2 years since 1992. It provides information on a broad array of domains including income and wealth; health, cognition and use

of healthcare services; work and retirement; and family connections. The samples of HRS are drawn based on a multi-stage area probability design, involving geographical stratification, clustering and oversampling of certain demographic groups. HRS includes data for over 37000 individuals over age 50 and 23000 households in the USA.[13]

Study Design

Figure 1 shows the flow chart for the analytic sample used in this study. There were 20,847 respondents in the 2018 HRS. 4,221 participants with a missing value in residence region were excluded. 7,333 participants that had a missing value in Medicare coverage or not covered by Medicare were dropped as well. Additionally, 544 participants with missing value on demographic characteristics were excluded. The final analytic sample included 8,749 HRS respondents with reported Medicare coverage. We separated Medicare beneficiaries into 2 mutually exclusive groups based on health insurance coverage type: 1) 4,098 participants are only covered by Medicare (henceforth, group 1); 2) 4,651 participants are covered by both Medicare and supplemental health insurance (e.g., Medicaid, VA/CHAMPUS, and private health insurance) (henceforth, group 2). We did not exclude individuals who were covered by long-term care insurance from the Medicare-only group due to a large number of individuals with chronic diseases.

Dependent variables

We constructed four dependent variables. Two dummy variables for whether the individual had any hospital stay or doctor's visit in the last two years. The other two variables measured the number of hospital stays for survey respondents with an inpatient visit in the previous two years and the number of doctor's visits for those with an outpatient visit during the previous two years.

Independent variables

Our primary independent variable of interest was the Medicare beneficiaries' region of residence, defined based on their reported state of residence: 1) New England Division & Middle Atlantic Division; 2) East North Central Division & West North Central Division; 3) South Atlantic Division; 4) East South Central Division & West South Central Division; 5) Mountain Division & Pacific Division.

Other variables included patient demographic characteristics: gender, age, educational level, total household annual income per capita (PCI), employment status and chronic disease conditions.

Statistical Analysis

We compared characteristics of Medicare-only covered beneficiaries and beneficiaries with Medicare and supplemental insurance. Means and proportions were compared using chi-square tests. We modeled health care utilization of Medicare beneficiaries using multivariate regression models. Logistic regressions were used to model binary outcomes (any hospital stay, any doctor's visit in the past two years). Negative binomial regressions were used to model count outcomes. To better reflect the variation of health care utilization, we used the country map to visualize hospital stays and doctor visits. In order to reflect the relative difference, we used event ratios instead of the exact events, directly. We set the New England & Mid Atlantic region as the reference group (i.e. event ratio = 1). The event ratio for other regions was calculated as hospital stays (in other regions)/hospital stays (the New England & Mid Atlantic region) or doctor's visits (in other regions)/doctor visits (the New England & Mid Atlantic region), separately. All our analyses are conducted with R 4.1.1.

Patient and public involvement

We report no patient or public involvement in the design or implementation of the study.

Results

Demographic Characteristics

Among Medicare-only covered beneficiaries, all demographic characteristics were significantly different across beneficiary region of residence, except for gender and employment status (Table 1). In terms of health care utilization, we found that individuals living in the Mountain & Pacific region had the lowest number of hospital stay in both groups. Individuals living in the East North & West North Central region had the lowest number of doctor visit in both groups (Figure 2).

Among individuals who were only covered by Medicare, 546, 885, 1,049, 755, and 863 individuals were in New England & Mid Atlantic regions, EN Central & WN Central regions, S Atlantic regions, ES Central & WS Central regions, and Mountain & Pacific regions, respectively. Among individuals who are both covered by Medicare and other health insurances, 720, 1,093, 1,151, 893, and 794 individuals are in each region category, respectively. ES and WS central regions had the highest percentage of individuals who were below age 65 (16.82%) and the lowest percentage of individuals who were over age 85 (11.39%). Mountain and Pacific regions had the lowest percentage of individuals who were below 65 (8.23%) and the highest percentage of individuals who were over 85 (12.86%) (Table 1).

Table 1: Descriptive Statistics

	Individuals Who Are Only Covered by Medicare (N=4,098)										Individuals Who Are Covered by Medicare and Other Health Insurance (N=4,651)									
Region	**New England & Mid Atlantic**		**EN Central & WN Central**		**S Atlantic**		**ES Central & WS Central**		**Mountain & Pacific**		**New England & Mid Atlantic**		**EN Central & WN Central**		**S Atlantic**		**ES Central & WS Central**		**Mountain & Pacific**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	N	%	N	%	N	%	N	%	N	%
Total	546	13.32	885	21.6	1,049	25.6	755	18.42	863	21.065	720	15.48	1,093	23.5	1,151	24.74	893	19.2	794	17.07
Age																				
<65	60	10.99	75	8.47	118	11.25	127	16.82	71	8.23	111	15.42	132	12.08	142	12.34	146	16.35	105	13.22
65-74	198	36.26	317	35.82	386	36.8	271	35.89	354	41.02	286	39.72	429	39.25	462	40.14	365	40.87	346	43.58
75-84	187	34.25	360	40.68	418	39.85	271	35.89	327	37.89	228	31.67	356	32.57	414	35.97	289	32.36	245	30.86
>85	101	18.5	133	15.03	127	12.11	86	11.39	111	12.86	95	13.19	176	16.1	133	11.56	93	10.41	98	12.34
Gender																				
Male	229	41.94	373	42.15	424	40.42	311	41.19	367	42.53	281	39.03	445	40.71	472	41.01	326	36.51	357	44.96
Female	317	58.06	512	57.85	625	59.58	444	58.81	496	57.47	439	60.97	648	59.29	679	58.99	567	63.49	437	55.04
Race																				
NH White	364	66.67	699	78.98	595	56.72	351	46.49	513	59.44	464	64.44	864	79.05	740	64.29	482	53.98	504	63.48
NH Black	115	21.06	146	16.5	323	30.79	223	29.54	71	8.23	151	20.97	186	17.02	309	26.85	216	24.19	56	7.05
Hispanic	53	9.71	21	2.37	96	9.15	161	21.32	229	26.54	90	12.5	15	1.37	68	5.91	173	19.37	188	23.68
Other	14	2.56	19	2.15	35	3.34	20	2.65	50	5.79	15	2.08	28	2.56	34	2.95	22	2.46	46	5.79
Education																				
Less than high school education	101	18.5	111	12.54	204	19.45	226	29.93	152	17.61	137	19.03	111	10.16	190	16.51	224	25.08	142	17.88
High School/GED	288	52.75	530	59.89	571	54.43	370	49.01	435	50.41	363	50.42	674	61.67	591	51.39	474	53.08	376	47.36
Undergraduate	103	18.86	170	19.21	192	18.3	115	15.23	192	22.25	152	21.11	213	19.49	227	19.73	135	15.12	179	22.54
Graduate	54	9.89	74	8.36	82	7.82	44	5.83	84	9.73	68	9.44	95	8.69	143	12.43	60	6.72	97	12.22
Chronic disease																				
No chronic disease	36	6.59	60	6.78	57	5.43	32	4.24	68	7.88	52	7.22	68	6.22	60	5.21	32	3.58	61	7.68
Only one chronic disease	96	17.58	141	15.93	167	15.92	117	15.5	181	20.97	127	17.64	212	19.4	179	15.55	132	14.78	162	20.4
More than one chronic disease	414	75.82	684	77.29	825	78.65	606	80.26	614	71.15	541	75.14	813	74.38	912	79.24	729	81.63	571	71.91
Employment status																				

Full-time	19	3.48	40	4.52	54	5.15	31	4.11	55	6.37	50	6.94	68	6.22	72	6.26	64	7.17	56	7.05
Part-time	65	11.9	100	11.3	115	10.96	76	10.07	100	11.59	71	9.86	113	10.34	122	10.61	77	8.62	75	9.45
Unemployed	34	6.23	30	3.39	52	4.96	52	6.89	43	4.98	56	7.78	50	4.57	59	5.13	66	7.39	53	6.68
Retired	428	78.39	715	80.79	828	78.93	596	78.94	665	77.06	543	75.42	862	78.87	898	78.02	686	76.82	610	76.83
Household income																				
Lower income	468	85.71	755	85.31	932	88.85	678	89.8	721	83.55	631	87.64	894	81.79	976	84.8	797	89.25	651	81.99
Middle income	39	7.14	62	7.01	69	6.58	42	5.56	54	6.26	51	7.08	97	8.87	96	8.34	56	6.27	68	8.56
Upper income	39	7.14	68	7.68	48	4.58	35	4.64	88	10.2	38	5.28	102	9.33	79	6.86	40	4.48	75	9.45

(EN: East North; WN: West North; S: South; ES: East South; WS: West South; NH: Non-Hispanic; GED: General Educational Development)

EN and WN central regions had the highest percentage of Non-Hispanic white beneficiaries (79.98%), while ES and WS central regions had the lowest percentage of Non-Hispanic whites (46.49%). South Atlantic regions had the highest percentage of Non-Hispanic Black beneficiaries (30.79%), while Mountain and Pacific regions had the lowest percentage of Non-Hispanic Blacks (8.23%). Mountain and pacific regions had the highest percentage of Hispanic beneficiaries (26.54%), while EN and WN central regions had the lowest percentage of Hispanics (2.37%). Beneficiaries with less than a high school education were more concentrated in ES and WS central regions (29.93%) and less concentrated in EN and WN central regions (12.54%). Beneficiaries with a graduate degree were more concentrated in Mountain and Pacific regions (9.73%), but less concentrated in ES and WS central regions (5.83%). Considering the distribution of beneficiaries according to chronic diseases conditions reporting, ES and WS central regions had the highest percentage of individuals with more than one chronic disease (80.26%). Mountain and Pacific regions had the lowest percentage of individuals with more than one chronic disease (71.15%).

We used Pew's study to categorize our income groups.[14] ES and WS central regions had the highest percentage of lower income (<$17,400) individuals (89.8%), while Mountain and Pacific regions had the lowest percentage of lower income individuals (83.55%). In contrast, South Atlantic regions had the lowest percentage of upper income (>$52,200) individuals (4.58%), while Mountain and Pacific regions had the highest percentage of upper income individuals (10.2%).

Among Medicare beneficiaries with supplemental insurances, there were significant variations in demographics across all residence regions (Table 1). Considering the distribution of health care utilization across regions, individuals living in the New England & Mid Atlantic regions had the highest number of hospital stays, while individuals living in the Mountain & Pacific regions had the lowest number of hospital stays (Figure 2). Individuals living in the South Atlantic regions had the highest number of doctor's visits, while individuals living in the East North & West North Central regions had the lowest number of doctor's visits (Figure 2).

ES and WS central regions had the highest percentage of individuals who were below 65 (16.35%) and the lowest percentage of individuals who were over 85 (10.41%) (Table 1). EN and WN central regions had the lowest percentage of individuals who were below 65 (12.08%) and the highest percentage of individuals who were over 85 (16.1%). EN and WN central regions had the highest percentage of Non-Hispanic white (79.05%), while ES and WS central regions had the

lowest percentage of Non-Hispanic white (53.98%). South Atlantic regions had the largest percentage of Non-Hispanic Black (26.85%), while Mountain and Pacific regions had the lowest percentage of Non-Hispanic Black (7.05%). Mountain and pacific regions had the largest percentage of Hispanics (23.68%), while EN and WN central regions had the lowest percentage of Hispanics (1.37%).The percentage of individuals without a high school degree was highest in ES and WS central regions (25.08%) and lowest in EN and WN central regions (10.16%). Conversely, the percentage of people with a graduate degree was highest in Mountain and Pacific regions (12.22%) and lowest in ES and WS central regions (6.72%).

The percentage of individuals with at least one chronic condition was highest in ES and WS central regions (81.63%), and lowest in Mountain and Pacific regions (71.91%).

Considering annual household income per capita, the percentage of individuals with lower income was highest in ES and WS central regions (89.25%) and lowest in Mountain and Pacific regions (81.99%). The percentage of individuals with higher income was highest in Mountain and Pacific regions (9.45%) and lowest in ES and WS central regions (4.48%).

Logistic regression Results

Factors associated with changes in hospital stays in Medicare beneficiaries

Logistic regressions suggested that individuals living in Mountain & Pacific region were less likely to have a hospital stay than those residing in New England & Mid-Atlantic region among Medicare-only covered beneficiaries (OR=0.766, P<0.05). However, there were no significant differences in the probability of having a hospital stay across different regions among Medicare beneficiaries with supplemental insurances (Table 2).

Table 2 : Logistic Regression Results

	Individuals Who Are Only Covered by Medicare (N=4,089) vs. Individuals Who Are Covered by Medicare and Other Health Insurances (N=4,642) in Hospital Stay								Individuals Who Are Only Covered by Medicare (N=3,641) vs. Individuals Who Are Covered by Medicare and Other Health Insurances (N=3,910) in Doctor Visit							
Have a visit last two years (no=0, yes=1)	**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**				**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**			
	OR		**95%**	**CI**	**OR**		**95%**	**CI**	**OR**		**95%**	**CI**	**OR**		**95%**	**CI**
Region																
New England & Mid Atlantic	Ref				Ref				Ref				Ref			
EN Central & WN Central	0.999		0.784	1.272	1.103		0.896	1.359	0.606	**	0.374	0.982	1.072		0.671	1.713
S Atlantic	1.11		0.879	1.402	1.012		0.824	1.244	0.619	**	0.392	0.977	0.893		0.576	1.383
ES Central & WS Central	0.921		0.714	1.187	0.871		0.7	1.084	0.472	***	0.299	0.746	0.909		0.585	1.414
Mountain & Pacific	0.766	**	0.594	0.987	0.918		0.73	1.154	0.618	**	0.386	0.99	1.116		0.804	2.152
Age																
<65	Ref				Ref				Ref				Ref			
65-74	0.821		0.637	1.058	0.722	***	0.586	0.889	0.887		0.578	1.363	0.884		0.568	1.375
75-84	1.046		0.813	1.344	0.882		0.713	1.091	0.996		0.643	1.541	0.967		0.607	1.543
>85	1.48	***	1.109	1.975	1.261	*	0.982	1.62	0.77		0.466	1.273	0.621	*	0.37	1.043
Gender																
Male	Ref				Ref				Ref				Ref			
Female	0.755	***	0.654	0.871	1.002		0.879	1.143	1.321	**	1.042	1.676	1.427	**	1.084	1.88
Race																
NH White	Ref				Ref											
NH Black	0.85	*	0.704	1.026	0.961		0.807	1.144	0.477	***	0.35	0.65	0.763	***	0.389	0.813
Hispanic	0.822		0.647	1.044	0.767	**	0.603	0.976	0.283	***	0.204	0.394	0.681	***	0.189	0.418
Other	1.451	*	0.985	2.138	1.303		0.911	1.862	0.684		0.356	1.314	1.086		0.42	2.808
Education																
Less than high school education	Ref				Ref				Ref				Ref			
High School/GED	1.079		0.888	1.312	1.156		0.958	1.396	2.142	***	1.627	2.821	1.955	***	1.403	2.724

Undergraduate	1.167		0.917	1.485	1.123		0.892	1.414	3.147	***	2.082	4.755	2.712	***	1.677	4.384
Graduate	0.87		0.631	1.199	0.912		0.687	1.21	2.875	***	1.639	5.042	5.295	***	2.25	11.535
Chronic disease																
No chronic disease	Ref				Ref				Ref				Ref			
Only one chronic disease	1.813	***	1.158	2.839	1.659	**	1.098	2.506	2.438	***	1.558	3.815	2.925	***	1.72	4.974
More than one chronic disease	3.579	***	2.369	5.406	3.832	***	2.618	5.609	3.891	***	2.606	5.81	3.945	***	2.433	6.078
Employment status																
Full-time	Ref				Ref				Ref				Ref			
Part-time	1.025		0.668	1.573	1.046		0.721	1.518	1.008		0.529	1.923	1.047		0.784	3.458
Unemployed	1.112		0.676	1.83	1.963	***	1.316	2.929	0.805		0.384	1.69	2.004		0.874	4.599
Retired	1.22		0.835	1.781	1.609	***	1.181	2.192	0.989		0.561	1.744	1.531		0.828	2.832
Household income																
Lower income	Ref				Ref				Ref				Ref			
Middle income	0.618	**	0.447	0.854	0.854		0.663	1.1	0.657	*	0.412	1.047	1.44	**	1.054	5.648
Upper income	0.949		0.702	1.283	0.963		0.738	1.255	0.925		0.542	1.578	1.157		0.602	2.223

(EN: East North; WN: West North; S: South; ES: East South; WS: West South; NH: Non-Hispanic; GED: General Educational Development)

We show odds ratios here, and 95% CI in parentheses. Counts do not sum to 4,098 or 4,651 due to missing values for some of the independent variables.

***Significant at 1 percent level (two-tailed test).

**Significant at 5 percent level (two-tailed test).

*Significant at 10 percent level (two-tailed test).

