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Role of health insurance and neighborhood-level social deprivation on hypertension control following the Affordable Care Act health insurance opportunities

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Introduction

Approximately 29.0% of US adults had hypertension in 2015–2016,¹ and the prevalence is projected to continue increasing over time.² Treatment and management of hypertension are important since it is a major risk factor for cardiovascular disease.³ Having health insurance impacts access to needed care,⁴ and people with limited access to care can incur negative hypertension outcomes.⁵ Health insurance facilitates blood pressure monitoring and receipt of antihypertensive medications.⁶ Therefore, increasing access to healthcare via health insurance is likely to improve hypertension treatment, management, and control.⁷ Health insurance also helps patients maintain a regular source of care,⁸ which is associated with improved hypertension treatment and control.⁹ Thus, health insurance is likely to reduce disparities in access to needed healthcare for hypertension and other health conditions. The Affordable Care Act (ACA) Medicaid expansion, which expanded Medicaid eligibility to individuals earning 138% of the federal poverty level (FPL) living in US states that

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implemented the expansion, created an opportunity for many patients to gain Medicaid coverage. In addition, health insurance marketplaces provided a way for individuals to gain private health insurance coverage, which led to significant growth in coverage.¹⁰ Many patients seen in community health centers, our nation's healthcare safety net, were positively impacted by the ACA health insurance opportunities, as CHCs serve predominantly uninsured and publicly-insured patients (82%).¹¹ Medicaid-insured visits in community health centers increased 60% post-ACA Medicaid expansion in states that expanded Medicaid.¹²

Health insurance and a regular source of care are not the only factors that contribute to hypertension screening, treatment, and control disparities. Neighborhood-level social determinants of health (SDH) may also influence hypertension control rates, but research to date is mixed. For example, higher neighborhood poverty and racial segregation are associated with worse hypertension control compared to lower neighborhood poverty and segregation.^{13,14} However, other research found participants living in more economically deprived areas received the same, or better, care for hypertension compared to less deprived areas.¹⁵ To help answer some of these unanswered questions, we used patient-level electronic health record data and neighborhood-level social deprivation information to understand the influence of neighborhood-level SDH on the relationship between health insurance and hypertension management.

Methods

Data and Study Population

We used electronic health record (EHR) data from the Accelerating Data Value Across a National Community Health Center Network (ADVANCE) clinical data research network from five states that expanded Medicaid eligibility on 1/1/2014 (CA, OH, OR, WA, WI). We included WI as an expansion state, as we have in previous papers.^{12,16} We observed patients 2 years prior to the ACA (pre-period: 1/1/2012–12/31/2013) and 4 years following ACA implementation (post-period: 1/1/2014–12/31/2017).

The study sample was comprised of primary care clinics who had fully implemented their EHR prior to the beginning of the study period and remained “live” on EHR during the full study period and who contributed at least 5 eligible patients (resulting in 89 study clinics). From these clinics, we included patients aged 19–64 because this is the age group that was most likely to gain coverage due to the ACA. Public health insurance coverage has (and has historically had) more generous eligibility for children under the Children's Health Insurance Program, and patients' 65 are likely eligible for Medicare (not Medicaid). Additionally, we excluded women during pregnancy because Medicaid has different eligibility criteria for pregnant women: they were included during times in the study period when they did not report being pregnant at an encounter.

Patients entered the study after being diagnosed with hypertension and had to have been diagnosed prior to ACA Medicaid expansion implementation on 1/1/2014. Further, patients had to have at least one ambulatory visit with a primary care provider in both the pre- and post-periods. Diagnoses were classified using International Classification of Diseases codes

(ICD-9: 401.00–401.99, 402.00–405.99 or ICD-10: I10–I13, I15) obtained from either the problem list or encounter diagnosis. Patients were also required to have reported address data within the study period that could be geocoded to a census tract to estimate a measure of neighborhood-level social deprivation.