Age was significantly associated with hospital stays. Among Medicare-only covered beneficiaries, individuals aged over 85 were significantly more likely to have a hospital stay (OR=1.480, p<0.01), compared to individuals under 65. Among Medicare beneficiaries with supplemental insurance, individuals aged between 65 and 74 were less likely to have a hospital stay (OR=0.722, p<0.01). Females were less likely to have a hospital stay (OR=0.755, p<0.01) among Medicare-only covered beneficiaries, while there were no significant differences across gender categories among Medicare beneficiaries with supplemental insurance. The results also suggested that race and education were not significantly related to hospital stays in Medicare-only covered beneficiaries. Among Medicare beneficiaries with supplemental insurance, Hispanic were less likely to have a hospital stay (OR=0.767, p<0.05), and there was no significant difference across education categories. The results also suggested that individuals with one chronic disease (OR=1.813, p<0.01) and with more than one chronic disease (OR=3.579, p<0.01) were more likely to have a hospital stay in group 1. In group 2, individuals with one chronic disease (OR=1.659, p<0.01) and with more than one chronic disease (OR=3.832, p<0.01) were also more likely to have a hospital stay. In terms of employment status, there was no significant differences in group 1. However, unemployment (OR=1.963, p<0.01) and retired (OR=1.609, p<0.01) individuals were more likely to have a hospital stay. In terms of household income, results suggested that only middle-income (≥$13,337 and ≤$4xxxx) individuals (OR=0.618, p<0.01) were significantly less likely to have a hospital stay compared to lower income individuals in group 1. However, there was no significant differences related to household income in group 2 (Table 2).

Factors associated with changes in doctor's visit in Medicare beneficiaries

Logistic regressions suggested that individuals in EN Central & WN Central region (OR=0.606, p<0.05), S Atlantic region (OR=0.619, p<0.05), ES Central & WS Central region (OR=0.472, p<0.01), and Mountain & Pacific region (OR=0.618, p<0.05) were less likely to have a doctor's visit than those residing in New England & Mid-Atlantic region among Medicare-only covered beneficiaries. However, there were no significant differences in the probability of having a doctor's visit among Medicare beneficiaries with supplemental insurances (Table 2).

There was no significant relationship between age and doctor's visits in both groups. Females were more likely to have a doctor's visit in both group 1 (OR=1.321, p<0.05) and group 2 (OR=1.427, p<0.05). Results also suggested that Non-Hispanic black (OR=0.477, p<0.01) and Hispanics (OR=0.283, p<0.01) were less likely to have a doctor's visit in group 1. In group 2, Non-

Hispanic white (OR=0.563, p<0.01) and Non-Hispanic black (OR=0.281, p<0.01) were also less likely to have a doctor's visit. Education was significantly related to doctor's visits in both group 1 and group 2. In group 1, individuals with a high school degree (OR=2.142, p<0.01), a college degree (OR=3.147, p<0.01), and a graduate degree (OR=2.875, p<0.01) were more likely to have a doctor's visit, compared to individuals without a high school degree. In group 2, the results were similar. Individuals with a high school degree (OR=1.955, p<0.01), a college degree (OR=2.712, p<0.01), and a graduate degree (OR=5.095, p<0.01) were more likely to have a doctor's visit, compared to individuals without a high school degree.

Results suggested that individuals with one chronic condition (OR=2.438, p<0.01 in Medicare-only covered individuals and OR=2.925, p<0.01 in Medicare beneficiaries with supplemental insurance) and those with more than one chronic condition (OR=3.891, p<0.01 01 in Medicare-only covered individuals and OR=3.845, p<0.01 in Medicare beneficiaries with supplemental insurance) were more likely to have a doctor's visit. We did not notice significant associations between the outcome variables and employment status in both groups, and between the outcome variables and household income in group 2. However, middle income (≥$13,367, and≤$40,133) individuals were more likely to have a doctor's visit among Medicare beneficiaries with supplemental insurance, compared to lower income individuals (Table 2).

Negative binomial regression results

In terms of hospital stays, results suggested that there was no difference in the incident rate among different regions among Medicare-only covered beneficiaries. However, individuals in EN Central & WN Central region (IRR=0.797, p<0.01), ES Central & WS Central region (IRR =0.740, p<0.01), and Mountain & Pacific region (IRR =0.726, p<0.01) had fewer incident rates of hospital stays than those residing in New England & Mid-Atlantic region in group 2 (Table 3).

Table 3: Negative Binomial Regression Results

	Individuals Who Are Only Covered by Medicare (N=1,126) vs. Individuals Who Are Covered by Medicare and Other Health Insurances (N=1,462) in Hospital Stay								Individuals Who Are Only Covered by Medicare (N=3,032) vs. Individuals Who Are Covered by Medicare and Other Health Insurances (N=3,307) in Doctor's Visit							
Visit times of last two years (visit >=1)	**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**				**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**			
	IRR		**95%**	**CI**	**IRR**		**95%**	**CI**	**IRR**		**95%**	**CI**	**IRR**		**95%**	**CI**
Region																
New England & Mid Atlantic	Ref				Ref				Ref				Ref			
EN Central & WN Central	0.902		0.756	1.076	0.797	***	0.691	0.919	0.743	***	0.668	0.826	0.884	**	0.797	0.981
S Atlantic	1.047		0.886	1.236	0.903		0.784	1.039	0.847	***	0.763	0.939	1.057	***	1.043	1.283
ES Central & WS Central	1.058		0.882	1.270	0.740	***	0.634	0.865	0.846	***	0.755	0.947	0.997		0.893	1.115
Mountain & Pacific	0.882		0.728	1.069	0.726	***	0.613	0.859	0.806	***	0.722	0.900	1.140	**	1.017	1.278
Age																
<65	Ref				Ref				Ref				Ref			
65-74	0.802	**	0.672	0.957	0.757	***	0.658	0.870	0.748	***	0.665	0.840	0.819	***	0.646	0.801
75-84	0.781	***	0.658	0.927	0.663	***	0.575	0.764	0.733	***	0.651	0.824	0.786	***	0.614	0.767
>85	0.785	**	0.646	0.954	0.644	***	0.545	0.761	0.717	***	0.626	0.822	0.781	***	0.686	0.890
Gender																
Male	Ref				Ref				Ref				Ref			
Female	1.111	**	1.002	1.233	0.872	***	0.793	0.957	1.002		0.940	1.068	1.043		0.977	1.113
Race																
NH White	Ref				Ref				Ref				Ref			
NH Black	0.937		0.819	1.072	1.035		0.916	1.170	0.932		0.857	1.015	0.823	***	0.754	0.898
Hispanic	1.066		0.898	1.265	1.066		0.893	1.272	1.011		0.904	1.129	1.029		0.817	1.057
Other	0.813		0.605	1.093	1.081		0.853	1.371	1.359	***	1.135	1.628	1.172	*	0.974	1.410
Education																
Less than high school education	Ref				Ref				Ref				Ref			
High School/GED	0.824	***	0.721	0.943	1.117		0.976	1.277	1.048		0.957	1.149	0.929		0.842	1.025

Undergraduate	0.859		0.724	1.020	0.914		0.773	1.081	1.174	***	1.052	1.310	0.933		0.830	1.048
Graduate	0.873		0.689	1.107	0.934		0.750	1.162	1.230	***	1.073	1.411	1.208	***	1.054	1.385
Chronic disease																
No chronic disease	Ref				Ref				Ref				Ref			
Only one chronic disease	0.829		0.549	1.252	0.983		0.671	1.440	1.712	***	1.450	2.021	1.467	***	1.243	1.731
More than one chronic disease	1.109		0.760	1.619	1.261		0.884	1.799	2.261	***	1.941	2.634	2.262	***	1.939	2.639
Employment status																
Full-time	Ref				Ref				Ref				Ref			
Part-time	0.865		0.607	1.232	1.115		0.801	1.550	1.132		0.942	1.360	1.092		0.907	1.316
Unemployed	1.002		0.679	1.478	1.310		0.942	1.820	1.706	***	1.363	2.135	1.651	***	1.090	1.674
Retired	1.147		0.841	1.564	1.562	***	1.185	2.058	1.358	***	1.152	1.602	1.283	***	1.089	1.513
Household income																
Lower income	Ref				Ref				Ref				Ref			
Middle income	0.911		0.702	1.181	1.042		0.862	1.260	1.133	*	0.997	1.287	0.951		0.847	1.068
Upper income	0.892		0.702	1.133	0.941		0.764	1.159	0.974		0.859	1.106	0.931		0.822	1.054

EN: East North; WN: West North; S: South; ES: East South; WS: West South; NH: Non-Hispanic; GED: General Educational Development)

We show odds ratios here, and 95% CI in parentheses. Counts do not sum to 4,098 or 4,651 due to missing values for some of the independent variables.

***Significant at 1 percent level (two-tailed test).

**Significant at 5 percent level (two-tailed test).

*Significant at 10 percent level (two-tailed test).

Individuals aged 65-74 years (IRR=0.802, p<0.05), 75-84 years (IRR=0.781, p<0.01), and over age 85 (IRR=0.785, p<0.05) had significantly fewer incident rates of hospital stays in group 1, compared to individuals under 65. In group 2, the results were similar. Individuals who were aged 65-74 years (IRR=0.757, p<0.01), 75-84 years (IRR=0.663, p<0.01), and over age 85 (IRR=0.644, p<0.01) had significantly fewer incident rates of hospital stays. Females had a higher incident rate of hospital stays in group 1 (IRR=0.111, p<0.05), while they had a lower incident rate of hospital stays in group 2 (IRR=0.872, p<0.01). Individuals with a high school degree had a significantly lower incident rate of hospital stays (IRR=0.824, p<0.01), compared to individuals without a degree. Retired individuals (IRR=1.562, p<0.01) had a higher incident rate of hospital stays, compared to individuals with a full-time job. However, we found that variables not significantly related to changes in the incident rate of hospital stays included race, chronic diseases, and household income in both groups, education in group 2, employment status in group 1 (Table 3).

In terms of doctor's visit, the results suggested that individuals in EN Central & WN Central region (IRR=0.743, p<0.01), S Atlantic region (IRR=0.847, p<0.01), ES Central & WS Central region (IRR=0.846, p<0.01), and Mountain & Pacific region (IRR=0.806, p<0.01) had lower incident rates of doctor's visits than those residing in New England & Mid-Atlantic region in group 1.

In group 2, results suggested that individuals in EN Central & WN Central region (IRR=0.884, p<0.01) had a lower incident rate of doctor's visits than individuals residing in New England & Mid-Atlantic region. However, individuals in S Atlantic region (IRR=1.157, p<0.01) and Mountain & Pacific region (IRR=1.140, p<0.01) had a higher incident rate of doctor's visits than those residing in New England & Mid-Atlantic region in group 2 (Table 3). There was a significant relationship between age and doctor's visits in both groups. Individuals who were aged 65-74 years (IRR=0.748, p<0.01), 75-84 years (IRR=0.733, p<0.01), and over age 85 (IRR=0.717, p<0.01) had significantly lower incident rates of doctor's visits in group 1, compared to individuals under 65. Individuals who were aged 65-74 years (IRR =0.719, p<0.01), 75-84 years (IRR=0.686, p<0.01), and over age 85 (IRR=0.781, p<0.01) had significantly lower incident rates of doctor's visits in group 2. Gender was not significantly related to doctor's visits in both groups this time. In terms of race, the results suggested that other races (IRR=1.359, p<0.01) had a higher incident rate of doctor's visits in group 1. In group 2, Non-Hispanic black (IRR=0.823, p<0.01) had a lower

incident rate of doctor's visits. In terms of education, individuals with a college degree (IRR=1.174, p<0.01) and a graduate degree (IRR=1.230, p<0.01 in group 1; IRR=1.208, p<0.01 in group 2) had higher incident rates of doctor's visit, compared to individuals without a degree.. In terms of chronic disease, the results suggested that individuals with one chronic disease (IRR=1.712, p<0.01 in group 1; IRR=1.467, p<0.01 in group 2) and with more than one chronic disease (IRR=2.261, p<0.01 in group 1; IRR=2.262, p<0.01 in group 2) had more incident rate of doctor's visits. In terms of employment status, the results were similar between group 1 and group 2. Unemployed individuals (IRR=1.706, p<0.01 in group 1; IRR=1.351, p<0.01 in group 2) and retired individuals (IRR=1.358, p<0.01 in group 1; IRR=1.283, p<0.01 in group 2) had more incident rate of doctor's visits, compared individuals with a full-time job. Household income was not significantly related to incident rate of doctor's visits in both groups (Table 3).

Discussion

Our analysis has identified significant regional variation in health care utilization among Medicare beneficiaries.

In terms of the probability of a hospital stay, the regional variation only occurred in the Mountain & Pacific region of group 1. Considering the frequency of hospital stays instead, regional variation only occurred in group 2. In terms of the probability of a doctor's visit, regional variation was only estimated in group 1. Considering the frequency of doctor's visits, regional variation was estimated in both groups. However, the magnitude of the estimated coefficient was smaller in group 2 relative to group 1.

One potential explanation may be that narrow provider networks restricted access to care for Medicare beneficiaries.[15–17] Compared to New England and Mid-Atlantic regions, Medicare plans in other regions may not provide large enough provider networks. Compared to Medicare beneficiaries with supplemental health insurance, Medicare-only beneficiaries are confronted with restrictions as an important barrier in health care access.[15,18] Other barriers to access like lack of transportation may further restrict access to health care for certain Medicare beneficiaries.[19] New England and Mid-Atlantic regions have better public transportations than other regions. Therefore, individuals in England and Mid-Atlantic regions may have less barrier to access health care utilization.

We found that, compared to individuals with a full-time job, unemployed and retired individuals were more likely to have health care visits and also had a higher number of visits.

These results are consistent with findings in other studies that show that individual's health is negatively related to economic profiles.[20,21] These studies also show reverse causality between lower health status and unemployment status. A potential reason is that poor health may cause longer unemployment spells.[22] Some studies also suggest that ill workers are more likely to become unemployed.[23–25] Moreover, this can also be a potential explanation for the regional variation estimated in health care utilization: Regions with different health care utilization may differ in their population's economic profiles.

Unlike findings in previous studies, we found that household income was not significantly related to frequency of health care visits.[26,27]

Policy Implications

There are several important implications of our research. First, regional variation broadly exists in Medicare beneficiaries. However, this variation is not in the same direction when considering different health care settings among different Medicare beneficiary groups. Second, although household income is not related to health care utilization, employment status is significantly associated with health care utilization. Unemployment and retired individuals seek more health care in both groups, especially in the outpatient setting. This suggests that unemployed individuals may need more care and potential assistance. Therefore, health care programs and reforms should increase health care access for unemployed and retired individuals. Finally, Health insurance coverage plays a role in changing regional variation. For different subgroups, the government can adjust different health insurance coverage to reduce regional variation.

Limitations

There are some important limitations in this study. First, we combined nearby regions to increase the sample size in selected region classifications. Each region has many states, so these average estimates may mask variation across states within the same region. Second, Medicare has undergone substantial changes including the growth of Medicare Advantage and the introduction of numerous pay-for-performance and value-based programs.[28,29] We cannot identify these specific plans in the HRS which limits our ability to assess the extent to which our estimated regional variations are driven by these different Medicare plans. Third, data were collected through a survey, which may lead to a recall bias. Fourth, our study was limited to general doctor's visits and hospital stays and we could not study any other specific health care services, due to data

limitations. Notwithstanding these limitations, our study provides a general landscape of health care utilization among Medicare beneficiaries.

Conclusion

Regional variation exists in health care utilization for Medicare beneficiaries, and regional variation also changes in beneficiaries with different types of coverage. Further studies are needed to elicit the reasons explaining these variations.

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This article is finished by myself for my personal interests.

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Competing interests

None declared.

Patient and public involvement statement

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

Patient consent for publication

Not required.

Ethics approval

Ethics approval was not required since this is an analysis of publicly available secondary data (Health and Retirement Study).

Data availability statement

Data are available in a public, open access repository (https://hrsdata.isr.umich.edu/data-products/rand-hrs-longitudinal-file-2018?_ga=2.258979978.1890758364.1616690587-360856504.1616690587)

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Figure 1: Flow Chart for Study Participant from the 2018 HRS Survey

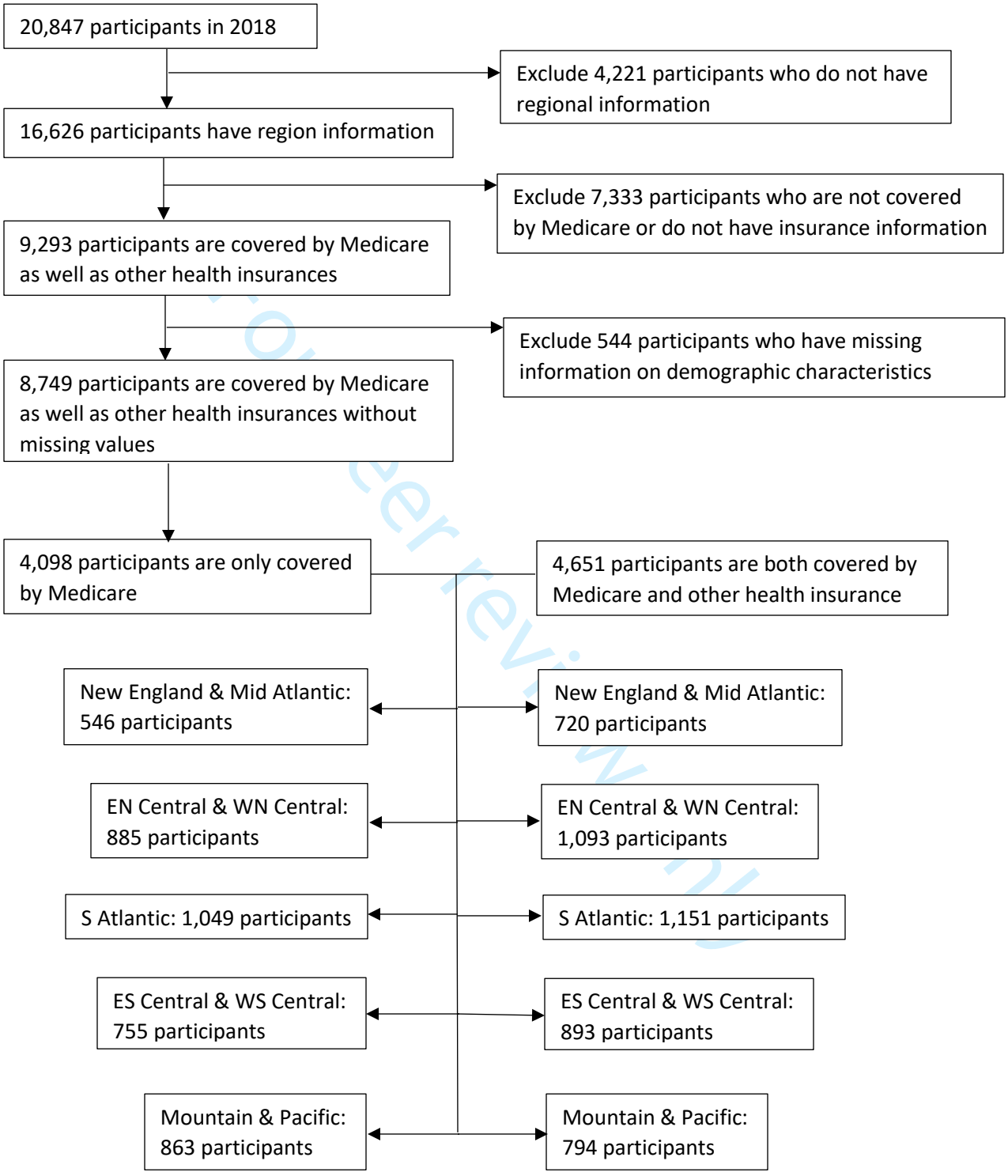
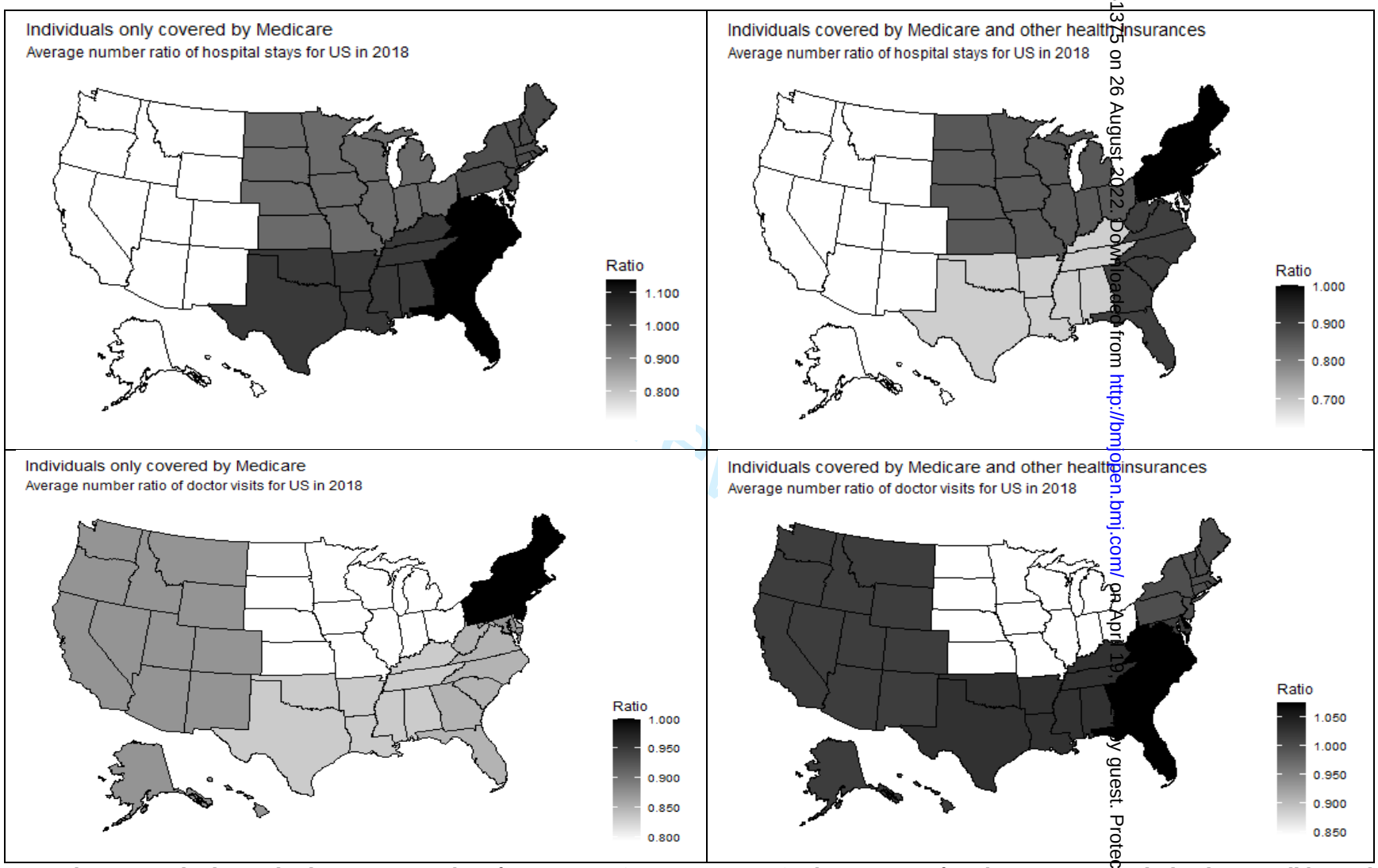


Figure 2: Average Number Ratio of Hospital Stays/Doctor Visits



We set the New England & Mid Atlantic region as the reference group (i.e. event ratio = 1). The event ratio for other regions was calculated as overall hospital stays (in other regions)/ overall hospital stays (the New England & Mid Atlantic region) or overall doctor's visits (in other regions)/ overall doctor visits (the New England & Mid Atlantic region), separately.

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Regional Variation in Health Care Utilization for Medicare Beneficiaries: A Cross-sectional Study Based on the Health and Retirement Study

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Abstract

Objectives

To investigate whether regional variation changes with different types of beneficiary health insurance coverage.

Design

A cross-sectional study of the Health Retirement Study (HRS) in 2018 was used.

Setting

We categorized Medicare beneficiaries into two groups: 1) those only covered by Medicare (group 1); 2) those covered by Medicare and other health insurance (group 2). Outcomes included health care utilization measures: 1) whether beneficiaries have a hospital stay and 2) the number for those with at least one stay; 3) whether beneficiaries have a doctor's visit and 4) the number for those with at least one visit. We compared health care utilization in both groups across the five regions: 1) New England & Mid Atlantic; 2) East North Central & West North Central; 3) South Atlantic; 4) East South Central & West South Central; 5) Mountain & Pacific. We used logistic regression for binary outcomes and negative binomial regression for count outcomes in each group.

Participants

We identified 8,749 Medicare beneficiaries, of which 4,098 in group 1 and 4,651 in group2.

Results

Logistic regression results suggested that residents in all non-reference regions had a significantly ($P<0.05$) lower probability of seeking a doctor's visit in group 1 (OR=0.606, 0.619, 0.472, and 0.618 in the order of above regions, respectively), which is not significant in group 2.

Negative binomial results suggested that residents in most non-reference regions (except South Atlantic) had a significantly ($P<0.05$) fewer numbers of seeking a hospital stay in group 2 (IRR=0.797, 0.740, 0.726 in the order of above regions, respectively), which is not significant in group 1.

Conclusion:

Regional variation in the likelihood of having a doctor's visit was reduced in Medicare beneficiaries covered by supplemental health insurance. Regional variation in hospital stays was accentuated among Medicare beneficiaries covered by supplemental health insurance.

Strengths and limitations of this study

- This nationwide study provides a large sample size to explore to explore the regional variation.
- This dataset uses a probability proportional to size (PPS) sampling strategy, which can decrease the selection bias.
- Our study was limited to general doctor's visits and hospital stays and we could not study any other specific health care services.
- We cannot identify these specific Medicare plans in our data, which limits our ability to assess the extent to which our estimated regional variations are driven by these different Medicare plans.
- We combined nearby regions to increase the sample size in selected region classifications, and each region has many states, so these average estimates may mask variation across states within the same region.
- Data were collected through a survey, which may lead to a recall bias.

Introduction

Equal access to health care is important to reduce health disparity.[1] People should be given the same chance of getting appropriate treatment if they share the same type and degree of health need.[2] The 2010 Patient Protection and Affordable Care Act (PPACA) was a substantial health care reform aiming to change the health care payment system and to improve quality of care while reducing cost.[3] Since equal access is not the primary goal of this health care reform, the concern of important geographic variation in the use of health care services have been raised.[4]

Medicare aims to cover all elderly individuals who are over 65, as well as individuals less than 65 years of age with disabilities and renal disease. Medicare experienced many changes in the PPACA health care reform. Since Medicare is managed by the federal government with nearly the same standard across the nation, regional variation may be a primary factor for unequal access to health care. Individuals in some regions will have barriers to access necessary health resources. These unequal access to healthcare may be related to possible inefficiencies and inequality in the supply of health care. Since many Medicare beneficiaries are also covered by other health insurance, an interesting question arises, "does regional variation change across beneficiaries with different types of health insurance coverage?" In the past few years, regional variations have been identified by some studies. These studies can be described as two types. The first type is to identify regional variations, and the second type is to identify the factors related to regional variations. In terms of the first type studies, an evidence reveals that regional variation in imaging costs is greater than imaging utilization.[5] One study suggests that the utilization of skilled nursing facility and hospital care among Medicare Advantage beneficiaries has greater regional variations than traditional Medicare beneficiaries.[6] Another study suggests that the number of days of care per capita can be substantially different in two regions even though the two regions have similar per capita costs of care.[7] Moreover, regional variation in Medicare spending and utilization are substantial at the state level, even though state differences in demographic, demand, and supply factors are controled.[8] In terms of the second type studies, socioeconomic characteristics have been proved to play a significant role in regional difference in admission rates and lengths of stay.[9] Convenient public transportation can be used to address geographic barriers to health care in rural area. [10] Some studies also suggest that regional variation is associated with bed availability, clinician workforce, and races.[11–13] However, these studies have some limitations. Many studies only explore regional variation in specific health care types, which cannot be extrapolated the

results to other types of health care services. Moreover, many studies were conducted over decades ago, but Medicare has experienced important changes in recent years. Thus, these studies may be limited to reflect the current situation.

Therefore, it is necessary to revisit the question of regional variation in health utilization among Medicare beneficiaries post-PPACA. Our new study bridges this research gap. We aim to identify 1) whether regional variation still exists among Medicare beneficiaries and 2) whether regional variation changes across Medicare beneficiaries with different types of health insurance coverage.

Method

Source of data

Data are based on the Health and Retirement Study (HRS) in 2018. HRS is a nationally longitudinal survey, which has been fielded every 2 years since 1992. This dataset concentrates on middle aged and elderly individuals, which is representative of the middle aged and elderly population over the country. It provides information on a broad array of domains including income and wealth; health, cognition and use of healthcare services; work and retirement; and family connections. The samples of HRS are drawn based on a multi-stage area probability design, involving geographical stratification, clustering and oversampling of certain demographic groups. HRS includes data for over 37000 individuals over age 50 and 23000 households in the USA.[14]

Study Design

Figure 1 shows the flow chart for the analytic sample used in this study. There were 20,847 respondents in the 2018 HRS. There were 4,221 participants with a missing value in residence region and these participants were excluded first. There were 7,333 participants that had a missing value in Medicare coverage or not covered by Medicare and these participants were dropped as well. Additionally, we dropped 544 participants with missing value on demographic characteristics. The final analytic sample included 8,749 HRS respondents with reported Medicare coverage. We separated Medicare beneficiaries into 2 mutually exclusive groups based on health insurance coverage type: 1) there were 4,098 participants are only covered by Medicare (henceforth, group 1), and 2) there were 4,651 participants are covered by both Medicare and supplemental health insurance (e.g., Medicaid, VA/CHAMPUS, and private health insurance) (henceforth, group 2). We did not exclude individuals who were covered by long-term care insurance from the Medicare-only group due to a large number of individuals with chronic diseases.

Dependent variables

We constructed four dependent variables. Two dummy variables for whether the individual had any hospital stay or doctor's visit in the last two years. The other two variables measured the number of hospital stays for survey respondents with an inpatient visit in the previous two years and the number of doctor's visits for those with an outpatient visit during the previous two years.

Independent variables

Our primary independent variable of interest was the Medicare beneficiaries' region of residence, defined based on their reported state of residence: 1) New England Division & Middle Atlantic Division; 2) East North Central Division & West North Central Division; 3) South Atlantic Division; 4) East South Central Division & West South Central Division; 5) Mountain Division & Pacific Division.

Other variables

Other variables included patient demographic characteristics: gender, age, educational level, total household annual income per capita (PCI), employment status and chronic disease conditions. Specific, we used Pew's study to categorize our income groups.[15] We categories PCI into three groups: lower income (<$13,367), middle income ($13,367-$40,133), and upper income (>$40,133).

Statistical Analysis

We compared characteristics of Medicare-only covered beneficiaries and beneficiaries with Medicare and supplemental insurance. Means and proportions were compared using chi-square tests. We modeled health care utilization of Medicare beneficiaries using multivariate regression models. Logistic regressions were used to model binary outcomes (any hospital stay, any doctor's visit in the past two years). The model specification is $\ln\left(\frac{p(x)}{1-p(x)}\right) = \alpha + \beta \cdot region + \gamma\theta$, α represents the intercept, p(x) represents the probability that individuals seek a doctor visit or a hospital stay, and γθ represents individual-level demographic characteristics. Negative binomial regressions were used to model count outcomes. To better reflect the variation of health care utilization, we used the country map to visualize hospital stays and doctor visits. The model specification is $log(count\ of\ doctor\ visits\ or\ hospital\ stays) = \alpha + \beta \cdot region + \gamma\theta$, α represents the intercept, and γθ represents individual-level demographic characteristics.

In order to visualize the relative difference directly, we graphed event ratios instead of the exact events in the national map as figure 2 shows. We set the New England & Mid Atlantic region as the reference group (i.e. event ratio = 1). The event ratio for other regions was calculated as hospital stays (in other regions)/hospital stays (the New England & Mid Atlantic region) or doctor's visits (in other regions)/doctor visits (the New England & Mid Atlantic region), separately. All our analyses are conducted with R 4.1.1.

Patient and public involvement

We report no patient or public involvement in the design or implementation of the study.

Results

Demographic Characteristics

Among individuals who were only covered by Medicare, 546, 885, 1,049, 755, and 863 individuals were in New England & Mid Atlantic regions, EN Central & WN Central regions, S Atlantic regions, ES Central & WS Central regions, and Mountain & Pacific regions, respectively. Among individuals who are both covered by Medicare and other health insurances, 720, 1,093, 1,151, 893, and 794 individuals are in each region category, respectively. ES and WS central regions had the highest percentage of individuals who were below age 65 (16.82%) and the lowest percentage of individuals who were over age 85 (11.39%). Mountain and Pacific regions had the lowest percentage of individuals who were below 65 (8.23%) and the highest percentage of individuals who were over 85 (12.86%) (Table 1).

Beneficiaries with less than a high school education were more concentrated in ES and WS central regions (29.93%) and less concentrated in EN and WN central regions (12.54%). Beneficiaries with a graduate degree were more concentrated in Mountain and Pacific regions (9.73%), but less concentrated in ES and WS central regions (5.83%). Considering the distribution of beneficiaries according to chronic diseases conditions reporting, ES and WS central regions had the highest percentage of individuals with more than one chronic disease (80.26%). Mountain and Pacific regions had the lowest percentage of individuals with more than one chronic disease (71.15%). ES and WS central regions had the highest percentage of lower income (<$13,367) individuals (89.8%), while Mountain and Pacific regions had the lowest percentage of lower income individuals (83.55%). In contrast, South Atlantic regions had the lowest percentage of upper income (>$40,133) individuals (4.58%), while Mountain and Pacific regions had the highest percentage of upper income individuals (10.2%).