Outcome

Controlled hypertension was defined as a binary indicator of whether a patient's blood pressure (BP) was within a normal range: <140 mm Hg systolic (SBP) and <90 mm Hg diastolic (DBP); if no valid BP was recorded at a visit during the measurement year, the patient was classified as "not controlled."¹⁷ We used hypertension data from the EHR (no home measurements were included) measured at the last eligible visit in the clinic in each year; blood pressure was measured by whichever method each clinic used. If a patient did not have an eligible visit in a certain year, they did not contribute an observation for that year. If more than one blood pressure measurement occurred on the same day and at least one reading was normal, we considered blood pressure normal for that day. Readings between 50 and 260 mmHg for SBP and between 0 and 200 mmHg for DBP were considered biologically plausible values.

Main Independent Variable

We defined the four insurance groups: newly insured, continuously insured, discontinuously insured, and continuously uninsured, in the following way:¹⁸

- *Newly insured* - uninsured at all visits in the pre-period and had all visits in the post-period paid by Medicaid or private payer.
- *Continuously insured* - all visits paid by Medicaid or private payer in both the pre- and post-periods.
- *Discontinuously insured* - some visits with coverage in both the pre- and post-periods; at least one visit without insurance coverage in either the pre- or post-period.
- *Continuously uninsured* - no coverage for all visits in both the pre- and post-periods.

Moderator

The national percentile ranked Social Deprivation Index (SDI) score is a validated measure that includes the proportion of single parent families, poverty, population with less than a high school diploma, unemployment, and car ownership in a geographic area.¹⁹ Higher scores indicate more area-level deprivation. The measure was built with the American Community Survey 5-year period estimate from 2011–2015. Patients were assigned a representative SDI score at their census tract of longest duration between 2012 – 2017; excluding those listing homelessness or a shelter as their address. Ongoing addresses (those with no end date) were censored to the date of patient's last ambulatory visit, regardless of encounter criteria, in study period. Additionally, addresses reported before 1/1/2012 and after 12/31/2017 were masked to those respective dates.

Patients living in areas with an SDI score in the highest observed quartile (SDI scores between 90 and 100) were identified as the most deprived and compared to patients with SDI scores less than 90. Preliminary analysis suggested that the lower three quartiles displayed similar rates of hypertension control over time so we proceeded with a binary representation of SDI level. Our population was skewed toward higher deprivation compared to national percentiles because the population getting care at safety net clinics is often more disadvantaged than the general population.²⁶

Covariates

Covariates included age at first eligible visit in the pre-period (19–34, 35–49, or 50–64 years old); sex (female or male); race/ethnicity (Hispanic, non-Hispanic white, non-Hispanic black, non-Hispanic other, or unknown); and expansion state (CA, OH, OR, WA, or WI) in which patient resided during study period indicated by assigned census tract, as described above. Additionally, several pre-period variables were included. The number of pre-ACA eligible visits (1–2, 3–4, 5–9, 10) between 1/1/2012 and 12/31/2013; the most frequently occurring FPL at these visits (< 138%, ≥ 138%, or missing); the patient's Charlson Comorbidity Index Score in 2013 (< 2, 3–4, ≥ 5);²⁰ and whether the patient was prescribed any anti-hypertensive medication (yes or no) at the time of or after hypertension diagnosis and prior to 1/1/2014.

Statistical Analysis

First, we described our study population by insurance group. Next, we used logistic mixed effects models to derive the predicted probabilities of controlled hypertension in 2012, 2014, and 2017 and compared these across insurance and SDI groups. Year was represented as a linear spline with one knot at 2014 – the year of ACA implementation. This allowed changes in the likelihood of controlled hypertension to change with ACA Medicaid expansion implementation. Unadjusted profile plots (Appendix Figures 3 and 4, Appendix Table 1) suggested that directional trends in hypertension control were relatively constant in the pre- and post-period for each group. Use of random intercepts for patients and clinics and a random slope for year accounted for temporal correlation of observations within patients and clustering of patients within clinics. Controlled hypertension was regressed on insurance group, SDI category (most deprived vs. less deprived), and year spline terms, including interactions between these variables. All models adjusted for sex, age category at first eligible ambulatory visit, race/ethnicity, number of ambulatory care visits, state, FPL, Charlson Comorbidity Index Score, and anti-hypertensive medication prescription.