Among Medicare beneficiaries with supplemental insurances, there were significant variations in demographics across all residence regions (Table 1). Considering the distribution of health care utilization across regions, individuals living in the New England & Mid Atlantic regions had the highest number of hospital stays, while individuals living in the Mountain & Pacific regions had the lowest number of hospital stays (Figure 2). Individuals living in the South Atlantic regions had the highest number of doctor's visits, while individuals living in the East North & West North Central regions had the lowest number of doctor's visits (Figure 2).

ES and WS central regions had the highest percentage of individuals who were below 65 (16.35%) and the lowest percentage of individuals who were over 85 (10.41%) (Table 1). EN and WN central regions had the lowest percentage of individuals who were below 65 (12.08%) and the highest percentage of individuals who were over 85 (16.1%). The percentage of individuals without a high school degree was highest in ES and WS central regions (25.08%) and lowest in EN and WN central regions (10.16%). Conversely, the percentage of people with a graduate degree was highest in Mountain and Pacific regions (12.22%) and lowest in ES and WS central regions (6.72%). The percentage of individuals with at least one chronic condition was highest in ES and WS central regions (81.63%), and lowest in Mountain and Pacific regions (71.91%). Considering annual household income per capita, the percentage of individuals with lower income was highest in ES and WS central regions (89.25%) and lowest in Mountain and Pacific regions (81.99%). The percentage of individuals with higher income was highest in Mountain and Pacific regions (9.45%) and lowest in ES and WS central regions (4.48%).

Table 1: Descriptive Statistics

	Individuals Who Are Only Covered by Medicare (N=4,098)										Individuals Who Are Covered by Medicare and Other Health Insurance (N=4,651)									
Region	**New England & Mid Atlantic**		**EN Central & WN Central**		**S Atlantic**		**ES Central & WS Central**		**Mountain & Pacific**		**New England & Mid Atlantic**		**EN Central & WN Central**		**S Atlantic**		**ES Central & WS Central**		**Mountain & Pacific**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	N	%	N	%	N	%	N	%	N	%
Total	546	13.32	885	21.6	1,049	25.6	755	18.42	863	21.065	720	15.48	1,093	23.5	1,151	24.74	893	19.2	794	17.07
Age																				
<65	60	10.99	75	8.47	118	11.25	127	16.82	71	8.23	111	15.42	132	12.08	142	12.34	146	16.35	105	13.22
65-74	198	36.26	317	35.82	386	36.8	271	35.89	354	41.02	286	39.72	429	39.25	462	40.14	365	40.87	346	43.58
75-84	187	34.25	360	40.68	418	39.85	271	35.89	327	37.89	228	31.67	356	32.57	414	35.97	289	32.36	245	30.86
>85	101	18.5	133	15.03	127	12.11	86	11.39	111	12.86	95	13.19	176	16.1	133	11.56	93	10.41	98	12.34
Gender																				
Male	229	41.94	373	42.15	424	40.42	311	41.19	367	42.53	281	39.03	445	40.71	472	41.01	326	36.51	357	44.96
Female	317	58.06	512	57.85	625	59.58	444	58.81	496	57.47	439	60.97	648	59.29	679	58.99	567	63.49	437	55.04
Race																				
NH White	364	66.67	699	78.98	595	56.72	351	46.49	513	59.44	464	64.44	864	79.05	740	64.29	482	53.98	504	63.48
NH Black	115	21.06	146	16.5	323	30.79	223	29.54	71	8.23	151	20.97	186	17.02	309	26.85	216	24.19	56	7.05
Hispanic	53	9.71	21	2.37	96	9.15	161	21.32	229	26.54	90	12.5	15	1.37	68	5.91	173	19.37	188	23.68
Other	14	2.56	19	2.15	35	3.34	20	2.65	50	5.79	15	2.08	28	2.56	34	2.95	22	2.46	46	5.79
Education																				
Less than high school education	101	18.5	111	12.54	204	19.45	226	29.93	152	17.61	137	19.03	111	10.16	190	16.51	224	25.08	142	17.88
High School/GED	288	52.75	530	59.89	571	54.43	370	49.01	435	50.41	363	50.42	674	61.67	591	51.39	474	53.08	376	47.36
Undergraduate	103	18.86	170	19.21	192	18.3	115	15.23	192	22.25	152	21.11	213	19.49	227	19.73	135	15.12	179	22.54
Graduate	54	9.89	74	8.36	82	7.82	44	5.83	84	9.73	68	9.44	95	8.69	143	12.43	60	6.72	97	12.22
Chronic disease																				
No chronic disease	36	6.59	60	6.78	57	5.43	32	4.24	68	7.88	52	7.22	68	6.22	60	5.21	32	3.58	61	7.68
Only one chronic disease	96	17.58	141	15.93	167	15.92	117	15.5	181	20.97	127	17.64	212	19.4	179	15.56	132	14.78	162	20.4
More than one chronic disease	414	75.82	684	77.29	825	78.65	606	80.26	614	71.15	541	75.14	813	74.38	912	79.25	729	81.63	571	71.91
Employment status																				

Full-time	19	3.48	40	4.52	54	5.15	31	4.11	55	6.37	50	6.94	68	6.22	72	6.26	64	7.17	56	7.05
Part-time	65	11.9	100	11.3	115	10.96	76	10.07	100	11.59	71	9.86	113	10.34	122	10.61	77	8.62	75	9.45
Unemployed	34	6.23	30	3.39	52	4.96	52	6.89	43	4.98	56	7.78	50	4.57	59	5.13	66	7.39	53	6.68
Retired	428	78.39	715	80.79	828	78.93	596	78.94	665	77.06	543	75.42	862	78.87	898	78.02	686	76.82	610	76.83
Household income																				
Lower income	468	85.71	755	85.31	932	88.85	678	89.8	721	83.55	631	87.64	894	81.79	976	84.8	797	89.25	651	81.99
Middle income	39	7.14	62	7.01	69	6.58	42	5.56	54	6.26	51	7.08	97	8.87	96	8.34	56	6.27	68	8.56
Upper income	39	7.14	68	7.68	48	4.58	35	4.64	88	10.2	38	5.28	102	9.33	79	6.86	40	4.48	75	9.45

(EN: East North; WN: West North; S: South; ES: East South; WS: West South; NH: Non-Hispanic; GED: General Educational Development)

Logistic regression Results

In terms of hospital stays, logistic regressions suggested that individuals living in Mountain & Pacific region were less likely to have a hospital stay than those residing in New England & Mid-Atlantic region among Medicare-only covered beneficiaries (OR=0.766, P<0.05). However, there were no significant differences in the probability of having a hospital stay across different regions among Medicare beneficiaries with supplemental insurances (Table 2).

Age was significantly associated with hospital stays. Among Medicare-only covered beneficiaries, individuals aged over 85 were significantly more likely to have a hospital stay (OR=1.480, p<0.01), compared to individuals under 65. Among Medicare beneficiaries with supplemental insurance, individuals aged between 65 and 74 were less likely to have a hospital stay (OR=0.722, p<0.01). The results also suggested that education were not significantly related to hospital stays in both groups. The results also suggested that individuals with one chronic disease (OR=1.813, p<0.01) and with more than one chronic disease (OR=3.579, p<0.01) were more likely to have a hospital stay in group 1. In group 2, individuals with one chronic disease (OR=1.659, p<0.01) and with more than one chronic disease (OR=3.832, p<0.01) were also more likely to have a hospital stay. In terms of employment status, there was no significant differences in group 1. However, unemployment (OR=1.963, p<0.01) and retired (OR=1.609, p<0.01) individuals were more likely to have a hospital stay. In terms of household income, results suggested that only middle-income (≥13,367, and≤$40,133) individuals (OR=0.618, p<0.01) were significantly less likely to have a hospital stay compared to lower income individuals in group 1. However, there was no significant differences related to household income in group 2 (Table 2).

In terms of doctor's visit, logistic regressions suggested that individuals in EN Central & WN Central region (OR=0.606, p<0.05), S Atlantic region (OR=0.619, p<0.05), ES Central & WS Central region (OR=0.472, p<0.01), and Mountain & Pacific region (OR=0.618, p<0.05) were less likely to have a doctor's visit than those residing in New England & Mid-Atlantic region among Medicare-only covered beneficiaries. However, there were no significant differences in the probability of having a doctor's visit among Medicare beneficiaries with supplemental insurances (Table 2).

There was no significant relationship between age and doctor's visits in both groups. Females were more likely to have a doctor's visit in both group 1 (OR=1.321, p<0.05) and group 2 (OR=1.427, p<0.05). Education was significantly related to doctor's visits in both group 1 and

group 2. In group 1, individuals with a high school degree (OR=2.142, p<0.01), a college degree (OR=3.147, p<0.01), and a graduate degree (OR=2.875, p<0.01) were more likely to have a doctor's visit, compared to individuals without a high school degree. In group 2, the results were similar. Individuals with a high school degree (OR=1.955, p<0.01), a college degree (OR=2.712, p<0.01), and a graduate degree (OR=5.095, p<0.01) were more likely to have a doctor's visit, compared to individuals without a high school degree.

Results suggested that individuals with one chronic condition (OR=2.438, p<0.01 in Medicare-only covered individuals and OR=2.925, p<0.01 in Medicare beneficiaries with supplemental insurance) and those with more than one chronic condition (OR=3.891, p<0.01 01 in Medicare-only covered individuals and OR=3.845, p<0.01 in Medicare beneficiaries with supplemental insurance) were more likely to have a doctor's visit. We did not notice significant associations between the outcome variables and employment status in both groups, and between the outcome variables and household income in group 2. However, middle income (≥$13,367, and ≤$40,133) individuals were more likely to have a doctor's visit among Medicare beneficiaries with supplemental insurance, compared to lower income individuals (Table 2).

Table 2：Logistic Regression Results

	Individuals Who Are Only Covered by Medicare (N=4,089) and Individuals Who Are Covered by Medicare and Other Health Insurances (N=4,642) in Hospital Stay								Individuals Who Are Only Covered by Medicare (N=3,641) and Individuals Who Are Covered by Medicare and Other Health Insurances (N=3,910) in Doctor Visit							
Have a visit last two years (no=0, yes=1)	**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**				**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**			
	OR		**95%**	**CI**	**OR**		**95%**	**CI**	**OR**		**95%**	**CI**	**OR**		**95%**	**CI**
Region																
New England & Mid Atlantic	Ref				Ref				Ref				Ref			
EN Central & WN Central	0.999		0.784	1.272	1.103		0.896	1.359	0.606	**	0.374	0.982	1.072		0.671	1.713
S Atlantic	1.11		0.879	1.402	1.012		0.824	1.244	0.619	**	0.392	0.977	0.893		0.576	1.383
ES Central & WS Central	0.921		0.714	1.187	0.871		0.7	1.084	0.472	***	0.299	0.746	0.909		0.585	1.414
Mountain & Pacific	0.766	**	0.594	0.987	0.918		0.73	1.154	0.618	**	0.386	0.99	1.116		0.804	2.152
Age																
<65	Ref				Ref				Ref				Ref			
65-74	0.821		0.637	1.058	0.722	***	0.586	0.889	0.887		0.578	1.363	0.884		0.568	1.375
75-84	1.046		0.813	1.344	0.882		0.713	1.091	0.996		0.643	1.541	0.967		0.607	1.543
>85	1.48	***	1.109	1.975	1.261	*	0.982	1.62	0.77		0.466	1.273	0.621	*	0.37	1.043
Gender																
Male	Ref				Ref				Ref				Ref			
Female	0.755	***	0.654	0.871	1.002		0.879	1.143	1.321	**	1.042	1.676	1.427	**	1.084	1.88
Race																
NH White	Ref				Ref											
NH Black	0.85	*	0.704	1.026	0.961		0.807	1.144	0.477	***	0.35	0.65	0.763	***	0.389	0.813
Hispanic	0.822		0.647	1.044	0.767	**	0.603	0.976	0.283	***	0.204	0.394	0.481	***	0.189	0.418
Other	1.451	*	0.985	2.138	1.303		0.911	1.862	0.684		0.356	1.314	1.086		0.42	2.808
Education																
Less than high school education	Ref				Ref				Ref				Ref			
High School/GED	1.079		0.888	1.312	1.156		0.958	1.396	2.142	***	1.627	2.821	1.955	***	1.403	2.724

Undergraduate	1.167		0.917	1.485	1.123		0.892	1.414	3.147	***	2.082	4.755	2.712	***	1.677	4.384
Graduate	0.87		0.631	1.199	0.912		0.687	1.21	2.875	***	1.639	5.042	5.295	***	2.25	11.535
Chronic disease																
No chronic disease	Ref				Ref				Ref				Ref			
Only one chronic disease	1.813	***	1.158	2.839	1.659	**	1.098	2.506	2.438	***	1.558	3.815	2.925	***	1.72	4.974
More than one chronic disease	3.579	***	2.369	5.406	3.832	***	2.618	5.609	3.891	***	2.606	5.81	3.945	***	2.433	6.078
Employment status																
Full-time	Ref				Ref				Ref				Ref			
Part-time	1.025		0.668	1.573	1.046		0.721	1.518	1.008		0.529	1.923	1.047		0.784	3.458
Unemployed	1.112		0.676	1.83	1.963	***	1.316	2.929	0.805		0.384	1.69	2.004		0.874	4.599
Retired	1.22		0.835	1.781	1.609	***	1.181	2.192	0.989		0.561	1.744	1.531		0.828	2.832
Household income																
Lower income	Ref				Ref				Ref				Ref			
Middle income	0.618	**	0.447	0.854	0.854		0.663	1.1	0.657	*	0.412	1.047	1.44	**	1.054	5.648
Upper income	0.949		0.702	1.283	0.963		0.738	1.255	0.925		0.542	1.578	1.157		0.602	2.223

(EN: East North; WN: West North; S: South; ES: East South; WS: West South; NH: Non-Hispanic; GED: General Educational Development)

We show odds ratios here, and 95% CI in parentheses. Counts do not sum to 4,098 or 4,651 due to missing values for some of the independent variables.

***Significant at 1 percent level (two-tailed test).

**Significant at 5 percent level (two-tailed test).

*Significant at 10 percent level (two-tailed test).

Negative binomial regression results

In terms of hospital stays, results suggested that there was no difference in the incident rate among different regions among Medicare-only covered beneficiaries. However, individuals in EN Central & WN Central region (IRR=0.797, p<0.01), ES Central & WS Central region (IRR =0.740, p<0.01), and Mountain & Pacific region (IRR =0.726, p<0.01) had fewer incident rates of hospital stays than those residing in New England & Mid-Atlantic region in group 2 (Table 3).

Individuals aged 65-74 years (IRR=0.802, p<0.05), 75-84 years (IRR=0.781, p<0.01), and over age 85 (IRR=0.785, p<0.05) had significantly fewer incident rates of hospital stays in group 1, compared to individuals under 65. In group 2, the results were similar. Individuals who were aged 65-74 years (IRR=0.757, p<0.01), 75-84 years (IRR=0.663, p<0.01), and over age 85 (IRR=0.644, p<0.01) had significantly fewer incident rates of hospital stays. Individuals with a high school degree had a significantly lower incident rate of hospital stays (IRR=0.824, p<0.01), compared to individuals without a degree. Retired individuals (IRR=1.562, p<0.01) had a higher incident rate of hospital stays, compared to individuals with a full-time job. However, we found that variables not significantly related to changes in the incident rate of hospital stays included chronic diseases, and household income in both groups, education in group 2, employment status in group 1 (Table 3).

In terms of doctor's visit, the results suggested that individuals in EN Central & WN Central region (IRR=0.743, p<0.01), S Atlantic region (IRR=0.847, p<0.01), ES Central & WS Central region (IRR=0.846, p<0.01), and Mountain & Pacific region (IRR=0.806, p<0.01) had lower incident rates of doctor's visits than those residing in New England & Mid-Atlantic region in group 1. In group 2, results suggested that individuals in EN Central & WN Central region (IRR=0.884, p<0.01) had a lower incident rate of doctor's visits than individuals residing in New England & Mid-Atlantic region. However, individuals in S Atlantic region (IRR=1.157, p<0.01) and Mountain & Pacific region (IRR=1.140, p<0.01) had a higher incident rate of doctor's visits than those residing in New England & Mid-Atlantic region in group 2 (Table 3).

There was a significant relationship between age and doctor's visits in both groups. Individuals who were aged 65-74 years (IRR=0.748, p<0.01), 75-84 years (IRR=0.733, p<0.01), and over age 85 (IRR=0.717, p<0.01) had significantly lower incident rates of doctor's visits in group 1, compared to individuals under 65. Individuals who were aged 65-74 years (IRR =0.719, p<0.01), 75-84 years (IRR=0.686, p<0.01), and over age 85 (IRR=0.781, p<0.01) had significantly

lower incident rates of doctor's visits in group 2. In terms of education, individuals with a college degree (IRR=1.174, p<0.01) and a graduate degree (IRR=1.230, p<0.01 in group 1; IRR=1.208, p<0.01 in group 2) had higher incident rates of doctor's visit, compared to individuals without a degree.. In terms of chronic disease, the results suggested that individuals with one chronic disease (IRR=1.712, p<0.01 in group 1; IRR=1.467, p<0.01 in group 2) and with more than one chronic disease (IRR=2.261, p<0.01 in group 1; IRR=2.262, p<0.01 in group 2) had more incident rate of doctor's visits. In terms of employment status, the results were similar between group 1 and group 2. Unemployed individuals (IRR=1.706, p<0.01 in group 1; IRR=1.351, p<0.01 in group 2) and retired individuals (IRR=1.358, p<0.01 in group 1; IRR=1.283, p<0.01 in group 2) had more incident rate of doctor's visits, compared individuals with a full-time job. Household income was not significantly related to incident rate of doctor's visits in both groups (Table 3).

Table 3: Negative Binomial Regression Results

	Individuals Who Are Only Covered by Medicare (N=1,126) and Individuals Who Are Covered by Medicare and Other Health Insurances (N=1,462) in Hospital Stay								Individuals Who Are Only Covered by Medicare (N=3,032) and Individuals Who Are Covered by Medicare and Other Health Insurances (N=3,307) in Doctor's Visit							
Visit times of last two years (visit >=1)	**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**				**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**			
	IRR		**95%**	**CI**	**IRR**		**95%**	**CI**	**IRR**		**95%**	**CI**	**IRR**		**95%**	**CI**
Region																
New England & Mid Atlantic	Ref				Ref				Ref				Ref			
EN Central & WN Central	0.902		0.756	1.076	0.797	***	0.691	0.919	0.743	***	0.668	0.826	0.884	**	0.797	0.981
S Atlantic	1.047		0.886	1.236	0.903		0.784	1.039	0.847	***	0.763	0.939	1.157	***	1.043	1.283
ES Central & WS Central	1.058		0.882	1.270	0.740	***	0.634	0.865	0.846	***	0.755	0.947	0.997		0.893	1.115
Mountain & Pacific	0.882		0.728	1.069	0.726	***	0.613	0.859	0.806	***	0.722	0.900	1.140	**	1.017	1.278
Age																
<65	Ref				Ref				Ref				Ref			
65-74	0.802	**	0.672	0.957	0.757	***	0.658	0.870	0.748	***	0.665	0.840	0.819	***	0.646	0.801
75-84	0.781	***	0.658	0.927	0.663	***	0.575	0.764	0.733	***	0.651	0.824	0.786	***	0.614	0.767
>85	0.785	**	0.646	0.954	0.644	***	0.545	0.761	0.717	***	0.626	0.822	0.781	***	0.686	0.890
Gender																
Male	Ref				Ref				Ref				Ref			
Female	1.111	**	1.002	1.233	0.872	***	0.793	0.957	1.002		0.940	1.068	1.043		0.977	1.113
Race																
NH White	Ref				Ref				Ref				Ref			
NH Black	0.937		0.819	1.072	1.035		0.916	1.170	0.932		0.857	1.015	0.823	***	0.754	0.898
Hispanic	1.066		0.898	1.265	1.066		0.893	1.272	1.011		0.904	1.129	0.929		0.817	1.057
Other	0.813		0.605	1.093	1.081		0.853	1.371	1.359	***	1.135	1.628	1.172	*	0.974	1.410
Education																
Less than high school education	Ref				Ref				Ref				Ref			
High School/GED	0.824	***	0.721	0.943	1.117		0.976	1.277	1.048		0.957	1.149	0.929		0.842	1.025

Undergraduate	0.859		0.724	1.020	0.914		0.773	1.081	1.174	***	1.052	1.310	0.933		0.830	1.048
Graduate	0.873		0.689	1.107	0.934		0.750	1.162	1.230	***	1.073	1.411	1.108	***	1.054	1.385
Chronic disease																
No chronic disease	Ref				Ref				Ref				Ref			
Only one chronic disease	0.829		0.549	1.252	0.983		0.671	1.440	1.712	***	1.450	2.021	1.467	***	1.243	1.731
More than one chronic disease	1.109		0.760	1.619	1.261		0.884	1.799	2.261	***	1.941	2.634	2.262	***	1.939	2.639
Employment status																
Full-time	Ref				Ref				Ref				Ref			
Part-time	0.865		0.607	1.232	1.115		0.801	1.550	1.132		0.942	1.360	1.092		0.907	1.316
Unemployed	1.002		0.679	1.478	1.310		0.942	1.820	1.706	***	1.363	2.135	1.651	***	1.090	1.674
Retired	1.147		0.841	1.564	1.562	***	1.185	2.058	1.358	***	1.152	1.602	1.283	***	1.089	1.513
Household income																
Lower income	Ref				Ref				Ref				Ref			
Middle income	0.911		0.702	1.181	1.042		0.862	1.260	1.133	*	0.997	1.287	0.951		0.847	1.068
Upper income	0.892		0.702	1.133	0.941		0.764	1.159	0.974		0.859	1.106	0.931		0.822	1.054

EN: East North; WN: West North; S: South; ES: East South; WS: West South; NH: Non-Hispanic; GED: General Educational Development)

We show odds ratios here, and 95% CI in parentheses. Counts do not sum to 4,098 or 4,651 due to missing values for some of the independent variables.

***Significant at 1 percent level (two-tailed test).

**Significant at 5 percent level (two-tailed test).

*Significant at 10 percent level (two-tailed test).

Discussion

In our study, we used four health outcomes as the health care utilization metrics: 1) the probability of hospital stay, 2) the probability of doctor's visit, 3) the frequency of hospital stay, and 4) the frequency of doctor's visit. The regional variation is identified as the health care utilization metrics are different among different regions even though we have controlled demographic, health and socioeconomic characteristics. Based on our results, our analysis has identified significant regional variation in health care utilization among Medicare beneficiaries.

In terms of the logistic regression results in hospital stay, all ORs are not significant in both groups except Mountain & Pacific regions in group 1. In this case, we can conclude that regional variation does not exist most regions on the probability of a hospital stay. In terms of the logistic regression results in doctor's visit, all ORs are significant in group 1, while all ORs are insignificant in group 2. Therefore, regional variation exists in group 1, while it does not exist in group 2. We can also conclude that if Medicare beneficiaries are covered by other health insurance, regional variation can be reduced and even eliminated on the probability of doctor visit.

In terms of the negative binomial regression results in hospital stay, all ORs are not significant in group1, while all ORs are significant in group 2 except South Atlantic regions. In this case, regional variation exists in most regions in group 2, but it does not exist in group 1. Therefore, we can conclude that if Medicare beneficiaries are covered by other health insurance, regional variation can be reduced and even eliminated on the frequency of hospital stay. In terms of the negative binomial regression results in doctor's visit, all ORs are significant in both groups except ES Central & WS Central regions in group 2. In this case, regional variation exists in most regions in both groups and the coverage of health insurance does not affect the frequency of doctor's visits.

One potential explanation may be that narrow provider networks restricted access to care for Medicare beneficiaries.[16–18] Compared to New England and Mid-Atlantic regions, Medicare plans in other regions may not provide large enough provider networks.[17–19] Compared to Medicare beneficiaries with supplemental health insurance, Medicare-only beneficiaries are confronted with restrictions as an important barrier in health care access.[16,20] Other barriers to access like lack of transportation may further restrict access to health care for certain Medicare beneficiaries.[10] New England and Mid-Atlantic regions have better public transportations than other regions. Therefore, individuals in England and Mid-Atlantic regions may have less barrier

to access health care utilization. Bed availability and the number of physicians will also restrict health care utilization.[11,21] Moreover, physicians burn out are usually highly related to adverse health outcomes.[22]

We found that, compared to individuals with a full-time job, unemployed and retired individuals were more likely to have health care visits and also had a higher number of visits. These results are consistent with findings in other studies that show that individual's health is negatively related to economic profiles.[23,24] These studies also show reverse causality between lower health status and unemployment status. A potential reason is that poor health may cause longer unemployment spells.[25] Some studies also suggest that ill workers are more likely to become unemployed.[26–28] Moreover, this can also be a potential explanation for the regional variation estimated in health care utilization: Regions with different health care utilization may differ in their population's economic profiles. Unlike findings in previous studies, we found that household income was not significantly related to frequency of health care visits.[29,30]

Hospitalization usually spends than doctor visits. In order to control health care costs, we should concentrate on minimizing hospital visit and stay. However, I think doctor visits are high correlated with hospital stays. Hospital stay usually means patients have some serious issues. However, some serious disease can be avoided by early detections. For example, if individuals have more frequencies to health examination, they can detect their diseases earlier and therefore they can avoid diseases become more serious. In this case, individuals have more doctor visits can avoid potential hospital stays. As we mentioned above, regional variation means individuals in some regions have more or less health care utilizations than other regions even though they have similar demographic, health and socioeconomic characteristics. In other words, there are some regional factors will restrict or encourage individuals to have doctor visits or hospital stays. If individuals' needs of health care are restricted, they cannot get treatment in time and therefore cause much more health care costs in the future. If individuals' health needs are encouraged, they will consume more health resources even though they do not really need them. This is a waste of health care resources. Therefore, the ideal situation is that individuals in different regions have similar health care utilization if they have similar demographic, health and socioeconomic characteristics. If the regional variation exists, we also have to figure out a way to reduce or solve it. In our study, we have identified regional variations, and we also found that insurance coverage

has impact on regional variation. In this case, adjusting insurance coverage could be one potential strategy to reduce regional variations.

Policy Implications

There are several important implications of our research. First, regional variation broadly exists in Medicare beneficiaries. However, this variation is not in the same direction when considering different health care settings among different Medicare beneficiary groups. Second, although household income is not related to health care utilization, employment status is significantly associated with health care utilization. Unemployment and retired individuals seek more health care in both groups, especially in the outpatient setting. This suggests that unemployed individuals may need more care and potential assistance. Therefore, health care programs and reforms should increase health care access for unemployed and retired individuals. Finally, Health insurance coverage plays a role in changing regional variation. For different subgroups, the government can adjust different health insurance coverage to reduce regional variation.

Limitations

There are some important limitations in this study. First, we combined nearby regions to increase the sample size in selected region classifications. Each region has many states, so these average estimates may mask variation across states within the same region. Second, Medicare has undergone substantial changes including the growth of Medicare Advantage and the introduction of numerous pay-for-performance and value-based programs.[31,32] We cannot identify these specific plans in the HRS which limits our ability to assess the extent to which our estimated regional variations are driven by these different Medicare plans. Third, data were collected through a survey, which may lead to a recall bias. Fourth, our study was limited to general doctor's visits and hospital stays and we could not study any other specific health care services, due to data limitations. Notwithstanding these limitations, our study provides a general landscape of health care utilization among Medicare beneficiaries.

Conclusion

Regional variation exists in health care utilization for Medicare beneficiaries, and regional variation also changes in beneficiaries with different types of coverage. Specifically, Regional variation in the likelihood of having a doctor's visit was reduced in Medicare beneficiaries covered by supplemental health insurance. Regional variation in hospital stays was accentuated among Medicare

beneficiaries covered by supplemental health insurance. Further studies are needed to elicit the reasons explaining these variations.

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This article is finished by myself for my personal interests.

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Competing interests

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Patient and public involvement statement

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

Patient consent for publication

Not required.

Ethics statements

Patient consent for publication

Not applicable.

Ethics approval

Ethics approval was not required since this is an analysis of publicly available secondary data (Health and Retirement Study).

Data availability statement

Data are available in a public, open access repository (https://hrsdata.isr.umich.edu/data-products/rand-hrs-longitudinal-file-2018?_ga=2.258979978.1890758364.1616690587-360856504.1616690587)

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Figure 1: Flow Chart for Study Participant from the 2018 HRS Survey

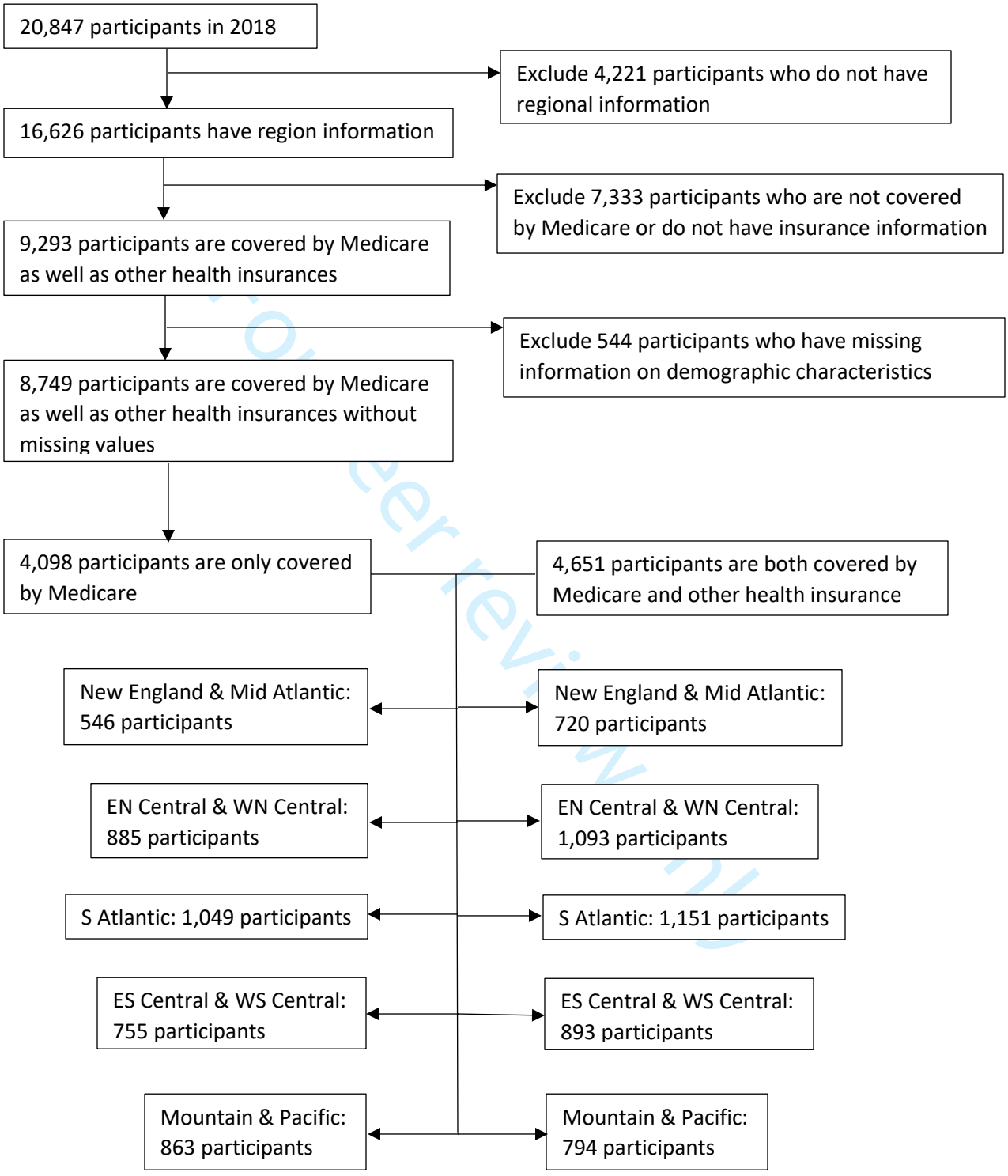
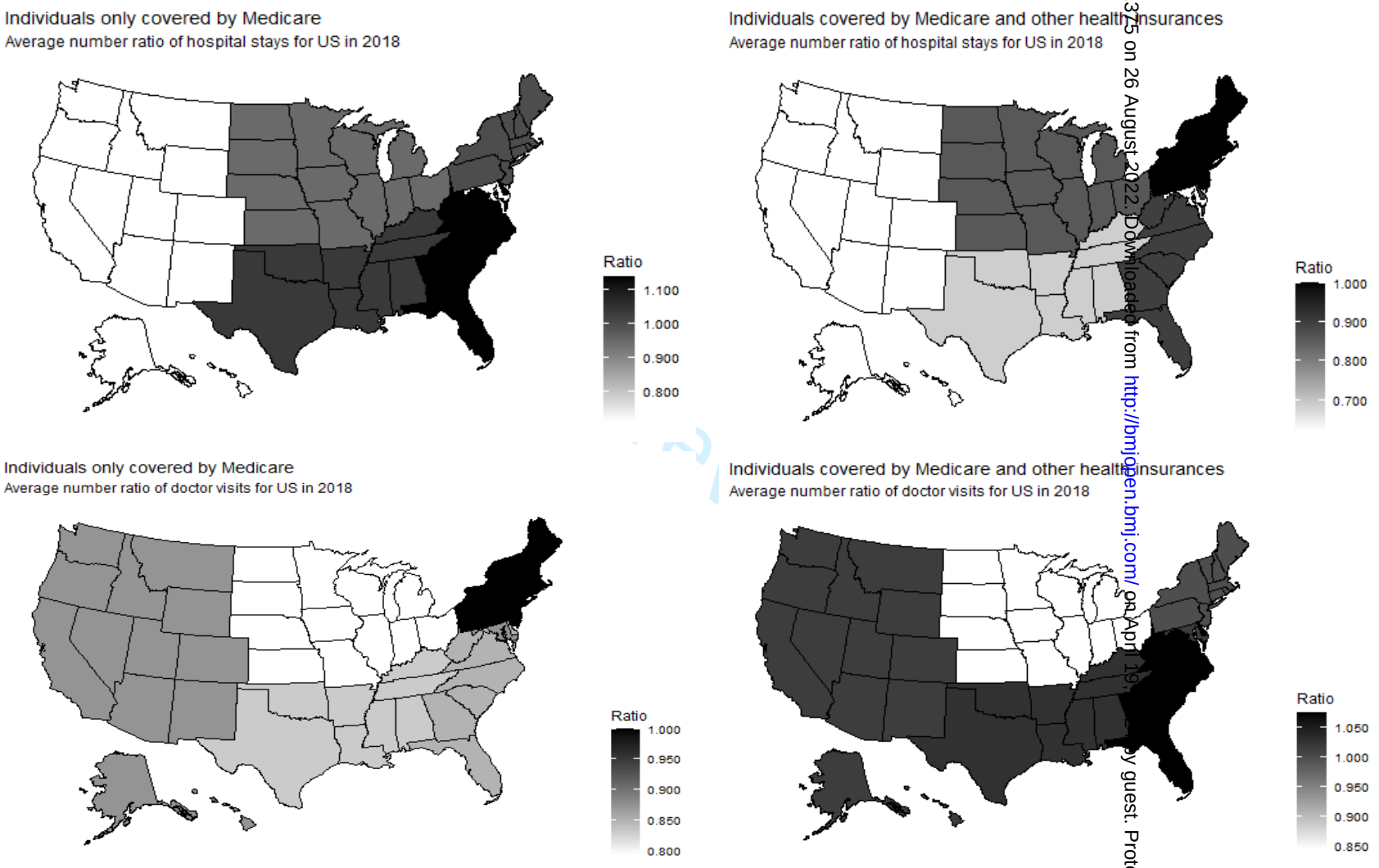


Figure 2: Average Number Ratio of Hospital Stays/Doctor Visits



We set the New England & Mid Atlantic region as the reference group (i.e. event ratio = 1). The event ratio for other regions was calculated as overall hospital stays (in other regions)/ overall hospital stays (the New England & Mid Atlantic region) or overall doctor's visits (in other regions)/ overall doctor visits (the New England & Mid Atlantic region), separately.