Data were prepared for analysis in R version 3.5.1 (R Core Team, Vienna, Austria) and all statistical analyses were performed in Stata, version MP 15.1 (StataCorp LLC, College Station, TX). The study was approved by our Institutional Review Board.

Results

Patient Population

Our total population included 28,485 patients (Table 1), 10.7% of which were newly insured, 43.2% continuously insured, 7.9% continuously uninsured, and 38.1% discontinuously

insured across the study period. Several patient characteristics differed by insurance status. For example, 55.7% of continuously uninsured were Hispanic, whereas 25.6% were non-Hispanic white. Among newly insured patients, 83.2% had an FPL of $\geq 138\%$ compared to 69.0% among the continuously insured. The proportion of patients in the most deprived neighborhoods was highest in the continuously uninsured group and lowest among the newly insured.

Hypertension Control by Health Insurance Group

All insurance groups saw an improvement in hypertension control from 2012 to 2017, but some experienced greater improvement than others. The likelihood of control for the newly insured increased 8.6% from 57.3% [95% confidence interval (CI): 55.0%–59.6%] in 2012 to 65.9% (95% CI: 63.6%–68.1%) in 2017, while the likelihood of control for the continuously uninsured only increased 0.9% from 60.1% (95% CI: 57.6%–62.7%) in 2012 to 61.0% (95% CI: 58.1%–63.9%) in 2017. Among continuously insured patients, the predicted rate of control in 2012 was 64.2% (95% CI: 62.7%–65.7%) and increased 1.3% to 65.5% (95% CI: 64.0%–66.9%) in 2017. Control improved among the discontinuously insured, where the probability of control increased 3.0% from 60.7% (95% CI: 59.2%–62.3%) to 63.7% (95% CI: 62.2%–65.2%) from 2012 to 2017. Moreover, in 2012 the newly insured group had a significantly lower likelihood of controlled hypertension compared to patients with at least some insurance (the continuously and discontinuously insured), by 2017 they had a significantly higher probability of control than both patients who remained uninsured ($p=0.003$) and those that had been discontinuously insured ($p=0.046$). By 2017, they had a similar predicted rate of control to patients that had always been insured.

Hypertension Control by Health Insurance Group and Social Deprivation

Adjusted likelihood of hypertension control for patients living in less deprived areas was similar to the overall trends by insurance group. Conversely, the newly insured group living in the most deprived neighborhoods had a noticeable increase in hypertension control over the study period compared to the other insurance groups. Newly insured patients in the most deprived neighborhoods had the highest probability of control in 2017 at 69.0% (95% CI: 64.5%–73.5%) compared to having the lowest probability in 2012 (52.7%; 95% CI: 48.1%–57.2%).

Discussion

Hypertension control increased among all groups regardless of insurance status. However, gains were largest among the newly insured who saw an 8.6% increase in hypertension control from pre- to post-ACA Medicaid expansion, compared to the continuously insured (1.3%), discontinuously insured (3.0%), and continuously uninsured (0.9%). Furthermore the greatest increase in hypertension control occurred among newly insured patients living in the most deprived neighborhoods where we found a 16% increase in hypertension control from pre- to post-ACA Medicaid expansion. These results demonstrate that gaining health insurance improves hypertension control, especially for individuals living in the most disadvantaged neighborhoods, therefore reducing disparities in chronic condition control.