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Regional Variation in Health Care Utilization for Medicare Beneficiaries: A Cross-sectional Study Based on the Health and Retirement Study

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Abstract

Objectives

To investigate whether regional variation changes with different beneficiary health insurance coverage types.

Design

A cross-sectional study of the Health Retirement Study (HRS) in 2018 was used.

Setting

Medicare beneficiaries only covered by Medicare (group 1) are compared with those covered by Medicare and other health insurance (group 2). Outcomes included health care utilization measures: 1) whether beneficiaries have a hospital stay and 2) the number for those with at least one stay; 3) whether beneficiaries have a doctor's visit, and 4) the number for those with at least one visit. We compared health care utilization in both groups across the five regions: 1) New England & Mid Atlantic; 2) East North Central & West North Central; 3) South Atlantic; 4) East South Central & West South Central; 5) Mountain & Pacific. We used logistic regression for binary outcomes and negative binomial regression for count outcomes in each group.

Participants

We identified 8,749 Medicare beneficiaries, of which 4,098 in group 1 and 4,651 in group2.

Results

Residents in all non-reference regions had a significantly lower probability of seeking a doctor's visit in group 1 (OR with 95% CI=0.606 (0.374, 0.982), 0.619 (0.392, 0.977), 0.472 (0.299, 0.746), and 0.618 (0.386, 0.990) in the order of above regions, respectively), which is not significant in group 2. Residents in most non-reference regions (except South Atlantic) had a significantly fewer number of seeking a hospital stay in group 2 (IRR with 95% CI=0.797 (0.691, 0.919), 0.740 (0.643, 0.865), 0.726 (0.613, 0.859) in the order of above regions, respectively), which is not significant in group 1.

Conclusion:

Regional variation in the likelihood of having a doctor's visit was reduced in Medicare beneficiaries covered by supplemental health insurance. Regional variation in hospital stays was accentuated among Medicare beneficiaries covered by supplemental health insurance.

Strengths and limitations of this study

- This nationwide study provides a large sample size to explore to explore the regional variation.
- Our study was limited to general doctor's visits and hospital stays and we could not study any other specific health care services.
- We cannot identify these specific Medicare plans in our data, which limits our ability to assess the extent to which our estimated regional variations are driven by these different Medicare plans.
- We combined nearby regions to increase the sample size in selected region classifications, and each region has many states, so these average estimates may mask variation across states within the same region.
- Data were collected through a survey, which may lead to a recall bias.

Introduction

Equal access to health care is important to reduce health disparity.[1] People should be given the same chance of getting appropriate treatment if they share the same type and degree of health need.[2] The 2010 Patient Protection and Affordable Care Act (PPACA) was a substantial health care reform aiming to change the health care payment system and to improve quality of care while reducing cost.[3] Since equal access is not the primary goal of this health care reform, the concern of important geographic variation in the use of health care services have been raised.[4]

Medicare aims to cover all elderly individuals who are over 65, as well as individuals less than 65 years of age with disabilities and renal disease. Medicare experienced many changes in the PPACA health care reform. Since Medicare is managed by the federal government with nearly the same standard across the nation, regional variation may be a primary factor for unequal access to health care. Individuals in some regions will have barriers to access necessary health resources. These unequal access to healthcare may be related to possible inefficiencies and inequality in the supply of health care. Since many Medicare beneficiaries are also covered by other health insurance, an interesting question arises, "does regional variation change across beneficiaries with different types of health insurance coverage?" In the past few years, regional variations have been identified by some studies. These studies can be described as two types. The first type is to identify regional variations, and the second type is to identify the factors related to regional variations. In terms of the first type studies, an evidence reveals that regional variation in imaging costs is greater than imaging utilization.[5] One study suggests that the utilization of skilled nursing facility and hospital care among Medicare Advantage beneficiaries has greater regional variations than traditional Medicare beneficiaries.[6] Another study suggests that the number of days of care per capita can be substantially different in two regions even though the two regions have similar per capita costs of care.[7] Moreover, regional variation in Medicare spending and utilization are substantial at the state level, even though state differences in demographic, demand, and supply factors are controled.[8] In terms of the second type studies, socioeconomic characteristics have been proved to play a significant role in regional difference in admission rates and lengths of stay.[9] Convenient public transportation can be used to address geographic barriers to health care in rural area. [10] Some studies also suggest that regional variation is associated with bed availability, clinician workforce, and races.[11–13] However, these studies have some limitations. Many studies only explore regional variation in specific health care types, which cannot be extrapolated the

results to other types of health care services. Moreover, many studies were conducted over decades ago, but Medicare has experienced important changes in recent years. Thus, these studies may be limited to reflect the current situation.

Therefore, it is necessary to revisit the question of regional variation in health utilization among Medicare beneficiaries post-PPACA. Our new study bridges this research gap. We aim to identify 1) whether regional variation still exists among Medicare beneficiaries and 2) whether regional variation changes across Medicare beneficiaries with different types of health insurance coverage.

Method

Source of data

The HRS (Health and Retirement Study) is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan. Data in our study are based on the HRS in 2018.[14] HRS is a nationally longitudinal survey, which has been fielded every 2 years since 1992. This dataset concentrates on middle aged and elderly individuals, which is representative of the middle aged and elderly population over the country. It provides information on a broad array of domains including income and wealth; health, cognition and use of healthcare services; work and retirement; and family connections. The samples of HRS are drawn based on a multi-stage area probability design, involving geographical stratification, clustering and oversampling of certain demographic groups. HRS includes data for over 37000 individuals over age 50 and 23000 households in the USA.[15]

Study Design

Figure 1 shows the flow chart for the analytic sample used in this study. There were 20,847 respondents in the 2018 HRS. There were 4,221 participants with a missing value in residence region and these participants were excluded first. There were 7,333 participants that had a missing value in Medicare coverage or not covered by Medicare and these participants were dropped as well. Additionally, we dropped 544 participants with missing value on demographic characteristics. The final analytic sample included 8,749 HRS respondents with reported Medicare coverage. We separated Medicare beneficiaries into 2 mutually exclusive groups based on health insurance coverage type: 1) there were 4,098 participants are only covered by Medicare (henceforth, group 1), and 2) there were 4,651 participants are covered by both Medicare and supplemental health insurance (e.g., Medicaid, VA/CHAMPUS, and private health insurance) (henceforth, group 2).

We did not exclude individuals who were covered by long-term care insurance from the Medicare-only group due to a large number of individuals with chronic diseases.

Dependent variables

We constructed four dependent variables. Two dummy variables for whether the individual had any hospital stay or doctor's visit in the last two years. The other two variables measured the number of hospital stays for survey respondents with an inpatient visit in the previous two years and the number of doctor's visits for those with an outpatient visit during the previous two years.

Independent variables

Our primary independent variable of interest was the Medicare beneficiaries' region of residence, defined based on their reported state of residence: 1) New England Division & Middle Atlantic Division; 2) East North Central Division & West North Central Division; 3) South Atlantic Division; 4) East South Central Division & West South Central Division; 5) Mountain Division & Pacific Division.

Other variables

Other variables included patient demographic characteristics: gender, age, educational level, total household annual income per capita (PCI), employment status and chronic disease conditions. Specific, we used Pew's study to categorize our income groups.[16] We categories PCI into three groups: lower income (<$13,367), middle income ($13,367-$40,133), and upper income (>$40,133).

Statistical Analysis

We compared characteristics of Medicare-only covered beneficiaries and beneficiaries with Medicare and supplemental insurance. Means and proportions were compared using chi-square tests. We modeled health care utilization of Medicare beneficiaries using multivariate regression models. Logistic regressions were used to model binary outcomes (any hospital stay, any doctor's visit in the past two years). The model specification is $\ln\left(\frac{p(x)}{1-p(x)}\right) = \alpha + \beta \cdot region + \gamma\theta$, α represents the intercept, p(x) represents the probability that individuals seek a doctor visit or a hospital stay, and γθ represents individual-level demographic, socioeconomic, and health characteristics. Negative binomial regressions were used to model count outcomes. To better reflect the variation of health care utilization, we used the country map to visualize hospital stays and doctor visits. The model specification is log

$(count\ of\ doctor\ visits\ or\ hospital\ stays) = \alpha + \beta \cdot region + \gamma\theta$, α represents the intercept, and γθ represents individual-level demographic socioeconomic, and health characteristics.

In order to visualize the relative difference directly, we graphed event ratios instead of the exact events in the national map as figure 2 shows. We set the New England & Mid Atlantic region as the reference group (i.e. event ratio = 1). The event ratio for other regions was calculated as hospital stays (in other regions)/hospital stays (the New England & Mid Atlantic region) or doctor's visits (in other regions)/doctor visits (the New England & Mid Atlantic region), separately. All our analyses are conducted with R 4.1.1.

Patient and public involvement

We report no patient or public involvement in the design or implementation of the study.

Results

Demographic Characteristics

Among individuals who were only covered by Medicare, 546, 885, 1,049, 755, and 863 individuals were in New England & Mid Atlantic regions, EN Central & WN Central regions, S Atlantic regions, ES Central & WS Central regions, and Mountain & Pacific regions, respectively. Among individuals who are both covered by Medicare and other health insurances, 720, 1,093, 1,151, 893, and 794 individuals are in each region category, respectively. ES and WS central regions had the highest percentage of individuals who were below age 65 (16.82%) and the lowest percentage of individuals who were over age 85 (11.39%). Mountain and Pacific regions had the lowest percentage of individuals who were below 65 (8.23%) and the highest percentage of individuals who were over 85 (12.86%) (Table 1).

Beneficiaries with less than a high school education were more concentrated in ES and WS central regions (29.93%) and less concentrated in EN and WN central regions (12.54%). Beneficiaries with a graduate degree were more concentrated in Mountain and Pacific regions (9.73%), but less concentrated in ES and WS central regions (5.83%). Considering the distribution of beneficiaries according to chronic diseases conditions reporting, ES and WS central regions had the highest percentage of individuals with more than one chronic disease (80.26%). Mountain and Pacific regions had the lowest percentage of individuals with more than one chronic disease (71.15%). ES and WS central regions had the highest percentage of lower income (<$13,367) individuals (89.8%), while Mountain and Pacific regions had the lowest percentage of lower income individuals (83.55%). In contrast, South Atlantic regions had the lowest percentage of

upper income (>$40,133) individuals (4.58%), while Mountain and Pacific regions had the highest percentage of upper income individuals (10.2%).

Among Medicare beneficiaries with supplemental insurances, there were significant variations in demographics across all residence regions (Table 1). Considering the distribution of health care utilization across regions, individuals living in the New England & Mid Atlantic regions had the highest number of hospital stays, while individuals living in the Mountain & Pacific regions had the lowest number of hospital stays (Figure 2). Individuals living in the South Atlantic regions had the highest number of doctor's visits, while individuals living in the East North & West North Central regions had the lowest number of doctor's visits (Figure 2).

ES and WS central regions had the highest percentage of individuals who were below 65 (16.35%) and the lowest percentage of individuals who were over 85 (10.41%) (Table 1). EN and WN central regions had the lowest percentage of individuals who were below 65 (12.08%) and the highest percentage of individuals who were over 85 (16.1%). The percentage of individuals without a high school degree was highest in ES and WS central regions (25.08%) and lowest in EN and WN central regions (10.16%). Conversely, the percentage of people with a graduate degree was highest in Mountain and Pacific regions (12.22%) and lowest in ES and WS central regions (6.72%). The percentage of individuals with at least one chronic condition was highest in ES and WS central regions (81.63%), and lowest in Mountain and Pacific regions (71.91%). Considering annual household income per capita, the percentage of individuals with lower income was highest in ES and WS central regions (89.25%) and lowest in Mountain and Pacific regions (81.99%). The percentage of individuals with higher income was highest in Mountain and Pacific regions (9.45%) and lowest in ES and WS central regions (4.48%).

Table 1: Descriptive Statistics

	Individuals Who Are Only Covered by Medicare (N=4,098)										Individuals Who Are Covered by Medicare and Other Health Insurance (N=4,651)									
Region	**New England & Mid Atlantic**		**EN Central & WN Central**		**S Atlantic**		**ES Central & WS Central**		**Mountain & Pacific**		**New England & Mid Atlantic**		**EN Central & WN Central**		**S Atlantic**		**ES Central & WS Central**		**Mountain & Pacific**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	N	%	N	%	N	%	N	%	N	%
Total	546	13.32	885	21.6	1,049	25.6	755	18.42	863	21.065	720	15.48	1,093	23.5	1,151	24.7[illegible]	893	19.2	794	17.07
Age																				
<65	60	10.99	75	8.47	118	11.25	127	16.82	71	8.23	111	15.42	132	12.08	142	12.34	146	16.35	105	13.22
65-74	198	36.26	317	35.82	386	36.8	271	35.89	354	41.02	286	39.72	429	39.25	462	40.14	365	40.87	346	43.58
75-84	187	34.25	360	40.68	418	39.85	271	35.89	327	37.89	228	31.67	356	32.57	414	35.9[illegible]	289	32.36	245	30.86
>85	101	18.5	133	15.03	127	12.11	86	11.39	111	12.86	95	13.19	176	16.1	133	11.5[illegible]	93	10.41	98	12.34
Gender																				
Male	229	41.94	373	42.15	424	40.42	311	41.19	367	42.53	281	39.03	445	40.71	472	41.0[illegible]	326	36.51	357	44.96
Female	317	58.06	512	57.85	625	59.58	444	58.81	496	57.47	439	60.97	648	59.29	679	58.9[illegible]	567	63.49	437	55.04
Race																				
NH White	364	66.67	699	78.98	595	56.72	351	46.49	513	59.44	464	64.44	864	79.05	740	64.2[illegible]	482	53.98	504	63.48
NH Black	115	21.06	146	16.5	323	30.79	223	29.54	71	8.23	151	20.97	186	17.02	309	26.8[illegible]	216	24.19	56	7.05
Hispanic	53	9.71	21	2.37	96	9.15	161	21.32	229	26.54	90	12.5	15	1.37	68	5.91	173	19.37	188	23.68
Other	14	2.56	19	2.15	35	3.34	20	2.65	50	5.79	15	2.08	28	2.56	34	2.95	22	2.46	46	5.79
Education																				
Less than high school education	101	18.5	111	12.54	204	19.45	226	29.93	152	17.61	137	19.03	111	10.16	190	16.5[illegible]	224	25.08	142	17.88
High School/GED	288	52.75	530	59.89	571	54.43	370	49.01	435	50.41	363	50.42	674	61.67	591	51.3[illegible]	474	53.08	376	47.36
Undergraduate	103	18.86	170	19.21	192	18.3	115	15.23	192	22.25	152	21.11	213	19.49	227	19.7[illegible]	135	15.12	179	22.54
Graduate	54	9.89	74	8.36	82	7.82	44	5.83	84	9.73	68	9.44	95	8.69	143	12.4[illegible]	60	6.72	97	12.22
Chronic disease																				
No chronic disease	36	6.59	60	6.78	57	5.43	32	4.24	68	7.88	52	7.22	68	6.22	60	5.21	32	3.58	61	7.68
Only one chronic disease	96	17.58	141	15.93	167	15.92	117	15.5	181	20.97	127	17.64	212	19.4	179	15.5[illegible]	132	14.78	162	20.4
More than one chronic disease	414	75.82	684	77.29	825	78.65	606	80.26	614	71.15	541	75.14	813	74.38	912	79.2[illegible]	729	81.63	571	71.91
Employment status																				

Full-time	19	3.48	40	4.52	54	5.15	31	4.11	55	6.37	50	6.94	68	6.22	72	6.26	64	7.17	56	7.05
Part-time	65	11.9	100	11.3	115	10.96	76	10.07	100	11.59	71	9.86	113	10.34	122	10.6	77	8.62	75	9.45
Unemployed	34	6.23	30	3.39	52	4.96	52	6.89	43	4.98	56	7.78	50	4.57	59	5.13	66	7.39	53	6.68
Retired	428	78.39	715	80.79	828	78.93	596	78.94	665	77.06	543	75.42	862	78.87	898	78.02	686	76.82	610	76.83
Household income																				
Lower income	468	85.71	755	85.31	932	88.85	678	89.8	721	83.55	631	87.64	894	81.79	976	84.8	797	89.25	651	81.99
Middle income	39	7.14	62	7.01	69	6.58	42	5.56	54	6.26	51	7.08	97	8.87	96	8.34	56	6.27	68	8.56
Upper income	39	7.14	68	7.68	48	4.58	35	4.64	88	10.2	38	5.28	102	9.33	79	6.86	40	4.48	75	9.45

(EN: East North; WN: West North; S: South; ES: East South; WS: West South; NH: Non-Hispanic; GED: General Educational Development)

Logistic regression Results

In terms of hospital stays, logistic regressions suggested that individuals living in Mountain & Pacific region were less likely to have a hospital stay than those residing in New England & Mid-Atlantic region among Medicare-only covered beneficiaries (OR=0.766, 95% CI= (0.594, 0.987)). However, there were no significant differences in the probability of having a hospital stay across different regions among Medicare beneficiaries with supplemental insurances (Table 2).

Age was significantly associated with hospital stays. Among Medicare-only covered beneficiaries, individuals aged over 85 were significantly more likely to have a hospital stay (OR=1.480, 95% CI= (1.109, 1.975)), compared to individuals under 65. Among Medicare beneficiaries with supplemental insurance, individuals aged between 65 and 74 were less likely to have a hospital stay (OR=0.722, 95% CI= (0.586, 0.889)). The results also suggested that education was not significantly related to hospital stays in both groups. The results also suggested that individuals with one chronic disease (OR=1.813, 95% CI= (1.158, 2.839)) and with more than one chronic disease (OR=3.579, 95% CI= (2.369, 5.406)) were more likely to have a hospital stay in group 1. In group 2, individuals with one chronic disease (OR=1.659, 95% CI= (1.098, 2.506)) and with more than one chronic disease (OR=3.832, 95% CI= (2.618, 5.609)) were also more likely to have a hospital stay. In terms of employment status, there was no significant differences in group 1. However, unemployment (OR=1.963, 95% CI= (1.316, 2.929)) and retired (OR=1.609, 95% CI= (1.181, 2.192)) individuals were more likely to have a hospital stay. In terms of household income, results suggested that only middle-income (≥13,367, and≤$40,133) individuals (OR=0.618, 95% CI= (0.447, 0.854)) were significantly less likely to have a hospital stay compared to lower income individuals in group 1. However, there was no significant differences related to household income in group 2 (Table 2).

In terms of doctor's visit, logistic regressions suggested that individuals in EN Central & WN Central region (OR=0.606, 95% CI= (0.374, 0.982)), S Atlantic region (OR=0.619, 95% CI= (0.392, 0.977)), ES Central & WS Central region (OR=0.472, 95% CI= (0.299, 0.746)), and Mountain & Pacific region (OR=0.618, 95% CI= (0.386, 0.99)) were less likely to have a doctor's visit than those residing in New England & Mid-Atlantic region among Medicare-only covered beneficiaries. However, there were no significant differences in the probability of having a doctor's visit among Medicare beneficiaries with supplemental insurances (Table 2).

There was no significant relationship between age and doctor's visits in both groups. Females were more likely to have a doctor's visit in both group 1 (OR=1.321, 95% CI= (1.042, 1.676)) and group 2 (OR=1.427, 95% CI= (1.084, 1.88)). Education was significantly related to doctor's visits in both group 1 and group 2. In group 1, individuals with a high school degree (OR=2.142, 95% CI= (1.627, 2.821)), a college degree (OR=3.147, 95% CI= (2.082, 4.755)), and a graduate degree (OR=2.875, 95% CI= (1.639, 5.042)) were more likely to have a doctor's visit, compared to individuals without a high school degree. In group 2, the results were similar. Individuals with a high school degree (OR=1.955, 95% CI= (1.403, 2.724)), a college degree (OR=2.712, 95% CI= (1.677, 4.384)), and a graduate degree (OR=5.095, 95% CI= (2.25, 11.535)) were more likely to have a doctor's visit, compared to individuals without a high school degree.

Results suggested that individuals with one chronic condition (OR=2.438, 95% CI= (1.558, 3.815) in Medicare-only covered individuals and OR=2.925, 95% CI= (1.72, 4.974) in Medicare beneficiaries with supplemental insurance) and those with more than one chronic condition (OR=3.891, 95% CI= (2.606, 5.81) in Medicare-only covered individuals and OR=3.845, 95% CI= (2.433, 6.078) in Medicare beneficiaries with supplemental insurance) were more likely to have a doctor's visit. We did not notice significant associations between the outcome variables and employment status in both groups, and between the outcome variables and household income in group 2. However, middle income (≥$13,367, and≤$40,133) individuals were more likely to have a doctor ' s visit (OR=2.44, 95% CI= (1.054, 5.648)) among Medicare beneficiaries with supplemental insurance, compared to lower income individuals (Table 2).

Table 2：Logistic Regression Results

	Individuals Who Are Only Covered by Medicare (N=4,089) and Individuals Who Are Covered by Medicare and Other Health Insurances (N=4,642) in Hospital Stay								Individuals Who Are Only Covered by Medicare (N=3,641) and Individuals Who Are Covered by Medicare and Other Health Insurances (N=3,910) in Doctor Visit							
Have a visit last two years (no=0, yes=1)	**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**				**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**			
	OR		**95%**	**CI**	**OR**		**95%**	**CI**	**OR**		**95%**	**CI**	**OR**		**95%**	**CI**
Region																
New England & Mid Atlantic	Ref				Ref				Ref				Ref			
EN Central & WN Central	0.999		0.784	1.272	1.103		0.896	1.359	0.606	**	0.374	0.982	1.072		0.671	1.713
S Atlantic	1.11		0.879	1.402	1.012		0.824	1.244	0.619	**	0.392	0.977	0.893		0.576	1.383
ES Central & WS Central	0.921		0.714	1.187	0.871		0.7	1.084	0.472	***	0.299	0.746	0.909		0.585	1.414
Mountain & Pacific	0.766	**	0.594	0.987	0.918		0.73	1.154	0.618	**	0.386	0.99	1.116		0.804	2.152
Age																
<65	Ref				Ref				Ref				Ref			
65-74	0.821		0.637	1.058	0.722	***	0.586	0.889	0.887		0.578	1.363	0.884		0.568	1.375
75-84	1.046		0.813	1.344	0.882		0.713	1.091	0.996		0.643	1.541	0.967		0.607	1.543
>85	1.48	***	1.109	1.975	1.261	*	0.982	1.62	0.77		0.466	1.273	0.621	*	0.37	1.043
Gender																
Male	Ref				Ref				Ref				Ref			
Female	0.755	***	0.654	0.871	1.002		0.879	1.143	1.321	**	1.042	1.676	1.427	**	1.084	1.88
Race																
NH White	Ref				Ref											
NH Black	0.85	*	0.704	1.026	0.961		0.807	1.144	0.477	***	0.35	0.65	0.763	***	0.389	0.813
Hispanic	0.822		0.647	1.044	0.767	**	0.603	0.976	0.283	***	0.204	0.394	0.481	***	0.189	0.418
Other	1.451	*	0.985	2.138	1.303		0.911	1.862	0.684		0.356	1.314	1.086		0.42	2.808
Education																
Less than high school education	Ref				Ref				Ref				Ref			
High School/GED	1.079		0.888	1.312	1.156		0.958	1.396	2.142	***	1.627	2.821	1.955	***	1.403	2.724

Undergraduate	1.167		0.917	1.485	1.123		0.892	1.414	3.147	***	2.082	4.755	2.712	***	1.677	4.384
Graduate	0.87		0.631	1.199	0.912		0.687	1.21	2.875	***	1.639	5.042	5.295	***	2.25	11.535
Chronic disease																
No chronic disease	Ref				Ref				Ref				Ref			
Only one chronic disease	1.813	***	1.158	2.839	1.659	**	1.098	2.506	2.438	***	1.558	3.815	2.925	***	1.72	4.974
More than one chronic disease	3.579	***	2.369	5.406	3.832	***	2.618	5.609	3.891	***	2.606	5.81	3.945	***	2.433	6.078
Employment status																
Full-time	Ref				Ref				Ref				Ref			
Part-time	1.025		0.668	1.573	1.046		0.721	1.518	1.008		0.529	1.923	1.047		0.784	3.458
Unemployed	1.112		0.676	1.83	1.963	***	1.316	2.929	0.805		0.384	1.69	2.004		0.874	4.599
Retired	1.22		0.835	1.781	1.609	***	1.181	2.192	0.989		0.561	1.744	1.531		0.828	2.832
Household income																
Lower income	Ref				Ref				Ref				Ref			
Middle income	0.618	**	0.447	0.854	0.854		0.663	1.1	0.657	*	0.412	1.047	1.44	**	1.054	5.648
Upper income	0.949		0.702	1.283	0.963		0.738	1.255	0.925		0.542	1.578	1.157		0.602	2.223

(EN: East North; WN: West North; S: South; ES: East South; WS: West South; NH: Non-Hispanic; GED: General Educational Development)

We show odds ratios here, and 95% CI in parentheses. Counts do not sum to 4,098 or 4,651 due to missing values for some of the independent variables.

***Significant at 1 percent level (two-tailed test).

**Significant at 5 percent level (two-tailed test).

*Significant at 10 percent level (two-tailed test).

Negative binomial regression results

In terms of hospital stays, results suggested that there was no difference in the incident rate among different regions among Medicare-only covered beneficiaries. However, individuals in EN Central & WN Central region (IRR=0.797, 95% CI= (0.691, 0.919)), ES Central & WS Central region (IRR =0.740, 95% CI= (0.634, 0.865)), and Mountain & Pacific region (IRR =0.726, 95% CI= (0.613, 0.859)) had fewer incident rates of hospital stays than those residing in New England & Mid-Atlantic region in group 2 (Table 3).

Individuals aged 65-74 years (IRR=0.802, 95% CI= (0.672, 0.957)), 75-84 years (IRR=0.781, 95% CI= (0.658, 0.927)), and over age 85 (IRR=0.785, 95% CI= (0.646, 0.954)) had significantly fewer incident rates of hospital stays in group 1, compared to individuals under 65. In group 2, the results were similar. Individuals who were aged 65-74 years (IRR=0.757, 95% CI= (0.658, 0.870)), 75-84 years (IRR=0.663, 95% CI= (0.575, 0.764)), and over age 85 (IRR=0.644, 95% CI= (0.545, 0.761)) had significantly fewer incident rates of hospital stays. In group 1, individuals with a high school degree had a significantly lower incident rate of hospital stays (IRR=0.824, 95% CI= (0.721, 0.943)), compared to individuals without a degree. In group 2, retired individuals (IRR=1.562, 95% CI= (1.185, 2.058)) had a higher incident rate of hospital stays, compared to individuals with a full-time job. However, we found that variables not significantly related to changes in the incident rate of hospital stays included chronic diseases, and household income in both groups, education in group 2, employment status in group 1 (Table 3).

In terms of doctor's visit, the results suggested that individuals in EN Central & WN Central region (IRR=0.743, 95% CI= (0.668, 0.826)), S Atlantic region (IRR=0.847, 95% CI= (0.763, 0.939)), ES Central & WS Central region (IRR=0.846, 95% CI= (0.755, 0.947)), and Mountain & Pacific region (IRR=0.806, 95% CI= (0.722, 0.900)) had lower incident rates of doctor's visits than those residing in New England & Mid-Atlantic region in group 1. In group 2, results suggested that individuals in EN Central & WN Central region (IRR=0.884, 95% CI= (0.797, 0.981)) had a lower incident rate of doctor's visits than individuals residing in New England & Mid-Atlantic region. However, individuals in S Atlantic region (IRR=1.157, 95% CI= (1.043, 1.283)) and Mountain & Pacific region (IRR=1.140, 95% CI= (1.017, 1.278)) had a higher incident rate of doctor's visits than those residing in New England & Mid-Atlantic region in group 2 (Table 3).

There was a significant relationship between age and doctor's visits in both groups. Individuals who were aged 65-74 years (IRR=0.748, 95% CI= (0.665, 0.840)), 75-84 years (IRR=0.733, 95% CI= (0.651, 0.824)), and over age 85 (IRR=0.717, 95% CI= (0.626, 0.822)) had significantly lower incident rates of doctor's visits in group 1, compared to individuals under 65. Individuals who were aged 65-74 years (IRR =0.719, 95% CI= (0.646, 0.801)), 75-84 years (IRR=0.686, 95% CI= (0.614, 0.767)), and over age 85 (IRR=0.781, 95% CI= (0.686, 0.890)) had significantly lower incident rates of doctor's visits in group 2. In terms of education, individuals with a college degree (IRR=1.174, 95% CI= (1.052, 1.310)) and a graduate degree (IRR=1.230, 95% CI= (1.073, 1.411) in group 1; IRR=1.208, 95% CI= (1.054, 1.385) in group 2) had higher incident rates of doctor's visit, compared to individuals without a degree. In terms of chronic disease, the results suggested that individuals with one chronic disease (IRR=1.712, 95% CI= (1.450, 2.021) in group 1; IRR=1.467, 95% CI= (1.243, 1.731) in group 2) and with more than one chronic disease (IRR=2.261, 95% CI= (1.941, 2.634) in group 1; IRR=2.262, 95% CI= (1.939, 2.639) in group 2) had more incident rate of doctor's visits. In terms of employment status, the results were similar between group 1 and group 2. Unemployed individuals (IRR=1.706, 95% CI= (1.363, 2.135) in group 1; IRR=1.351, 95% CI= (1.090, 1.674) in group 2) and retired individuals (IRR=1.358, 95% CI= (1.152, 1.602) in group 1; IRR=1.283, 95% CI= (1.089, 1.513) in group 2) had more incident rate of doctor's visits, compared individuals with a full-time job. Household income was not significantly related to incident rate of doctor's visits in both groups (Table 3).