The clinical impact of this improvement is expected to result in important health outcomes as previous evidence shows that 10% improvement in hypertension control is associated with 11.01 fewer heart failure events for African Americans and 4.44 fewer heart failure events for all races per 100,000 person years.²¹ These gains in hypertension management might account for some of the health outcome gains reported in previous research that demonstrated cardiovascular mortality reductions after ACA Medicaid expansions.²²

Continuously uninsured and continuously insured individuals had smaller increases in hypertension control, and when comparing all four groups in 2017, rates of control were lowest among the continuously uninsured group (61.0% versus 65.5% continuously insured), providing further evidence of the relationship between health insurance and hypertension control.

Hypertension control rates (<140/90 mmHg) in our study were higher than those reported by the National Health and Nutrition Examination Survey (NHANES), 48.3% in 2015–2016,¹ but similar to those reported by health center program grantees (63%) drawn from the Uniform Data System (UDS) used by Health Resources and Services Administration.¹¹ Differences between NHANES and UDS rates might be related to how hypertension is measured and reported, that blood pressure readings in NHANES are not part of a healthcare visit, and/or could be related to community health centers' quality improvement activities and approach to delivering high-quality care to vulnerable populations. Another national benchmark, the National Committee for Quality Assurance (NCQA), reported 2018 hypertension control rates (also defined as <140/90 mm Hg) as 61% among commercially-insured individuals and 59% among individuals insured by Medicaid health maintenance organizations.²³ All of these numbers; however, fall far short of the Millions Hearts 2022 goal of 80% hypertension control.²⁴

The group benefiting most from gaining health insurance were patients living in the most deprived neighborhoods rather than those from less deprived areas. Among those in areas of highest deprivation (most disadvantaged group), newly insured individuals had significantly greater increases in hypertension control than those who were continuously, discontinuously, or never insured. This finding suggests that newly insured individuals living in the most disadvantaged neighborhoods, with the lowest rates of control to begin with, experienced the greatest benefit from gaining health insurance and suggest that access to health insurance is an important facilitator of reducing health disparities. Though further investigation is needed as to the reasons behind this finding, we suspect that those living in the most deprived neighborhoods had the fewest financial resources and that gaining health insurance allowed them to access healthcare, including medications. Indeed, individuals with hypertension and no health insurance are almost three times less likely to take antihypertensive medications⁵ and are also less likely to seek healthcare compared to those with health insurance.²⁵ Although community health centers provide healthcare regardless of a patient's ability to pay,¹¹ uninsured visits can still incur a fee and adding that fee to medication costs may make it impossible for patients living in the most economically deprived areas to adhere to a medication regime and other interventions that enable them to get their hypertension under control.

Limitations

Our study has several limitations. First, as with any real-world study, unobserved changes might occur over time, making it difficult to isolate the effect of gaining ACA Medicaid coverage on hypertension control. Second, there was evidence that patients in the newly insured group were improving prior to 2014 – when they were still uninsured. As the continuously uninsured group did not exhibit a similar increase in hypertension control during the pre-period, there may be unobserved characteristics that differentiated patients who gained insurance with the implementation of the ACA Medicaid expansion from those that remained uninsured after implementation. Third, we used SDI score for patient's census tract of longest duration between 2012 – 2017, which did not account for the possibility of a patient moving from one community to another or the length of time at an address prior to 2012. Fourth, the 'continuously insured' may have had a mixture of public to private or private to public coverage, but we selected only patients from Medicaid expansion states and observed that 80.1% of encounters among this group were paid by Medicaid. Thus, given the patient sample and setting, the continuously insured were predominantly low-income patients with Medicaid throughout the entirety of the study period. Lastly, we included 89 community health centers in 5 states that expanded Medicaid, which may not be representative of all community health centers or all states.

Conclusions

Compared with other modifiable cardiovascular risk factors, elevated blood pressure is the largest single contributor to all-cause mortality (30%) and cardiovascular mortality (41%) in the US population.^{26,27} Improving hypertension control by over 10% is clinically important and could lead to substantial numbers of averted cardiovascular events and death.²⁸ Here, we found an increase in hypertension control of 16% among those newly insured living in the most deprived neighborhoods. Thus, ensuring access to health insurance is important for the cardiovascular health of the population and reduces health disparities. This may be even more important for those living in states that chose not to expand Medicaid, as they likely cannot afford private coverage of any type and have been left continuously uninsured. Furthermore, focused efforts to improve hypertension control among the most disadvantaged populations will have a particularly large impact on mortality and decrease disparities in adverse cardiovascular outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Hypertension control gains were largest among the newly insured.
- Newly insured in the most deprived neighborhoods improved hypertension control by 16%.
- Efforts focused on deprived neighborhoods will decrease disparities.

Figure 1: Predicted probability of hypertension control by health insurance group and year
Adjusted for: sex, age category at first eligible ambulatory visit*, race/ethnicity, number of ambulatory care visits*, state, federal poverty level*, Charlson Comorbidity Index Score*, anti-hypertensive medication prescription**

*Pre-ACA Medicaid expansion, **Pre-ACA Medicaid expansion and after hypertension diagnosis

Figure 2: Predicted probability of hypertension control by insurance group, and Social Deprivation Index, and year

Adjusted for: sex, age category at first eligible ambulatory visit*, race/ethnicity, number of ambulatory care visits*, state, federal poverty level*, Charlson Comorbidity Index Score*, anti-hypertensive medication prescription**

*Pre-ACA Medicaid expansion, **Pre-ACA Medicaid expansion and after hypertension diagnosis

Table 1.

Patient demographics by health insurance group

		Total N (%)	Newly Insured N (%)	Continuously Insured N (%)	Discontinuously Insured N (%)	Continuously Uninsured N (%)
Total		28485 (100.0)	3054 (10.7)	12314 (43.2)	10853 (38.1)	2264 (7.9)
Gender	<i>Female</i>	15746 (55.3)	1485 (48.6)	6846 (55.6)	6459 (59.5)	956 (42.2)
	<i>Male</i>	12739 (44.7)	1569 (51.4)	5468 (44.4)	4394 (40.5)	1308 (57.8)
Age group at first eligible visit*	<i>19–34</i>	3270 (11.5)	287 (9.4)	1599 (13.0)	1119 (10.3)	265 (11.7)
	<i>35–49</i>	12492 (43.9)	1259 (41.2)	5131 (41.7)	4930 (45.4)	1172 (51.8)
	<i>50+</i>	12723 (44.7)	1508 (49.4)	5584 (45.3)	4804 (44.3)	827 (36.5)
Race/ethnicity	<i>NH White</i>	14369 (50.4)	1884 (61.7)	7071 (57.4)	4835 (44.5)	579 (25.6)
	<i>Hispanic</i>	7163 (25.1)	482 (15.8)	2434 (19.8)	2987 (27.5)	1260 (55.7)
	<i>NH Black</i>	5251 (18.4)	471 (15.4)	1949 (15.8)	2495 (23.0)	336 (14.8)
	<i>NH Other</i>	1177 (4.1)	141 (4.6)	612 (5.0)	362 (3.3)	62 (2.7)
	<i>Unknown</i>	525 (1.8)	76 (2.5)	248 (2.0)	174 (1.6)	27 (1.2)
Patient's state of residence	<i>CA</i>	7379 (25.9)	128 (4.2)	4981 (40.4)	2142 (19.7)	128 (5.7)
	<i>OH</i>	3945 (13.8)	392 (12.8)	999 (8.1)	2161 (19.9)	393 (17.4)
	<i>OR</i>	14474 (50.8)	2219 (72.7)	5262 (42.7)	5487 (50.6)	1506 (66.5)
	<i>WA</i>	1368 (4.8)	228 (7.5)	514 (4.2)	493 (4.5)	133 (5.9)
	<i>WI</i>	1319 (4.6)	87 (2.8)	558 (4.5)	570 (5.3)	104 (4.6)
Number of visits*	<i>1–2</i>	5792 (20.3)	983 (32.2)	2561 (20.8)	1563 (14.4)	685 (30.3)
	<i>3–4</i>	5623 (19.7)	762 (25.0)	2334 (19.0)	1954 (18.0)	573 (25.3)
	<i>5–9</i>	9494 (33.3)	863 (28.3)	4060 (33.0)	3863 (35.6)	708 (31.3)
	<i>10+</i>	7576 (26.6)	446 (14.6)	3359 (27.3)	3473 (32.0)	298 (13.2)
Federal Poverty Level (mode)*	<i>138%</i>	21309 (74.8)	2540 (83.2)	8498 (69.0)	8509 (78.4)	1762 (77.8)
	<i>>138%</i>	3837 (13.5)	396 (13.0)	1458 (11.8)	1555 (14.3)	428 (18.9)
	<i>Missing</i>	3339 (11.7)	118 (3.9)	2358 (19.1)	789 (7.3)	74 (3.3)
Charlson Comorbidity Index score*	<i>2</i>	14462 (50.8)	1577 (51.6)	5691 (46.2)	5644 (52.0)	1550 (68.5)
	<i>3–4</i>	6865 (24.1)	785 (25.7)	3001 (24.4)	2616 (24.1)	463 (20.5)
	<i>5+</i>	7158 (25.1)	692 (22.7)	3622 (29.4)	2593 (23.9)	251 (11.1)
Received prescription for any anti-hypertensive medication**	<i>No</i>	3730 (13.1)	406 (13.3)	1853 (15.0)	1193 (11.0)	278 (12.3)
	<i>Yes</i>	24755 (86.9)	2648 (86.7)	10461 (85.0)	9660 (89.0)	1986 (87.7)
Social Deprivation Index level	<i>Less deprived</i>	21692 (76.2)	2438 (79.8)	9501 (77.2)	1739 (76.8)	8014 (73.8)