Table 3: Negative Binomial Regression Results

	Individuals Who Are Only Covered by Medicare (N=1,126) and Individuals Who Are Covered by Medicare and Other Health Insurances (N=1,462) in Hospital Stay								Individuals Who Are Only Covered by Medicare (N=3,032) and Individuals Who Are Covered by Medicare and Other Health Insurances (N=3,307) in Doctor's Visit							
Visit times of last two years (visit >=1)	**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**				**Medicare Only (Group 1)**				**Medicare and Other Health Insurances (Group 2)**			
	IRR		**95%**	**CI**	**IRR**		**95%**	**CI**	**IRR**		**95%**	**CI**	**IRR**		**95%**	**CI**
Region																
New England & Mid Atlantic	Ref				Ref				Ref				Ref			
EN Central & WN Central	0.902		0.756	1.076	0.797	***	0.691	0.919	0.743	***	0.668	0.826	0.884	**	0.797	0.981
S Atlantic	1.047		0.886	1.236	0.903		0.784	1.039	0.847	***	0.763	0.939	1.157	***	1.043	1.283
ES Central & WS Central	1.058		0.882	1.270	0.740	***	0.634	0.865	0.846	***	0.755	0.947	0.997		0.893	1.115
Mountain & Pacific	0.882		0.728	1.069	0.726	***	0.613	0.859	0.806	***	0.722	0.900	1.140	**	1.017	1.278
Age																
<65	Ref				Ref				Ref				Ref			
65-74	0.802	**	0.672	0.957	0.757	***	0.658	0.870	0.748	***	0.665	0.840	0.819	***	0.646	0.801
75-84	0.781	***	0.658	0.927	0.663	***	0.575	0.764	0.733	***	0.651	0.824	0.786	***	0.614	0.767
>85	0.785	**	0.646	0.954	0.644	***	0.545	0.761	0.717	***	0.626	0.822	0.781	***	0.686	0.890
Gender																
Male	Ref				Ref				Ref				Ref			
Female	1.111	**	1.002	1.233	0.872	***	0.793	0.957	1.002		0.940	1.068	1.043		0.977	1.113
Race																
NH White	Ref				Ref				Ref				Ref			
NH Black	0.937		0.819	1.072	1.035		0.916	1.170	0.932		0.857	1.015	0.823	***	0.754	0.898
Hispanic	1.066		0.898	1.265	1.066		0.893	1.272	1.011		0.904	1.129	1.029		0.817	1.057
Other	0.813		0.605	1.093	1.081		0.853	1.371	1.359	***	1.135	1.628	1.172	*	0.974	1.410
Education																
Less than high school education	Ref				Ref				Ref				Ref			
High School/GED	0.824	***	0.721	0.943	1.117		0.976	1.277	1.048		0.957	1.149	0.929		0.842	1.025

Undergraduate	0.859		0.724	1.020	0.914		0.773	1.081	1.174	***	1.052	1.310	0.933		0.830	1.048
Graduate	0.873		0.689	1.107	0.934		0.750	1.162	1.230	***	1.073	1.411	1.208	***	1.054	1.385
Chronic disease																
No chronic disease	Ref				Ref				Ref				Ref			
Only one chronic disease	0.829		0.549	1.252	0.983		0.671	1.440	1.712	***	1.450	2.021	1.467	***	1.243	1.731
More than one chronic disease	1.109		0.760	1.619	1.261		0.884	1.799	2.261	***	1.941	2.634	2.262	***	1.939	2.639
Employment status																
Full-time	Ref				Ref				Ref				Ref			
Part-time	0.865		0.607	1.232	1.115		0.801	1.550	1.132		0.942	1.360	1.092		0.907	1.316
Unemployed	1.002		0.679	1.478	1.310		0.942	1.820	1.706	***	1.363	2.135	1.551	***	1.090	1.674
Retired	1.147		0.841	1.564	1.562	***	1.185	2.058	1.358	***	1.152	1.602	1.283	***	1.089	1.513
Household income																
Lower income	Ref				Ref				Ref				Ref			
Middle income	0.911		0.702	1.181	1.042		0.862	1.260	1.133	*	0.997	1.287	0.951		0.847	1.068
Upper income	0.892		0.702	1.133	0.941		0.764	1.159	0.974		0.859	1.106	0.931		0.822	1.054

EN: East North; WN: West North; S: South; ES: East South; WS: West South; NH: Non-Hispanic; GED: General Educational Development)

We show odds ratios here, and 95% CI in parentheses. Counts do not sum to 4,098 or 4,651 due to missing values for some of the independent variables.

***Significant at 1 percent level (two-tailed test).

**Significant at 5 percent level (two-tailed test).

*Significant at 10 percent level (two-tailed test).

Discussion

In our study, we used four health outcomes as the health care utilization metrics: 1) the probability of hospital stay, 2) the probability of doctor's visit, 3) the frequency of hospital stay, and 4) the frequency of doctor's visit. The regional variation is identified as the health care utilization metrics are different among different regions even though we have controlled demographic, health and socioeconomic characteristics. Based on our results, our analysis has identified significant regional variation in health care utilization among Medicare beneficiaries.

In terms of the logistic regression results in hospital stay, all ORs are not significant in both groups except Mountain & Pacific regions in group 1. In this case, we can conclude that regional variation does not exist most regions on the probability of a hospital stay. In terms of the logistic regression results in doctor's visit, all ORs are significant in group 1, while all ORs are insignificant in group 2. Therefore, regional variation exists in group 1, while it does not exist in group 2. We can also conclude that if Medicare beneficiaries are covered by other health insurance, regional variation can be reduced and even eliminated on the probability of doctor visit.

In terms of the negative binomial regression results in hospital stay, all ORs are not significant in group1, while all ORs are significant in group 2 except South Atlantic regions. In this case, regional variation exists in most regions in group 2, but it does not exist in group 1. Therefore, we can conclude that if Medicare beneficiaries are covered by other health insurance, regional variation can be reduced and even eliminated on the frequency of hospital stay. In terms of the negative binomial regression results in doctor's visit, all ORs are significant in both groups except ES Central & WS Central regions in group 2. In this case, regional variation exists in most regions in both groups and the coverage of health insurance does not affect the frequency of doctor's visits.

One potential explanation may be that narrow provider networks restricted access to care for Medicare beneficiaries.[17–19] Compared to New England and Mid-Atlantic regions, Medicare plans in other regions may not provide large enough provider networks.[18–20] Compared to Medicare beneficiaries with supplemental health insurance, Medicare-only beneficiaries are confronted with restrictions as an important barrier in health care access.[17,21] Other barriers to access like lack of transportation may further restrict access to health care for certain Medicare beneficiaries.[10] New England and Mid-Atlantic regions have better public transportations than other regions. Therefore, individuals in England and Mid-Atlantic regions may have less barrier

to access health care utilization. Bed availability and the number of physicians will also restrict health care utilization.[11,22] Moreover, physicians burn out are usually highly related to adverse health outcomes.[23]

We found that, compared to individuals with a full-time job, unemployed and retired individuals were more likely to have health care visits and also had a higher number of visits. These results are consistent with findings in other studies that show that individual's health is negatively related to economic profiles.[24,25] These studies also show reverse causality between lower health status and unemployment status. A potential reason is that poor health may cause longer unemployment spells.[26] Some studies also suggest that ill workers are more likely to become unemployed.[27–29] Moreover, this can also be a potential explanation for the regional variation estimated in health care utilization: Regions with different health care utilization may differ in their population's economic profiles. Unlike findings in previous studies, we found that household income was not significantly related to frequency of health care visits.[30,31]

Hospitalization usually spends than doctor visits. In order to control health care costs, we should concentrate on minimizing hospital visit and stay. However, I think doctor visits are high correlated with hospital stays. Hospital stay usually means patients have some serious issues. However, some serious disease can be avoided by early detections. For example, if individuals have more frequencies to health examination, they can detect their diseases earlier and therefore they can avoid diseases become more serious. In this case, individuals have more doctor visits can avoid potential hospital stays. As we mentioned above, regional variation means individuals in some regions have more or less health care utilizations than other regions even though they have similar demographic, health and socioeconomic characteristics. In other words, there are some regional factors will restrict or encourage individuals to have doctor visits or hospital stays. If individuals' needs of health care are restricted, they cannot get treatment in time and therefore cause much more health care costs in the future. If individuals' health needs are encouraged, they will consume more health resources even though they do not really need them. This is a waste of health care resources. Therefore, the ideal situation is that individuals in different regions have similar health care utilization if they have similar demographic, health and socioeconomic characteristics. If the regional variation exists, we also have to figure out a way to reduce or solve it. In our study, we have identified regional variations, and we also found that insurance coverage

has impact on regional variation. In this case, adjusting insurance coverage could be one potential strategy to reduce regional variations.

Policy Implications

There are several important implications of our research. First, regional variation broadly exists in Medicare beneficiaries. However, this variation is not in the same direction when considering different health care settings among different Medicare beneficiary groups. Second, although household income is not related to health care utilization, employment status is significantly associated with health care utilization. Unemployment and retired individuals seek more health care in both groups, especially in the outpatient setting. This suggests that unemployed individuals may need more care and potential assistance. Therefore, health care programs and reforms should increase health care access for unemployed and retired individuals. Finally, Health insurance coverage plays a role in changing regional variation. For different subgroups, the government can adjust different health insurance coverage to reduce regional variation.

Limitations

There are some important limitations in this study. First, we combined nearby regions to increase the sample size in selected region classifications. Each region has many states, so these average estimates may mask variation across states within the same region. Second, Medicare has undergone substantial changes including the growth of Medicare Advantage and the introduction of numerous pay-for-performance and value-based programs.[32,33] We cannot identify these specific plans in the HRS which limits our ability to assess the extent to which our estimated regional variations are driven by these different Medicare plans. Third, data were collected through a survey, which may lead to a recall bias. Fourth, our study was limited to general doctor's visits and hospital stays and we could not study any other specific health care services, due to data limitations. Finally, the sample weight this time is not available. Therefore, we cannot adjust our results by sampling weights, which leads to a potential selection bias. Notwithstanding these limitations, our study provides a general landscape of health care utilization among Medicare beneficiaries.

Conclusion

Regional variation exists in health care utilization for Medicare beneficiaries, and regional variation also changes in beneficiaries with different types of coverage. Specifically, Regional variation in the likelihood of having a doctor's visit was reduced in Medicare beneficiaries covered by

supplemental health insurance. Regional variation in hospital stays was accentuated among Medicare beneficiaries covered by supplemental health insurance. Further studies are needed to elicit the reasons explaining these variations.

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Competing interests

None declared.

Patient consent for publication

Not required.

Ethics statements

Patient consent for publication

Not applicable.

Ethics approval

Ethics approval was not required since this is an analysis of publicly available secondary data (Health and Retirement Study).

Data availability statement

Data are available in a public, open access repository (https://hrsdata.isr.umich.edu/data-products/rand-hrs-longitudinal-file-2018?_ga=2.258979978.1890758364.1616690587-360856504.1616690587)

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Figure 1: Flow Chart for Study Participant from the 2018 HRS Survey

Figure 2: Average Number Ratio of Hospital Stays/Doctor Visits

Figure 1: Flow Chart for Study Participant from the 2018 HRS Survey

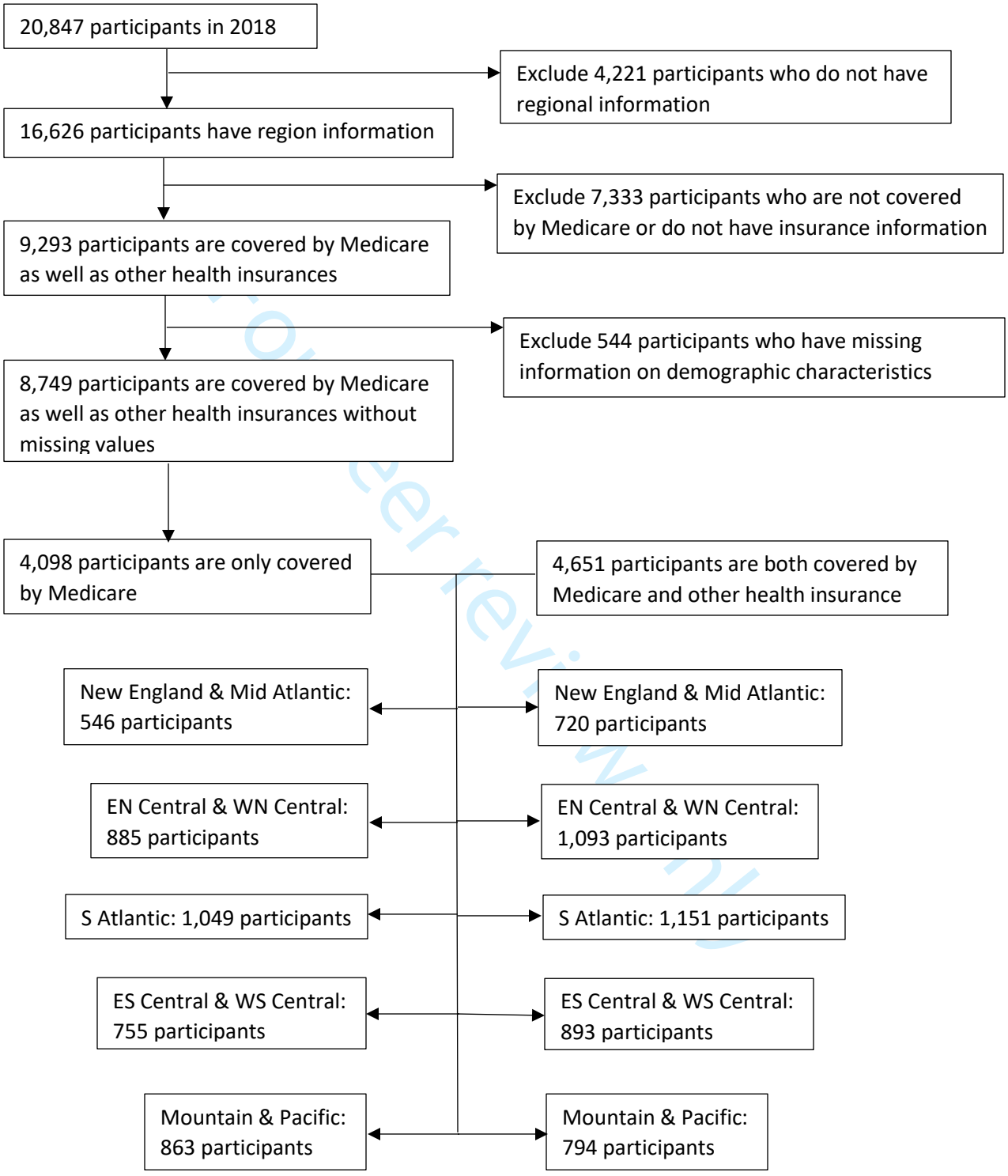
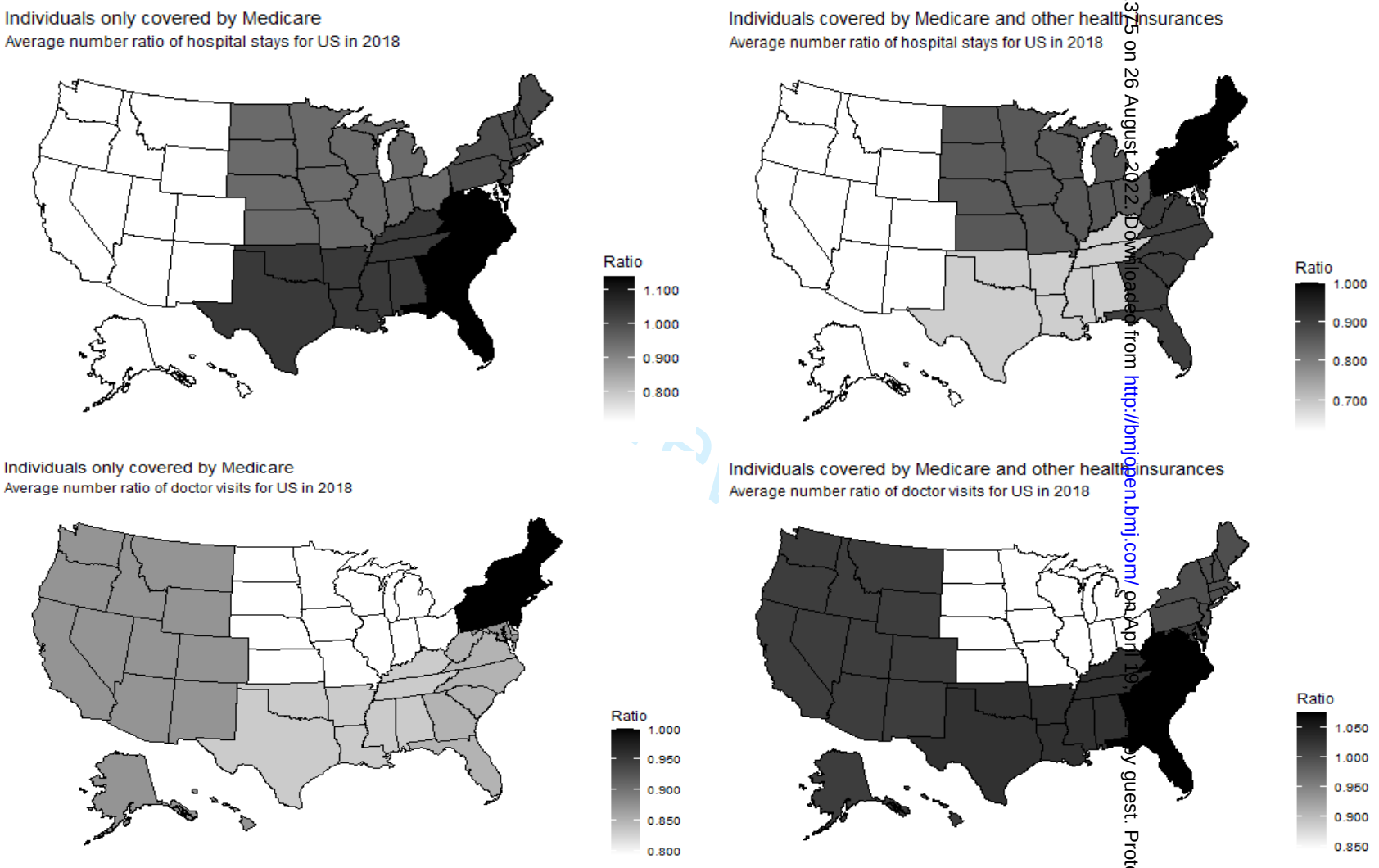


Figure 2: Average Number Ratio of Hospital Stays/Doctor Visits



We set the New England & Mid Atlantic region as the reference group (i.e. event ratio = 1). The event ratio for other regions was calculated as overall hospital stays (in other regions)/ overall hospital stays (the New England & Mid Atlantic region) or overall doctor's visits (in other regions)/ overall doctor visits (the New England & Mid Atlantic region), separately.