		Total N (%)	Newly Insured N (%)	Continuously Insured N (%)	Discontinuously Insured N (%)	Continuously Uninsured N (%)
	<i>Most deprived</i>	6789 (23.8)	616 (20.2)	2810 (22.8)	525 (23.2)	2838 (26.2)

NH: non-Hispanic

* Pre-ACA Medicaid expansion,

** Pre-ACA Medicaid expansion and after hypertension diagnosis

Table 2:

Predicted likelihood of hypertension control by health insurance group, deprivation level, and year

		2012		2014		2017	
		%	95% CI	%	95% CI	%	95% CI
All patients	Newly insured	57.26	54.95,59.57	61.82	59.76,63.89	65.87	63.62,68.13
	Continuously insured	64.23	62.72,65.74	63.24	61.75,64.72	65.46	64.00,66.93
	Continuously uninsured	60.12	57.57,62.66	60.95	58.64,63.25	61.00	58.13,63.86
	Discontinuously insured	60.72	59.17,62.28	61.73	60.23,63.24	63.68	62.19,65.16
Less deprived patients (Social Deprivation Index score < 90)	Newly insured	58.70	56.21,61.19	61.68	59.47,63.89	64.89	62.43,67.35
	Continuously insured	63.93	62.34,65.53	62.82	61.26,64.37	65.92	64.37,67.46
	Continuously uninsured	60.21	57.40,63.02	62.37	59.86,64.88	61.55	58.40,64.69
	Discontinuously insured	60.26	58.60,61.92	61.93	60.35,63.52	63.68	62.08,65.27
Most deprived patients (Social Deprivation Index score ≥ 90)	Newly insured	52.69	48.13,57.24	62.27	58.34,66.21	69.00	64.52,73.48
	Continuously insured	65.16	62.76,67.55	64.57	62.33,66.81	64.02	61.60,66.44
	Continuously uninsured	59.82	55.00,64.65	56.43	52.15,60.70	59.26	53.46,65.05
	Discontinuously insured	62.21	59.84,64.57	61.10	58.86,63.34	63.68	61.37,66.00

CI: confidence interval